ANNEX-E

SYSTEM MANAGEMENT

ANNEX - E

SYSTEM MANAGEMENT

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1. PRESENT WATER MANAGEMENT

1.1 Present Water Sources

All the six (6) systems depend on the unregulated river flow for their water sources. Any of the systems has reportedly experienced no water deficit according to the system offices.

Since the actually irrigated areas have been always much smaller than the originally designed and generated ones in any of the systems although no water deficit was reported, availability of water sources has been examined for diversion water requirement for each maximum service area of the systems, and the results are summarized as follows.

The Bonga Pump #1, #2 and #3 Irrigation Systems (IS), being dependent on the Bonga river, are expected to be satisfactorily fed by the river with a possibility of slight water deficit occurring once in 21 years for the respective maximum service areas according to the results of low flow analyses shown in ANNEX-B METEOROLOGY AND HYDROLOGY and diversion water requirement discussed in Chapter 6 of this report.

The Cagayan river, water source for the Alcala-Amulung and Solana Pump Irrigation Systems (PIS), could and would be able to serve these systems sufficiently according to the low flow analysis on the Cagayan river presented in the Master Plan Study on the Cagayan River Basin Water Resource Development (See IR-234 and -235).

The Libmanan-Cabusao PIS, taking irrigation water through the Sipocot pumping station from the Libmanan river, could be served sufficiently for the maximum service area with a possible occurrence of water deficit in three out of 24 cropping seasons, according to the result of the water balance calculation during 1975-86.

Brief information on the present water sources for the PISs is shown in Table 1.1.

1.2 Prevailing Irrigation Plan

1.2.1 General

The System Management Department (SMD) of the National Irrigation Administration (NIA) has prepared A Basic Consideration on Irrigation Water Management (See IR-309) and A Standard of Operation and Maintenance Plan for Irrigation Systems Management (See IR-304).

An annual operation plan for the Pumping Irrigation Systems (PIS) as well as the National Irrigation System (NIS) is prepared and submitted to the NIA central office for its approval two (2) months before the scheduled date of initial water delivery for every dry season crop by the respective field system offices. The operation plan is reviewed and authorized by the NIA central office. Upon approval of the the operation plan, irrigation schedule is announced to beneficiary farmers by the system offices. In preparation of the operation plan, the above-mentioned Basic Consideration and Standard Irrigation Plan are generally referred to by any of the system offices.

1.2.2 Procedure for Preparing Operation Plan (See IR-304)

A standard procedure for preparing operation plan adopted by the system office is as follows:

i) Calculation of monthly available water supply;
ii) Calculation of monthly effective rainfall;
iii) Calculation of irrigation water requirement;
iv) Calculation of program area to be irrigated;
v) Computation of weekly land soaking area; and
vi) Project weekly progress of farming activities.

The monthly available water supply is defined to be the smallest among the following:

- mean river discharge for the last 5-10 years;
- mean discharge diverted for the last 5-10 years in case of absence of river discharge record;
- canal/structure capacity; or
- actual pump capacity.

The monthly effective rainfall is prescribed to be an average effective rainfall during the last 5-10 years except extraordinary wet or dry year(s). In case daily rainfall is equal to or less than 50 mm, all rainfall is regarded effective, while in case daily rainfall exceeds 50 mm, that of 50 mm is considered to be fully effective.

In the pumping irrigation system, the effective rainfall prescribed is employed only for estimating cost for energy consumption by the pumps, which is needed for budgeting for the coming year of the system office. This prescribed effective rainfall is not considered in the actual operation, but part of rainfall is utilized for farming by suspending pump operation for a certain period after rainfall.

1.2.3 Parameters Adopted (See IR-304)

(1) Soil Saturation Requirement : Sn

In the absence of actual field data, the soil saturation requirement for each soil texture is recommended to be calculated by the following equation;

$$Sn = \{(Sc-Mc) \times Bd\}/100 \times Drz \quad \text{----------------} \quad (Eq.1)$$

Where:
Sc = soil saturation capacity (in weight %)
Mc = soil residual moisture (in weight %)
Mc = Pwp --- for wet season crop
Mc = (Fc+Pwp)/2 --- for dry season crop
where; Pwp = permanent wilting point (%)
Fc = field capacity (%)
Bd = bulk density
Drz = depth of root zone for paddy (300 mm)

A soil saturation period is recommended to be one week.

(2) Ponding Water : S

S = s ---------------------------------- (Eq.2)

where: S = ponding depth (mm)

(3) Land Preparation Requirement : Lp

Lp = Ev + P ---------------------------------- (Eq.3)

Where: Lp = land preparation requirement (mm/day)
Ev = evaporation (mm/day)
P = deep percolation (mm/day)

Evaporation (Ev) data are recommended in IR-309 to be obtained by a tank observation or to get data from a pilot area. In case no actual measurement data are available, the approximate Ev values recommended in IR-309 are 3 mm/day for the wet season and 5 mm/day for the dry season.

As for the deep percolation (P), however, only field observation by a Tank Method is discussed and definite figure for each soil texture is not mentioned in IR-309. Average percolation rates for the following three (3) generalized soil textures are presented in IR-306:

Soil Texture	Percolation Rates (mm/day)
sandy	2.5-8.0
loamy	1.5-2.5
clayey	1.0-1.5

A land preparation period is recommended to be three (3) weeks.

(4) Crop Water Requirement : Cwr

The crop water requirement consists of the evapotranspiration (Et) and the deep percolation and is generally presented by the following equation;

Cwr = Et + P ------------------------------ (Eq.4)

Where: Cwr = crop water requirement (mm/day)
Et = evapotranspiration (mm/day)
P = deep percolation (mm/day)

IR-309 suggests to employ Et by field measurement which would be obtained by Tank Observation, Lysimeter Method or Inflow-Outflow Method, or to use approximate values, of 4 - 6 mm/day for the wet season and 5 - 8 mm/day for the dry season, in case no field measurement data are available.

The System Management Department (SMD) of NIA had conducted nationwide field measurements on Et, P and Pan-evaporation(Ep) in national irrigation systems during 1980-83 and generalized those results by Region as a guideline for Operation and Maintenance Plan to be prepared annually by the respective system offices (See Attachment-I).

(5) Farm Waste and Distribution Loss : Fw+DL

FW + DL = 0.3 (Cwr - Re) -------------------- (Eq.5)
= 0.3 x Iwr -------------------- (Eq.5')

Where: FW = farm waste
DL = distribution loss
Re = effective rainfall (mm/day)
Iwr = irrigation water requirement (mm/day)

(6) Conveyance Loss : CL

CL = (Wpa x L x C.L)/86.4 ------------------- (Eq.6)

Where: CL = conveyance loss (l/s)
Wpa = average wetted perimeter of canal/canal section (m)
L = length of canal/canal section (m)
C.L = rate of conveyance loss (m^3/m^2/day, m/day)

In the absence of actual field data on the rate of conveyance loss, standardized ones by different soil textures are useful.

Seepage rates (rates of conveyance loss) have been observed by ponding method in various systems in the Philippines and summarized as follows (See IR-310);

Soil of Canal	Seepage Rate in m^3/m^2/day
Sandy to Gravelly	0.195-0.230
Loam	0.125-0.115
Silty Clay Loam	0.050-0.100
Clay Loam	0.005

According to the results of field observation in various national irrigation systems in the country (See IR-152), which had been carried out by the NIA Regional offices under supervision of SMD at the same time with field measurements on Et, P, Ep mentioned above, the seepage rates widely range from more than 1.000 m^3/m^2/day to 0.002 m^3/m^2/day and show much higher values than the above generalized ones in any of soil textures.

(7) Parameters Employed in the Present Operation Plan

Parameters employed for the six (6) PISs in the present operation plan are tabulated in Tables 1.2 and 1.3.

Soil saturation requirements (Sn) employed for five (5) systems except for the Alcala-Amulung PIS are computed based on the equation Eq.1 in Chapter 1.2.3 (1). They range from 62 mm for the dry season crop of the Libmanan-Cabusao PIS to some 95 mm for the wet season crop of the same. Sn for the Alcala-Amulung PIS is as low as 25 mm and its basis is not clear. In the Solana and the Libmanan Cabusao PISs, Sn for the wet season crop differs from one for the dry season in conformity with the SMD's guideline, while the other four (4) systems adopt the same amount of Sn for both the wet and dry season crops.

The ponding water (S) for all the systems is 50 mm for paddy in both the wet and dry seasons with an exception of 100 mm for the Alcala-Amulung PIS.

No systems employ the percolation rate (P) of less than 1.5 mm/day, while that of more than 2.5 mm/day is employed for the Bonga Pump #3 IS, and the Libmanan-Cabusao PIS, of which the Libmanan-Cabusao's one is as high as 3.92 mm/day although most of the farmlands are categorized into clay in soil classification. P for other systems is between 1.5 and 2.5 mm/day. No differences are seen in P for the wet and the dry seasons except for the Libmanan-Cabusao PIS. Judging from the average Ps presented in IR-306, the systems employing overestimated P are the Bonga Pump #1, #2, and #3 ISs, and the Libmanan-Cabusao PIS.

The evaporation rate (Ev) adopted for the present operation plan is constant throughout a cropping season or a year. Ev for the Bonga Pump #1,#2 and #3 ISs is average Ep of those obtained by field measurement in NISs during wet season in Region I, which is shown in the Attachment I mentioned above. The systems using Ev obtained by field measurement in the system or pilot farm nearby the system are not seen, and other systems employ approximate value. Table 1.4 shows Ev/Ep ratio by cropping season. Ep in the table shows seasonal mean daily Pan-evaporation (class A pan) obtained at meteorological stations adjacent to respective systems, data of which are given in Table 1.5. Ev/Ep ratio is generally between 0.7 and 0.9. For the Solana and Libmanan-Cabusao PISs, however, it shows about 1.0, which seems to be overestimated.

As same as Ev discussed above, the evapo-transpiration (Et) for the Bonga Pump #1,#2 and #3 ISs is based on the Attachment-I according to the system office but the same Et is employed for both the dry and the wet cropping seasons. Et for the other three (3) PISs is constant during the respective cropping seasons. Et/Ev and Et/Ep ratios for each PIS are shown in Table 1.4. Ets adopted for operation plan are generally conservatively estimated in respect of Et/Ev ratio, corresponding to "crop coefficient". Et/Ev ratio of more than 1.25 is seen in the Alcala Amulung PIS and between 1.25 and 1.00 in the Bonga Pump #1,#2 and #3 ISs. Et for any of the PISs is constant throughout a cropping season regardless of the growing stages of paddy nor the meteorological condition but for convenience of operation. As to the Libmanan-Cabusao PIS, it appears to be underestimated judging from a Et/Ev ratio of less than 1.00.

Farm waste and distribution loss are estimated to be 30% of on-farm irrigation water requirement in any of the PISs.

Conveyance loss is computed by the respective PISs using the equation Eq.6 discussed in previous Chapter 1.2.3(6). It varies depending upon the conditions of the PIS such as soil textures, canal size and length, condition of the canal embankment,etc. Rates of conveyance loss adopted are mostly beyond the ranges discussed in previous Chapter 1.2.3(6) for all the systems.

1.2.4 Irrigation Water Requirement for Irrigated Area

Irrigation water requirement for an actually irrigated area is computed for both cases of with and without effective rainfall in conformity with the procedure and the parameters discussed above.

Table 1.6 shows the monthly diversion irrigation water requirement for the systems for which weekly farming record is available.

1.3 Water Management

1.3.1 Method of Water Distribution

In all the six (6) systems, the irrigation facilities had been designed and constructed with a concept of continuous water supply and simultaneous distribution. During the initial stage of operation of the systems, simultaneous distribution has been practiced and water shortage has been experienced in the remote area from the pumping station due mainly to over application of water in the upper part. To solve such uneven water distribution problem, a rotational water distribution has been introduced and practiced since then for all the systems.

In 1986, an average rotation block of each PIS widely ranges from 550 ha in the Libmanan-Cabusao PIS to 35 ha in the Bonga Pump #3 IS. A 7-day rotation was rather common in rotational distribution method. Twenty-four hours continuous pump operation was not practiced in any of the systems. Most common practices on consecutive operating hours of the pumps were 11-16 hours a day, which is reportedly attributed mainly to prohibition of pump operation during the period of peak power demand (17:00 - 22:00) where electricity for the pumps is supplied by the Electric Cooperative and to possibility of low irrigation efficiency in the night time.

The following table shows water distribution practices for 1986 cropping.

Name of System	Rotation Block		Pump Operating Hours	
	Nos. L/S - N/I	Avg.Area (ha)	L/S & L/P	N/I
Bonga Pump #1	3	100	13-18	13
Bonga Pump #2	15(9)	13-21	13-21	
Bonga Pump #3				
wet season	6(8)	35	14-15	14-15
dry season	5(7)	40	12-13	12-13
Alcala-Amulung	6(7)	310	19 at max	
Solana	3(7)	440	15	15
Libmanan-Cabusao	4(7)	550	16	16

Note: L/S; Land soaking period
L/P; Land preparation period
N/I; Normal irrigation period
Avg.Area; Service area in 1986/number of rotation blocks.
Figures in parentheses show rotation period in day.

In order to examine whether the existing canals have sufficient flow capacity for the above rotational distribution, required canal capacity for the present practices of pump operation and rotational distribution is calculated in conformity with the schedule of the rotational distribution and of pump operation and summarized in Table 1.7 in comparison with the designed canal capacities. As obviously seen in the table, the required canal capacities for discontinuous water supply (discontinuous pump operation) and rotational distribution exceed the designed canal capacities (existing capacity) in most of the canals. This seems to be quite natural because the rotational distribution is being adopted although the existing canals have been constructed based on the unit design discharge with a concept of continuous water supply and simultaneous distribution. And the said rotational distribution plan regardless of the existing canal capacity resulted in shrinkage of irrigation area to a considerable extent within each rotation block. Further, practicing discontinuous pump operation despite the fact that irrigation facilities including pumping equipment had been designed and constructed with a concept of continuous pump operation, has become also one of the limiting factors to decrease irrigable area. Table 1.8 shows that the possibly maximum irrigation area for the Solana and Libmanan-Cabusao PISs is much smaller than the generated area even by the rated pumping capacity in case prevailing pump operation hours are adopted.

1.3.2 Irrigation Suspension Schedule

In order to maximally utilize precipitation for paddy cultivation and to minimize total operation hours of the pump eventually, a suspension of pump operation (irrigation suspension) was reportedly practiced on the basis of: i) actual daily rainfall record for the Bonga Pump #1, #2 and #3 ISs, and ii) field inspection (experience) for the Alcala-Amulung, Solana and Libmanan-Cabuusao PISs.

A suspension period adopted presently by the systems did not necessarily coincide with a suspension schedule recommended by SMD (See IR-309). The suspension schedule employed by respective PISs is as follows:

	Rainfall of Previous Day	Suspension Period
Bonga Pump #1 & #2	- 10 mm	1 day
	11 - 20 mm	2 days
	21 - 30 mm	3 days
	31 - 40 mm	4 days
	above 40 mm	7 days
Bonga #3	5 - 7 mm	By field inspection
	8 - 10 mm	4 days
	above 10 mm	7 days

As discussed later in Chapter 1.3.5, however, it is doubtful that whether actual pump operation has been practiced according to the above-mentioned suspension schedule, judging from the record of pump operation.

1.3.3 Irrigated Area

Table 1.9 shows an actual irrigation area by cropping season, while Fig.1.1 presents schematically a ratio of irrigated area by rotational area.

The average irrigation area during the last six (6) years coupled with an average irrigation intensity, a ratio of actually irrigated area to the service area, is tabulated below.

Average Irrigated Area

(Unit; ha)

Name of System	Generated Area	Service Area	Irrigated	
			Wet	Dry
Bonga Pump #1	298	298	119(40)	137(46)
Bonga Pump #2	1,200	665	225(34)	392(59)
Bonga Pump #3	218	202	74(37)	146(72)
Alcala-Amulung	2,279	1,771	1,107(63)	746(42)
Solana	2,865	1,155	638(55)	699(61)
Libmanan	4,102	3,016	1,530(51)	1,417(47)
Total	10,962	7,107	3,693(52)	3,537(50)

Figures in parentheses show irrigation intensities in percent.

An average annual irrigation intensity remains around only 100%, ranging from 86% in Bonga Pump #1 IS to 116% in Libmanan-Cabusao PIS.

1.3.4 Irrigation Water Diverted

(1) Irrigation Water Diverted

Since no reliable measurement records are available in any of the PISs, the amount of irrigation water actually diverted is estimated as a product of pump operation hours and discharge capacity. The discharge capacity of operational pumps has been obtained by field measurement in the course of the current study. Because of limitation of data available on daily pump operation record, actual farming calender and discharge capacity of pumps, the diverted irrigation water was examined for limited cropping seasons as shown in Table 1.10.

(2) Estimated Irrigation Water Requirement and Diverted

The following table shows the average amount of irrigation water diverted during 1982-1986 in comparison with the average irrigation water requirements estimated for each cropping season during 1981-1987 with and without effective rainfall.

Name of System	DWR(w/o;Re) (mm)		DWR(w;Re) (mm)		IWD (mm)	
	Dry	Wet	Dry	Wet	Dry	Wet
Bonga Pump #1	1,465	1,525	1,455	800	1,385	670
Bonga Pump #2	1,745	1,660	1,620	615	1,530	335
Bonga Pump #3	1,520	1,610	1,495	660	2,220	645
Alcala-Amulung	1,450	1,160	1,220	470	1,140	970
Solana	1,330	1,440	1,010	610	1,235	1,075
Libmanan-Cabusao	1,820	1,690	1,160	635	905	810

DWR(w/o;Re) : Diversion water requirement without effective rainfall (See Table 1.6)

DWR(w;Re) : Diversion water requirement with effective rainfall (See Table 1.6)

IWD : Irrigation water diverted (See Table 1.10)

The Bonga Pump #1 and #2 ISs are generally well operated in respect of effective rainfall. Water supply for the dry season crop for the Bonga #3 IS is extremely high, while that for the Libmanan-Cabusao PIS is considerably short. In the Alcala Amulung and Solana PISs, over-application of water for the wet season crop is remarkable.

Fig.1.2 shows a comparison among monthly diversion water requirement, diversion irrigation requirement and irrigation water diverted.

1.3.5 Effective Rainfall in Present Irrigation Practices

The effective rainfall is defined as all or part of the rainfall which meets all or part of land soaking, land preparation and crop water requirements (See IR-306). Any amount of rainfall would not be effective, if farm lots have no room to impound rainfall and unless irrigation is discontinued when rain comes down.

As it is hardly possible to predict precisely when rain comes down, discontinuing irrigation water supply for a certain period immediately after rainfall is the most practical way to substitute rainfall as much as possible for irrigation water. In this practical point of view, the effective rainfall is defined, in this study, to be the amount of rainfall corresponding to all or part of land soaking, land preparation, and crop water requirements which could be saved by suspending pump operation.

As discussed in previous Chapter 1.3.2, every system office has occasionally suspended operation of the pumps after rainfall in accordance with the suspension schedule based on the daily rainfall record or depending upon experiences. However, such suspension of pump operation does not appear to have been properly practiced judging from the pump operation record and diversion water requirement.

In order to evaluate the present pump operation and to establish the most appropriate pump operation, the possibly maximum effective rainfall on the basis of the suspension schedule recommended by SMD has been calculated first, then the results have been compared with the actual effective rainfall in the present operation. The actual effective rainfall has been computed as the difference of diversion water requirement and actually diverted irrigation water. Table 1.11, showing pairs of estimated and actual effective rainfall on monthly basis, reveals that there is much room for improvement in pump operation.

1.4 Farmer's Intention about Water Management

Interview surveys have been conducted in the course of the current study with beneficiary farmers of actually irrigated areas to grasp how they feel and understand the present water management and what they expect from the system office on the same. For interview, farmers were picked out from those in the service area by a random sampling. The number of samples for each of the systems, corresponding to 1% of total beneficiary farmers of each system, is as follows:

Name of the Systems	Number of Samples
Bonga Pump #1	5
Bonga Pump #2	9
Bonga Pump #3	5
Alcala-Amulung	37*
Solana	14
Libmanan-Cabusao	18
Total	88

* : Including Iguig PIS

The survey covered the aspects of water management, irrigation facilities, yield of palay, farmer's attitude, etc. The results of the survey are presented in Table 1.12.

About half of the sample farmers expressed their satisfaction with the present water management as a whole. Individually, the farmers in the Alcala-Amulung and Solana PISs rated the present water management so high, while those in the Libmanan-Cabusao PIS did not on the contrary. Regarding the condition of the present irrigation facilities, some 70% of the sample farmers felt more than fair. As for those in the Libmanan-Cabusao PIS, however, more than 50% of the farmers considered them poor. In the survey on the problem of irrigation facilities, the low embankment and silted canal were pointed out by 33% and 30% of them, respectively.

As the causes of the low yield of palay, the farmers considered that it was attributed mainly to; i) natural disasters such as typhoon and storm, ii) poor water management, and iii) damage by blight and insects.

2. PRESENT MONITORING AND COMMUNICATION SYSTEM

2.1 Monitoring System

The monitoring work in the pump irrigation systems consists of; i) measurement/recording of daily discharges at the major flow points and rainfall/effective rainfall, ii) monitoring of weekly progress of area under normal irrigation, transplanted lots and harvested lots, and iii) harvested/damaged area/yield of crops.

The monitoring work is carried out by the staff of NIA system offices or the Irrigator's Association (IA). The systems in which monitoring work is carried out by the system offices are the Bonga Pump #1, the Bonga Pump #2, the Bonga Pump #3, the Alcala-Amulung and the Libmanan Cabusao PISs. In the Solana PIS, the monitoring is undertaken by the Solana Cagayan River IA.

The monitoring work is generally conducted by the field O&M staff such as ditchtenders, watermasters and pump operators in the system offices and by farmers themselves in the IAs.

However, the monitoring work has not been conducted so systematically and at the right time, therefore the data monitored are not always satisfactory in accuracy. On the other hand, the monitoring equipment is sometimes deteriorated and are short in number. The location of this equipment is illustrated in Figs. 2.1 to 2.16 in ANNEX-A. The condition of this equipment is described in Table 2.1.

The major constraints for smooth monitoring work are considered to be the following;

i) Deterioration of monitoring equipment,
ii) Insufficient number of equipment, especially staff gauge,
iii) Lack of understanding of duties/skill of the monitoring work of the O&M staff in both the systems and the IA, and
iv) Insufficient number of O&M staff in the Libmanan-Cabusao irrigation system.

2.2 Communication System

There are several internal communication methods within each of the irrigation system offices such as; i) meeting/conference, ii) official memorandum circulars, iii) bulletin board, iv) public address and v) radio communication systems. Among them, meeting/conference is the most popular and effective means in communication system.

The meeting system of each of the system offices is illustrated in Figs. 2.1 to 2.3. Periodical meeting in the office is held formally and informally. Through the meeting, good communication is maintained. On the other hand, meetings are also held in the IAs.

The organization of each system office as well as IA is simple and small, therefore communication within the system is good in general.

Most of the system offices have only minor equipment such as radio set and walkie talkie because of small size of the systems. Table 2.2 shows the present condition of the communication equipment in each of the system offices. Provision of the radio equipment, however, will be needed at the pump station of the Libmanan-Cabusao PIS to connect the pumping station with the system office.

With respect to external communication, the communication between staff of the system offices and the farmers was investigated by questionnaire survey. The summary of the communication is shown in Table 2.3.

Most of the farmers do not frequently communicate with the NIA-staff except those in the Bonga Pump #3 IS. Though the main reason behind farmers' poor communication with the NIA-staff is the lack of time, there is also poor comprehension of the NIA-staff. The results of the survey also indicate that the farmers in most of the irrigation systems want to receive better supervision and regular visit of the NIA-staff to.

Improvement of communication between the NIA-staff and the farmers is essential to perform good system management including increase of the irrigation service fee collection efficiency.

2.3 Recording

The prescribed reports in each of the system offices are shown in Table 2.4. The reports are not prepared by the IA in general.

The common problems with regard to a recording are identified as follows;

i) inaccuracy of data,
ii) large volume of paper processing, and
iii) unstandardized formats for recording.

Especially inaccuracy of the meteo-hydrological data such as rainfall and flow discharge is accrued from no precise measurement by the O&M staff, because they do not exactly understand that such basic data are important for proper system management. For this purpose, quality improvement of the O&M staff through training is a prerequisite.

In addition, the conditions of the filling and keeping data are not always well, and this may be due mainly to lack of equipment and instruments for filling/keeping systems.

3. PRESENT O&M EQUIPMENT AND FACILITIES

The present O&M equipment and facilities for each of the systems are tabulated in Table 3.1.

These O&M equipment and facilities are mostly purchased at the implementation period. A considerable part of these has reached the expiration of their useful life. Further constraints which the system offices encounter at present are (i) shortage of equipment and facilities and (ii) decrease of workability of equipment due to lack of spareparts and insufficient maintenance.

4. PRESENT ORGANIZATION

4.1 System Office

The pump irrigation systems managed by the NIA system offices are the Bonga Pump #1, Bonga Pump #2, Bonga Pump #3, Alcala-Amulung, and Libmanan-Cabusao systems. The names of the system offices concerned with these systems are as follows; The Solana system is managed by the Irrigator's Association as explained later.

System Office	Pump Irrigation System
1. Ilocos Norte River Irrigation Service	Bonga #1, Bonga #2 & Bonga #3
2. Iguig, Alcala-Amulung Pump Irrigation System Office	Alcala-Amulung PIS
3. Libmanan Cabusao Pump Irrigation System Office	Libmanan Cabusao PIS

The organizational structure and staff of each system office are illustrated in the charts in Figs. 4.1 to 4.3. The organizational structure of the offices is generally simple. The system office is headed by the irrigation superintendent who undertakes an overall supervision and direction of operation and management of the system. Under the irrigation superintendent, there are two sections; administrative section and operation & maintenance section.

Staff and staffing pattern in the organization are also illustrated in Figs. 4.1 to 4.3. Staffing and work load of the O&M staff in each of the irrigation systems are summarized in Table 4.1. In comparison with the NIA criteria on work load of staff for "small" national irrigation system, the work load of staff in most irrigation systems is acceptable except for the Libmanan-Cabusao system. There are no ditchtenders in the Libmanan Cabusao system office, and this represents one of the most serious constraints for efficient O&M work.

4.2 Irrigator's Association

At present there are 5 irrigator's associations and 119 irrigator's groups/tertiary service areas in the six (6) pump irrigation systems as shown in Table 4.2. In the Libmanan Cabusao system, the irrigator's associations are now being set up under assistance of the community organizers. It is envisaged that ten irrigator's associations are to be created. Total membership of the irrigation systems is estimated at 2,500 or about 30% of total number of farmers in the irrigation service area.

The organization structures of these irrigator's associations and irrigator's groups are shown in Figs. 4.4 to 4.8. The structures of these associations are different depending on local conditions. In general there are officers under the Board of Directors. The number of officers is five, comprising a president, a vice president, a secretary, a treasurer and an auditor. The president is supported by several committees. Under the president there are irrigator's groups (tertiary service area) which are organized on the basis of one turnout.

At present the farmers in the irrigation systems attend several farmer's organizations such as irrigator's association (irrigator's group), agrarian reform beneficiary association, Kilusang Kabuhayan at Kaunlaran (KKK), Samahang Nayon, etc. According to the farmer's intention survey, the farmers in the irrigation systems appreciate the irrigator's group as the first rank among the organization and understand the necessity of the irrigator's group exactly as shown in Table 4.3. Also the farmers have intention to participate in the water scheduling and water control in group through irrigator's groups.

Based on the results of the farmer's intention survey and interview of representatives of the irrigator's associations and O&M staff of the system offices, activeness of the Irrigator's Association in water management may be roughly assessed as follows;

Name of IA	Assessment
Sarrat San Nicolas IA (Bonga #1)	not so much
San Nicolas Lasag IA (Bonga #2)	active
Western IA (Bonga #3)	active
Amalia IA (Alcala-Amulung)	-
Solana Cagayan River IA (Solana)	not so much

Remark: The Amalia IA was just set up in 1988.

4.3 Turnover Stage of Irrigator's Association

For effective management of the irrigation system, NIA has promoted the farmer's self-reliance in irrigation water management. NIA has undertaken the shared management (or turnover) for irrigator's association. There are three shared management stages; stage 1, stage 2 and stage 3. The definition of the stage and incentive given to the irrigator's associations are outlined as follows;

(i) Stage 1 : The irrigator's association participates in the operation and maintenance of the some ditch-tender's section and also assist in the collection of irrigation service fee among the members,

(ii) Stage 2 : The irrigator's association participates in the operation and maintenance of a system and undertakes collection of irrigation service fee among the members,

(iii) Stage 3 : The irrigator's association requests full turnover of a system with an area of less than 1,000 ha on condition that they will amortize the investment and rehabilitation costs before the turnover.

Remuneration and incentive given to irrigator's associations for the irrigation systems are as follows:

(i) Stage 1

- A remuneration of Pesos 610 is given to each ditchtender's section of not more than 3.5 km for earth canal or 7 km for lined canal per clearing; and clearing not to exceed once a month.

- For assisting in collection, an incentive of 2.5% of the total collection of irrigation service fees for a collections efficiency of 70-99% or 3% if collection is greater than 99-100%; provided that 70% of the current collectibles is collected; and 10% of the total amount in excess of 100% current collectibles is the gross current collectible.

(ii) Stage 2

- For collection at a break-even point, percentage share of NIA is equal to the sum of system O&M expenses without ditchtender, regional overhead cost and ICO expenses, all prorated to area under shared management times one hundred percent, divided by the product of 90% of gross collectibles and break even point.

- For collection above the break even point, the sharing is such that if 100% of current collectibles is collected 70% of collection goes to NIA and 30% goes to IA.

- The term collection is net of the 10% rebate for prompt payment before the specified deadline for each irrigation system.

- In order to abate deliberate delaying of payment by IA of current accounts, a 2% incentive is given for collection of back accounts incurred during the life of the contract after specific deadline.

- An incentive of 25% is given to IA for the collection of back accounts incurred prior to the contract effectivity.

(iii) Stage 3

- IA amortizes the development/construction cost of the system, at the equivalent cost of 1.5 cavans/ha/annum; and provided that the amortizing period shall not be more than 50 years.

- For collecting Back Accounts prior to turnover, 75% goes to NIA and 25% goes to IA.

The Solana pump irrigation system was fully turned over to the irrigator's associations of the Solana, Cagayan River Irrigation Association in July 1988 under the condition of supervision by NIA. The content of the contract document agreed upon NIA and the IA is as same as that of the usual turnover stage 3 except for the special provision as follows;

(a) All remaining rehabilitation works and system improvement shall be continued and completed by NIA even after the signing of this contract.

(b) Irrigation Association members shall be given first priority for work during rehabilitation of the irrigation system.

(c) NIA is responsible for the repair of the pumps units in case they will be damaged within the first two (2) years of initial implementation of this agreement, starting July 1, 1988 to June 30, 1990. The association is responsible for the repair of damage to the pump units thereafter.

(d) NIA and the Association shall jointly verify the reported list of irrigated and planted area (LIPA) in every cropping season.

(e) An evaluation meeting of NIA and the Association shall be held after every cropping season to trash out problems and consider solution thereto.

(f) NIA authorizes the Association to utilize the watermaster's working station.

(g) For a period of the first two (2) years of operation of the system, NIA shall extend loan (seed fund) in the amount of One Hundred Thousand Pesos (Peso 100,000) to the Association to defray the other incidental operation and maintenance expenses at the start of each cropping season to be paid back in fully by the Association without interest at the end of each season, not later than June 30, for the dry season crop and December 31, for the wet season crop.

Under such general and specific provisions, NIA will transfer ownership of the irrigation facilities in the system to the association after completion of the "token" repayment of the cost of construction and rehabilitation of one cavan per hectare irrigated or its cash equivalent by the association for 25 years.

The condition of the facilities of the system after turnover is, however, as same as what it was. Rehabilitation and improvement of the irrigation and drainage facilities are essential. Replacement and improvement of the pumps are also needed.

The irrigation systems of the Bonga Pump #1, Bonga #2, and Bonga #3 are managed by the Sarrat San Nicolas IA, San Nicolas Laoay IA and Western IA under the shared management of stage 2.

The Amalia IA in the Alcala-Amulung system is not yet in turnover stage.

5. FINANCIAL MANAGEMENT

5.1 Irrigation Service Fee and Collection

The irrigation service fee rate for each of the irrigation systems is shown in Table 5.1. It is different depending on locations, ranging from 7.5 cavans of paddy per ha per crop to 14 cavans of paddy per ha per crop. The irrigation service fee rate for the third crop is applied to 60% of that of the dry season in principle.

Payment of irrigation service fee is either in paddy or in cash equivalent to the prevailing government support price at the time of payment.

According to the result of farmer's interview survey, form of irrigation fee payment, number of persons who deliver fee bill and statement of account to farmers and number of persons to whom farmers pay irrigation fee in each of the irrigation systems are summarized in Table 5.2.

Irrigation service fee is paid in cash to a considerable extent. In case of payment in kind, however, shrinkage, impurity and inferior quality of paddy are the problems. Furthermore the irrigation system offices face difficulties in drying, classification, storage and sales. The system offices often need additional cost for treating paddy.

Distribution of bills and statement of account to farmers is carried out by various kinds of staff. Also collection of irrigation service fee seems not to be carried out systematically. Systematic approach to billing and collection of fee is necessary. In addition an efficiency of irrigation fee collection is often adversely affected due to incomplete and outdated land ledger and record of payment status of farmers.

5.2 O&M Cost

Detailed operation and maintenance costs in each of the irrigation systems are estimated and shown in Table 5.3.

The summary of O&M cost in 1987 is shown below;

Name of System	Total O&M Cost in 1987 (1,000 Pesos)	Pump Energy Cost (1,000 Pesos)	(%)	O&M Cost per ha (Peso/ha)	Water Consumption (mm/day)	Water Value (Peso/m^3)
	(1)	(2)	(3)=(1)/(2)	(4)	(5)	(6)
Bonga #1	529.1	389.5	74(84)**	2,389(1,312)**	9.4	0.16
Bonga #2	789.8	625.1	79(85)**	1,360 (902)**	7.4	0.12
Bonga #3	312.5	183.5	59(70)**	1,550(1,351)**	10.5	0.07
Alcala-Amulung	2,449.5	1,516.7	62 (-)**	1,210 (-)**	11.5	0.05
Solana*	2,226.8	1,745.2	78(77)**	2,630(3,472)**	12.6	0.14
Libmanan-Cabusao*	667.0	363.8	55(73)**	600(1,136)**	6.2	0.04

*: The pumps were not operated during the dry season of 1987 in the Salana and Libmanan Cabusao systems.
**: Data in 1986 as reference.

The O&M cost per ha ranges from 600 to 2,600 Pesos among the systems. The O&M cost of the Libmanan-Cabusao and Solana systems in 1987 were lower because the pumps were operated only in wet season. The pump energy cost is considerably higher and occupies 60% to 80% of the total O&M cost. The main causes of such high power energy consumption may result in (i) low efficiency of pumps, (ii) physical constraints such as higher head of the pumps and (iii) excessive irrigation water supply per ha. The actual irrigation water consumed by each system is estimated on the basis of the estimated total annually diverted irrigation water/the total annual irrigated area/120 days of growing period of paddy. Except for the Libmanan Cabusao system, the estimated water consumption (mm/day) is significantly high, ranging from 7 to 13 mm/day. This fact indicates that too excessive irrigation water has been applied without proper water management.

The water value (Peso/m^3) of each system is estimated as total pump energy cost/the estimated total annually diverted irrigation water, ranging from 0.04 to 0.16 Peso/m^3. The higher water value may result in (i) the higher head of the pumps, (ii) lower pump efficiency and (iii) high unit rate of electricity supplied from the local electric cooperative.

5.3 Financial Status

Financial status of each of the irrigation system is examined. The results are shown in Table 5.3.

The financial status of the irrigation system is summarized below;

Name of System	Fee Collective Efficiency* (%)	Income** (10^3 Pesos)	Expenditure*** (10^3 Pesos)	Balance (10^3 Pesos)
Bonga #1	83	283.4	529.1	-245.7
Bonga #2	60	509.0	789.8	-280.8
Bonga #3	32	100.0	312.5	-212.5
Alcala-Amulung	63	1,572.3	2,449.5	-877.2
Solana****	60	1,165.9	2,226.8	-1,060.9
Libmanan-Cabusao	16	181.9	667.0	-485.1

*: efficiency of irrigation service fee collection
**: collected amount of irrigation service fee
***: operation and maintenance cost
****: before turnover stage 3

As shown in the above table, the viability of all the irrigation systems shows a deficit ranging from -210×10^3 to $-1,060 \times 10^3$ Pesos.

6. PLAN OF SYSTEM MANAGEMENT

6.1 Basic Concept for Improvement

The previous chapter of this report as well as ANNEX C and D clarified the present problems and constraints of management of the irrigation systems. These may be summarized as follows; (i) the financial status of the systems is marginal or is becoming worse and (ii) the farmer's economy of most of the beneficiary farmers in the systems remains at the subsistence level.

The financial status of the systems has been seriously affected by rising operation and maintenance costs and low collection rate of irrigation service fees. The rising O&M costs result from (i) rising unit costs of electricity for operation of pumps, (ii) falling efficiency of pump facilities and (iii) falling overall irrigation efficiency due to deterioration of irrigation facilities and improper management of operation and maintenance. The low rate and amount of irrigation service fee collection results from a complicated combination of (i) negative farmer's perception of NIA services caused by shortage of irrigation water supply, (ii) low payment capacity of farmers, and (iii) constraints on the fee collection method.

The subsistence farmer's poor economy is considered to be the result of low farm income due to (i) low unit yield of paddy, (ii) low cropping intensity and (iii) small farm size.

In order to formulate a comprehensive improvement plan for each of the systems, the systems have been duly evaluated in various aspects such as irrigation/drainage facilities, pump equipment, O&M equipment, monitoring/communication system, electric power supply system, water management, institutional aspect of system offices, etc. The results are summarized in Table 6.1.

The basic development concept for this project is, therefore,

i) To increase farmer's income in the systems, and
ii) To improve financial status of the system offices

The above development concept would be achieved through;

i) reduction of operation and maintenance costs,
ii) improvement of land productivity, and
iii) reinforcement and/or establishment of proper system management.

This chapter discusses the improvement plan of system management which includes; i) institutional improvement plan of the system offices, ii) water management plan, iii) maintenance plan of irrigation and drainage facilities, iv) plan of O&M equipment and monitoring facilities, v) training program of O&M staff, and farmers in the systems.

6.2 Institutional Improvement Plan of System Office

The pump irrigation systems are managed by the NIA system offices and/or irrigator's associations. The Bonga Pump #1, Bonga Pump #2 and Bonga Pump #3 are under shared management. The Libmanan-Cabusao and the Alcala-Amulung systems are fully managed by the NIA system office. The

Solana pump irrigation system is under turn-over stage 3 and managed by the irrigator's associations.

The organizational structure of the present NIA system offices is simple in general. A superintendent is fully responsible for overall O&M management of the irrigation system. Under him there are two sections; administration and operation & management, in general. The system offices function well in general from the standpoint of structure. The present simple organizational structure will remain in the future.

The work load of O&M staff is different among the system offices. The institutional plan for the system offices, therefore, has been formulated to reinforce the O&M staff, especially ditchtenders and watermasters. The number of O&M staff to be required is estimated on the basis of about 1.5 times of minimum requirement of work load which is defined in the NIA criteria in Small National Irrigation System. The result is shown in Table 6.2.

6.3 Water Management Plan

6.3.1 Irrigation Water Requirement

(1) Proposed Parameters for Water Management Plan

Parameters presently adopted in the operation and maintenance plan are followed, as a rule, in the proposed water management plan. Modification of the parameters is limited to the case that it is judged to be somewhat inadequate. The proposed parameters are tabulated in Table 6.3.

The soil saturation requirement (Sn) has been examined by the equation (Eq.1) in Chapter 1.2.3 along with Appendix Table 4 in IR-306 taking into account; i) monthly mean rainfall during irrigation cut-off period, ii) monthly mean evaporation during the same period, iii) proposed cropping pattern shown in ANNEX-D AGRICULTURE AND AGRO-ECONOMY, and iv) soil texture. As for the Alcala-Amulung, Solana, and Libmanan-Cabusao PISs, it could be expected during irrigation cut-off period before the outset of the dry season cropping that the field would be well saturated by rainfall since the monthly mean rainfall during the period is more than double of the monthly mean evaporation during the same period.

The ponding water (S) for all the systems is proposed to be 50 mm each for both the dry and the wet croppings.

Since no field measurements on percolation rates (P) are available for any of the systems, generalized P mentioned in previous Chapter 1.2.3 along with area proportion in soil texture discussed in ANNEX-D AGRICULTURE AND AGRO-ECONOMY are referred to for determining P for the respective systems.

Evaporation (Ev) rate is needed to estimate the land preparation requirement as discussed previously, and hence monthly mean Ev during the land soaking and land preparation period for each of the systems is assumed to be 80% of the monthly mean pan-evaporation rate (Ep) during the same period, Eps presented in Table 1.5 are employed to estimate Evs for respective systems.

Proposed evapotranspiration (Et) rates are based on Attachment-I for all the systems.

Proposed on-farm application loss as well as conveyance loss are those employed presently. Besides, operation loss is newly taken into account.

(2) Unit Water Requirement

Unit water requirement for the each system is calculated based on the above-mentioned calculation basis and proposed cropping pattern illustrated in ANNEX-D AGRICULTURE AND AGRO-ECONOMY and is shown in Table 6.4.

6.3.2 Irrigation Water Distribution

(1) Basic Concepts for Water Distribution Method

In all the six(6) systems, the irrigation facilities had been constructed with a concept of continuous water supply and simultaneous distribution. During the initial operation stage, water shortage problem in remote area from the pumping station has taken place. This seems to be attributed mainly to over application in the upper part of the system and lack of skill in doing complicated gate operation. Then, rotational distribution was introduced to improve uneven water supply. This rotational distribution, however, has brought about water deficit within each rotation block because the schedule of the rotational distribution has been formulated regardless of the existing canal and structures' flow capacity.

Taking such bitter experience of the system offices into consideration, the basic concepts for formulating water distribution method are set up as follows:

a) To secure even water distribution in any part of the service area;

b) To avoid complicated gate adjustment as much as possible, in other words, to eliminate the factor of time lag as much as possible in discharge control at the gates;

c) To minimize enlargement of flow capacity of the existing irrigation facilities;

(2) Method of Water Distribution

General methods of water distribution are classified into simultaneous distribution and rotational distribution. The former involves simultaneous supply of water to all the canals. While the latter is practiced by rotating supply of water to different areas. Under rotational distribution, the following three practices, are conceivable (see Fig.6.1):

i) Rotation by section in the main canal or by lateral(s)

Water is conveyed by rotation to different sections in the main canal or to different laterals.

The advantage of this method is that water control can be accomplished by operating headgate(s) on the main canal or lateral(s), and that gates of turnouts could be left open once they are set at right position.

The disadvantage of this method, on the other hand, is that large discharge capacities would be needed for lower portions of the main canal and lateral(s). Since the existing irrigation canals of the six (6) systems have been designed and constructed for simultaneous distribution under continuous pumping operation condition, most of laterals should be enlarged, if this method is adopted. The extent of enlargement could be minimized by introducing minimum number of rotation block and maximizing operating hours of the pumps.

ii) Rotation by section or a group of turnouts in the laterals or sub-laterals

The main canal conveys irrigation water continuously while the water is rotated by the section or a group of turnouts of the lateral or sub-lateral.

In this case the existing main canals and laterals could afford to convey the required irrigation water with a minor enlargement at lower portions of the canals. However, all the control gates of the turnouts as well as headgates should be operated in accordance with an interval of rotation. And rather frequent gate operation is prerequisite to get the goal.

iii) Rotation by section in the farmditch

Water is rotated only within each rotational area (on-farm level). Conveyance of water in the main canal, laterals and sub-laterals is simultaneous. This is defined as simultaneous distribution in this study and is distinguished from the above two rotational distribution methods.

(3) Time Lag in Water Distribution

Consecutive operating hours of pumps of the six (6) systems are between 21 hrs/day and 13 hrs/day. And 24-hr consecutive operation has not been practiced in any of the six (6) systems.

Under such discontinuous water supply (pump operation), which has been forced by Electric Cooperatives, water travelling time (a time lag) is one of the most adversely affecting factors in proper water distribution.

i) Time lag in rotational distribution by section in the main canal or by lateral(s)

Rotation by section in the main canal or by lateral(s) is more preferable for water control in respect of the time lag than the rotation by section or a group of turnouts in the laterals or sub-laterals, because the time lag to be considered in water distribution is limited to within a section in the main canal or the lateral. In this case, therefore, a span of the time lag to be considered in gate operation is much shorter than in the other distribution methods.

ii) Time lag in rotational distribution by section or a group of turnouts in the laterals or sub-laterals

In case of rotation by section or a group of turnouts in the laterals or sub-laterals, the problem of time lag would more adversely affect the water control than the above because irrigation water should be delivered to all the laterals at a same time. More concretely, in this case the limits of the time lag extend over the whole of the main canal, and the span of time lag to be considered in gate operation is longer than the above. But the span of time lag within each section or each group of the turnouts becomes much shorter on the contrary.

iii) Time lag in simultaneous distribution

In case of simultaneous distribution or rotational distribution within a rotational area(on-farm level), the time lag to be considered in gate operation extends over the whole of the main canal, all the laterals, and all the sub-laterals. This means that the span of time lag between the head of the main canal and the remotest point of a canal should be taken into consideration in gate operation as well as in pump operation.

(4) Gate Operation in Different Distribution Methods

i) Gate operation in rotation by section in the main canal or by lateral(s)

In rotation by a section in the main canal or by lateral, the headgates to be operated in a section are, generally speaking, very limited in number compared with those for the other distribution methods, while the number of turnout gates within the section are larger than the case of rotation by section or a group of turnouts in the laterals or sub-laterals. This means that turnout gates in the section should be more carefully operated than the case of rotation by section or a group of turnouts in the laterals or sub-laterals to accomplish even water supply to each of the turnouts in the section.

ii) Rotation by section or a group of turnouts in the laterals or sub-laterals

Sophisticated gate operation is required for all the headgates in due consideration of actual irrigation area, period of pump operation, and time lag,etc. Among these, the time lag is one of the most important factors to be considered for equable water distribution in case the span of time lag in the main canal or the lateral is considerably long.

In this case, the upper headgates could receive water for longer time than the lower headgates if all the headgates are operated at the same time. As a result, the upper headgates would tap exceeding water, while the lower ones could divert deficient water on the contrary, if gate opening is set taking only actual irrigation area and its water requirement into account.

To cope with this, the headgates should be operated in such way that their opening is sophisticatedly adjusted taking into account, in addition to the actual irrigation area, the time span that each headgate could actually tap the water from the main canal or the laterals. For example, the headgates of the uppermost lateral should be partly opened to meet with the "q x 24/t1 x a1", while opening of the lowermost headgates should satisfy "q x 24/t2 x a2". Where, "q" means discharge to be diverted to a lateral under 24 hrs consecutive pump operation condition, "t" means the time span that each headgate could tap water and "a" means the actual irrigation area to be covered by each headgate.

In case discharge control is made by time to cope with the time lag instead of adjustment of gate opening, the time of opening/ closing the gates should be adjusted individually so that opening period for all the headgates becomes the same. This method, however, seems not to be practical in the sense that this forces the gatekeeper to operate the headgates even in the midnight.

Discharge control at the turnouts within each section for this distribution method is easier than the rotation by section in the main canal or by lateral in respect of the time lag, because in this case the span of time lag in each section would be much shorter and negligible.

iii) Gate operation in simultaneous distribution

As discussed in the previous chapter, in case of simultaneous distribution the span of time lag to be considered is the longest among the three distribution methods discussed above. All the unfavorable things in respect of the time lag discussed in the rotational distribution would be involved in this case. Only the advantage in gate operation in this case is that less frequency of gate operation is needed compared with the rotational distribution method. So far as discontinuous pump operation is practiced, therefore, even water distribution might not be accomplished by the simultaneous distribution.

(5) Proposed Water Distribution Method

Considering the present constraints in water distribution, basic concepts for water distribution, advantages and disadvantages in different methods of water distribution discussed above, and anticipated ability of watermasters and ditchtenders in water distribution, the rotational distribution is proposed for the six (6) systems.

The proposed rotational distribution is a combination of "rotation by section in the main canal or by lateral(s)" and "rotation by section or a group of turnouts in the laterals or sub-laterals".

The proposed limits of the rotation blocks for each systems are schematically shown in Figs. 3.1 to 3.10 in ANNEX-C IRRIGATION AND DRAINAGE. And the proposed numbers of the rotation blocks for each systems are as follows;

Name of System	Number of Rotation Block	
	Firmed-up Service Area	Maximum Service Area
Bonga Pump #1	2	2
Bonga Pump #2	3	-
Bonga Pump #3	2	2
Alcala Amulung	3	3
Solana	3	3
Libmanan Cabusao	3	2

6.3.3 Irrigation Schedule

(1) Irrigation Area

Irrigation schedule for each system has been examined for both the firmed-up service area and the maximum service area, which are tabulated below:

Unit; ha

Name of System	Firmed-up Service Area	Maximum Service Area
Bonga Pump #1	298	426
Bonga Pump #2	674	674
Bonga Pump #3	202	202
Alcala-Amulung	1,652	2,158
Solana	1,100	1,960
Libmanan-Cabusao	1,838	3,085

(2) Diversion Water Requirement

Diversion water requirements for both the firmed-up and the maximum service areas have been computed for each system based on the proposed unit water requirement, irrigation areas, and water distribution method and cropping pattern and calendar and summarized in Tables 6.5 to 6.10.

(3) Irrigation Schedule

The annual irrigation schedule would be prepared by each system office concerned in collaboration with the Irrigator's Association before the outset of every dry season crop on the basis of the proposed cropping pattern and the proposed unit water requirement. The schedule would consist of; i) cropping calendar, ii) programmed irrigation area by turnout, iii) weekly land soaking program, vi) weekly rotational distribution schedule, iv) diversion water requirement in accordance with the above-mentioned distribution schedule, v) estimated power consumption, etc.

Prior to the commencement of every cropping season, annual irrigation schedule would be reviewed and confirmed on programmed area in due consideration of physical condition of the irrigation facilities and beneficiary farmers' intention through discussion with the Irrigator's Association.

6.3.4 Operation Rule

(1) Control of Irrigation Water Delivery

Control of irrigation water delivery for each system would be made by conventional methods.

Delivery of the irrigation water would be managed by the following general procedure:

i) data collection
ii) data processing
iii) establishing operation plan
iv) operation & monitoring

The data required for operation would consist of, at least, i) farming activities, ii) canal water level at every measuring devices, iii) daily rainfall, and iv) river water level at pumping site.

The data processing work would include conversion of the data collected into the necessary dimensions required for operation and preparation of operation plan.

The operation plan to be prepared would cover seasonal plan and weekly plan. The weekly plan would cover; i) number of units of pumps to be operated and daily operating hours, ii) gate operation schedule.

In accordance with the operation order which would be issued based on the weekly operation plan, field staff would set the irrigation facilities to the right position weekly unless occasional order is issued. Occasional order would involve suspension and resumption of pump operation.

(2) Irrigation Suspension Schedule

The proposed irrigation suspension schedule is as follows;

Previous Day Rainfall Range	Period of Suspension of Irrigation
below 7 mm	0 day
8 - 15 mm	1 day
16 - 23 mm	2 days
24 - 30 mm	3 days
31 - 38 mm	4 days
39 - 46 mm	5 days
above 47 mm	6 days

(3) Amount of Irrigation Water to be Saved by Rainfall

In preparing the annual irrigation schedule, annual power consumption should be estimated to form the budget for the coming year. To this end, effective rainfall has been estimated by simulating above irrigation suspension schedule with daily rainfall data for the last ten

(10) years. And the results are summarized in Table 6.11 to 6.16. Daily rainfall data employed for respective PISs are as follows:

Name of PIS	Rain Gages
Bonga Pump #1	Laoag, Ilocos Norte
Bonga Pump #2	Laoag, Ilocos Norte
Bonga Pump #3	Laoag, Ilocos Norte
Alcala-Amulung	Tuguegarao, Cagayan
Solana	Tuguegarao, Cagayan
Libmanan-Cabusao	Pasacao, Camarines Sur

6.3.5 Monitoring System

Monitoring of meteo-hydrological measurements, progress of irrigated area and identification of agronomic characteristics is one of the most important key factors for operation. At present the equipment of meteo-hydrological measurement is considerably deteriorated and insufficient for smooth operation as shown in Table 2.1. The improvement plan for monitoring system, therefore, has been formulated to rehabilitate the existing equipment and reinforce its number. The proposed monitoring equipment is as follows:

(i) Rain gage : One set of rain gage in or around the service area for each system

Name of System	Location of Rain Gage
Bonga Pump #1	; pumping site
Bonga Pump #2	; pumping site
Bonga Pump #3	; pumping site
Alcala-Amulung	; system office
Solana	; pumping site
Libmanan-Cabusao	; system office

(ii) Staff gage: One set each at the outlet of the pump stations and at the head of lateral/sub-lateral canals.

The organization of the each of the system offices is simple and small, so that communication within the system office functions well. The improvement plan for communication system involving installation of radio sets, has therefore been formulated. Further reinforcement of transportation equipment is planned on the basis of the NIA's criteria.

6.4 Maintenance Rule of Irrigation and Drainage Facilities

Maintenance for the canal systems would consist of daily maintenance works and seasonal maintenance works. The former works would cover cleaning of canals and daily maintenance of pumping equipment, while the latter would be conducted during irrigation cut-off period and consist mainly of i) desilting of intake site, inlet channel and canals, ii) reforming of canal section, iii) resurfacing of service roads, iv) repainting and greasing metal works. Regular maintenance works such as daily, weekly, monthly and yearly maintenance works would be required for pumping facilities, details of which are presented in ANNEX-I OPERATION AND MAINTENANCE MANUAL OF IRRIGATION AND DRAINAGE FACILITIES.

In addition to the maintenance works for the irrigation and drainage facilities, maintenance works are needed also for the O&M equipment. To increase workability of the O&M equipment, preventive maintenance would be established through conducting regular maintenance by mechanics of the NIA Regional office.

Some of the facilities and equipment such as mechanical and electrical works and O&M equipment would be replaced at a certain interval within the anticipated project life because of their shorter durable years. The expected useful life of the relevant works and equipment are shown in Table 3.1 of ANNEX-C IRRIGATION AND DRAINAGE.

6.5 Reinforcement Plan of Operation and Maintenance Equipment

Reinforcement plan of O&M equipment has been formulated for the following works;

(i) Maintenance works for pump facilities, service roads, inlet channel to the pump, irrigation/drainage canal, substation and transmission line,

(ii) Meteo-hydrological measurement, and

(iii) Communication within the system.

To solve the present problems and constraints of O&M equipment mentioned in Chapter 3, strengthening of O&M equipment is planned to supplement (i) O&M equipment, (ii) maintenance tools, (iii) facilities of monitoring and communication and (iv) spareparts.

Number and kind of O&M equipment are determined from the standpoint of operation efficiency, easiness of operation and low operation cost of equipment taking account of the width of canal and service road, location of the pump station.

Monitoring of meteo-hydrological measurements is one of the most important factors for operation. At present the equipment of meteo-hydrological measurement is considerably deteriorated as shown in Chapter 3 and insufficient in number for smooth operation. The improvement plan for monitoring equipment has been formulated to rehabilitate the existing equipment and reinforce its number as discussed in previous Chapter 6.3.5.

Further, installation of radio sets at the pump station to connect with the system office is planned for the Libmanan Cabusao system.

Reinforcement of spareparts is planned to be for elements of the existing and newly purchased equipment for increasing their workability.

Number and kind of the proposed equipment in each irrigation system are summarized in Table 6.17.

6.6 Training Programme

6.6.1 General

In the framework of reinforcing institutional aspects, quality improvement of the O&M staff of the irrigation system offices as well as the farmers in the systems is one of the most important factors to improve the present system management for the irrigation systems.

For this purpose questionnaire surveys of the O&M staff comprising watermasters, pump operators and ditchtenders in each of the six pump irrigation systems have been carried out to clarify the features of these O&M personnel with respect to (i) general personnel background, (ii) basic knowledge on water management, (iii) basic knowledge on agro-production, (iv) experience in hydro-measurement, (v) experience in system management, (vi) experience in design, (vii) understanding of work duty and responsibility and (viii) understanding of pump management (only for pump operators).

The total number of respondents is 33 consisting of ten(10) pump operators, nine(9) watermasters and 14 ditchtenders.

The results of the survey are shown in Tables 6.18 to 6.20. The summary is outlined below;

Particular	Water-master	Ditch-tender	Pump Operator
1) Personal background			
i) average age	43	42	49
ii) average service period in NIA (year)	11	10	11
iii) status of employment			
a) permanent (%)	83	17	43
b) temporary (%)	37	83	57
iv) education			
a) primary school (%)	0	15	0
b) intermediate school (%)	0	0	30
c) high school (%)	25	85	40
d) college (%)	75	0	30
2) Basic knowledge on water management (%)	17	13	4
3) Basic knowledge on agro-production (%)*	56	49	6
4) Experience n			
i) hydro-measurement (%)*	42	35	14
ii) system management (%)*	67	58	16
iii) design (%)*	30	10	10
5) Understanding of his own duty (%)*	67	0	21
6) Understanding of pump management (%)*	-	-	77

*: Percentage in partcular items (2 to 6) indicates the ratio of number of correct answer to total number of questions.

The above table may suggest that quality of the present O&M staff should be improved especially in the following aspects:

(i) Understanding of duty and responsibility of the job,
(ii) Hydro-measurement, and
(iii) Basic knowledge on water management.

On the other hand, features of the farmers in the irrigation systems are grasped through the questionnaire survey of the farmers, directors of the irrigator's associations. The major points to be improved may be summarized as follows;

(i) leadership of directors of the irrigator's association, and

(ii) basic knowledge and self-reliance on water management of the farmers.

6.6.2 Training for O&M Staff

(1) Objectives

The O&M training programme will be designed to expand the knowledge, understanding and practical ability of the operation and maintenance staff. This will enable them to actively introduce improved O&M procedures and increase the level of efficiency and effectiveness of the system management.

The training programme is planned for watermasters, pump operators and ditchtenders.

The general objectives of their training programmes are to improve the following points.

(i) correct and accurate collection of discharge, rainfall, crop area and other data required for system operation,

(ii) processing, analysis and recording data in a systematic, logical and uniform manner,

(iii) planning, allocating and controlling water distribution so that prescribed discharges are maintained at control points,

(iv) promoting a real understanding of interdependence of water supply and crop production,

(v) implementing routine preventive maintenance of irrigation facilities, pump equipment, monitoring equipment, etc. on a regular and timely basis,

(vi) promoting a real understanding of duties and responsibilities of the O&M staff, and

(vii) providing an understanding on development of the irrigator's associations.

(2) Training Methods

The training methods to be used during the programmes will be (i) lectures and field practice (on-the-job training), (ii) workshops and (iii) field visits.

(i) <u>lectures and field practice</u>: lectures and field inspection will be made, based on the training modules and materials prepared by the consultants in consultation with the professional members of the NIA central office,

(ii) workshops: O&M staff, professional members of the NIA central office and the consultant will made discussions on specific technical and managerial problems on the improved method of working and better procedures, and

(iii) field visit: field visit will be made to the existing pump irrigation systems of the Bustos-Pandi, Buenavista and Tibagan in AMRIS which are some of the most successful irrigation systems among the pump irrigation systems in the country.

(3) Training Modules and Materials

Training modules and materials will be prepared by foreign consultants. The training materials to be used will include the following;

(i)	trainer's handbook	: handbook detailing the principles behind the format of providing advice on methods of presenting and conducting training
(ii)	training modules	: as an introduction and background to each subject for the trainer
(iii)	trainer/trainee notes	: short, succinct notes for lectures, workshops
(iv)	practical exercises	: exercises for the trainee to carry out follow-on from a lecture, to reinforce and show the relevance of the training curriculum materials

(4) Trainers and Trainees

Trainers in the training for the O&M staff in the irrigation systems will be composed of the professional members of the NIA central office. Foreign consultants will assist these trainers.

The required trainers and the objective trainees are estimated as shown in Table 6.21.

(5) Training Curriculum and Programme

The training curriculum for the O&M staff is made to expand their knowledge, understanding and practical ability. The outline of the curriculum is shown in Table 6.22 for watermasters, Table 6.23 for pump operators and Table 6.24 for ditchtenders.

The training programmes will be performed during the first year of the implementation period. Each of the curricula will be one week. These trainings are recommended to be carried out in the following training institutions;

System	Training Institutions
Bonga #1, #2 & #3	Mariano Marcos University
Solana/Alcala-Amulung	Agricultural Training Institute, RTC
Libmanan-Cabusao	PCAR Training Center, Camarines Sur State Agricultural College

Availability of logistic and equipment of these institutions is shown in Table 6.25.

6.6.3 Training of Farmers

(1) Objectives

It is also prerequisite for effective and smooth performance of water management to reinforce the ability of the farmers in the irrigation systems.

Objectives of the training programmes are to promote leadership of representative IA farmers (or candidates) and to improve technical knowledge and skills of farmers in system management and financial management.

(2) Training Methods

The training methods to be used during the programmes will be (i) lectures and field practice (on-the-job training) and (ii) workshop. These methods are as same as described in section 6.6.2(2).

(3) Training Modules and Materials

Training modules and materials will be prepared by local consultants. The training materials to be used will include (i) trainer's handbook, (ii) training modules, (iii) trainer and trainee notes and (iv) practical exercises.

(4) Trainers and Trainees

The Bustos-Pandi, the Buenavista and the Tibagan pump irrigation systems are among the most successful pump irrigation systems in the turnover programme in the country. The main cause of the success in water management is considered to be the effect of training of farmers in the irrigator's association which has been done by the staff of the AMRIS office. Three different training programmes, namely (i) leadership, (ii) system management and (iii) financial management were performed for about 25% of total farmers in these systems.

Based on the above fact, the numbers of the farmers to be trained are estimated as shown in Table 6.26.

Trainers for the training will become the professional members of the NIA central office under local consultants.

(5) Training Curriculum and Programmes

Training curricula will be made to improve quality of the farmers on water management. These curricula comprise three parts namely (i) leadership, (ii) system management and (iii) financial management as shown in Tables 6.26, 6.27 and 6.28.

The training programmes will be undertaken during the first year of the implementation period. Each of the curricula will be four days. The training will be done in the same institutions as shown in section 6.6.2(5).

Table 1.1 SOURCE OF IRRIGATION WATER

Name of Pump Irrigation System	Primary Source of Water: Name	Primary Source of Water: C.A* at Intake (km2)	Primary Source of Water: Annual Mean Discharge (m3/s)	Supplemental Source of Water
Bonga Pump #1	Bonga river	1,275	84.40	
Bonga Pump #2	Bonga river	1,326	87.78	
Bonga Pump #3	Bonga river	1,360	91.91	
Alcala-Amulung	Cagayan river	20,472	982	
Solana	Cagayan river	19,445	933	
Libmanan-Cabusao	Libmanan river	695	36.10	

*: Catchment area

Table i.2 PARAMETERS EMPLOYED IN PRESENT OPERATION AND MAINTENANCE PLAN

Name of System	Year	Sn(mm) Dry Season	Sn(mm) Wet Season	S(mm/d) Dry Season	S(mm/d) Wet Season	P(mm/d) Dry Season	P(mm/d) Wet Season	Ev(mm/d) Dry Season	Ev(mm/d) Wet Season	Et(mm/d) Dry Season	Et(mm/d) Wet Season	LPWR(mm/d) Dry Season	LPWR(mm/d) Wet Season	CWR(mm/d) Dry Season	CWR(mm/d) Wet Season	FD+DL(%) Dry Season	FD+DL(%) Wet Season	CL(%) Dry Season	CL(%) Wet Season
Bonga Pump #1	1982																		
	1983	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1984	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1985	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1986	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1987	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
Bonga Pump #2	1982																		
	1983	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1984	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1985	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1986	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
	1987	94	94	50	50	2.42	2.42	5.07	5.07	6.20	6.20	7.49	7.49	8.62	8.62	30	30	10	10
Bonga Pump #3	1982																		
	1983	94	94	50	50	3.00	3.00	5.40	5.40	6.35	6.35	8.40	8.40	9.35	9.35	30	30	10	10
	1984	94	94	50	50	3.00	3.00	5.40	5.40	6.35	6.35	8.40	8.40	9.35	9.35	30	30	10	10
	1985	94	94	50	50	3.00	3.00	5.40	5.40	6.35	6.35	8.40	8.40	9.35	9.35	30	30	10	10
	1986	94	94	50	50	3.00	3.00	5.40	5.40	6.35	6.35	8.40	8.40	9.35	9.35	30	30	10	10
	1987	94	94	50	50	3.00	3.00	5.40	5.40	6.35	6.35	8.40	8.40	9.35	9.35	30	30	10	10
Alcala-Amulung	1982	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	1983	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	1984	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	1985	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	1986	25	25	100	100	2.00	2.00	4.00	4.00	5.00	5.00	6.00	6.00	7.00	7.00	30	30	15	15
										7.00	7.00			9.00	9.00	30	30	15	15
	1987	25	25	100	100	2.00	2.00	4.00	4.00	5.00	5.00	6.00	6.00	7.00	7.00	30	30	15	15
										7.00	7.00			9.00	9.00	30	30	15	15
Solana	1982	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	1983	66	94	50	50	2.00	2.00	5.00	5.00	6.00	6.00	7.00	7.00	8.00	8.00	30	30	16.18	14.51
	1984	66	94	50	50	2.00	2.00	5.00	5.00	6.00	6.00	7.00	7.00	8.00	8.00	30	30	15.59	14.72
	1985	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
	1986	66	94	50	50	2.00	2.00	5.00	5.00	6.00	6.00	7.00	7.00	8.00	8.00	30	30	23.94	26.45
	1987	95	63	50	50	4.00	4.00	5.00	5.00	6.00	6.00	9.00	9.00	10.00	10.00	30	30	31.26	30.58
Libmanan-Cabusao	1982	62	95	50	50	3.90	3.82	4.23	3.85	4.09	3.52	8.13	7.67	7.99	7.34	30	30	24	24
	1983	62	95	50	50	3.90	3.82	4.23	3.85	4.09	3.52	8.13	7.67	7.99	7.34	30	30	24	24
	1984	62	95	50	50	3.90	3.82	4.23	3.85	4.09	3.52	8.13	7.67	7.99	7.34	30	30	21	21
	1985	62	95	50	50	3.92	3.70	4.21	4.15	4.21	3.78	8.13	7.85	8.13	7.48	30	30	24	24
	1986	62	95	50	50	3.92	3.70	4.21	4.15	4.21	3.78	8.13	7.85	8.13	7.48	30	30	24	24
	1987	62	95	50	50	3.92	3.70	4.21	4.15	4.21	3.78	8.13	7.85	8.13	7.48	30	30	24	24

Sn(mm) ; Land soaking requirement
S(mm) ; Flooding Water
P(mm/d) ; Deep percolation
Ev(mm/d) ; Evaporation rate
Et(mm/) ; Evapotranspiration
LPWR(mm/d); Land preparation requiremen
CWR(mm/d) ; Crop water requirement
FD+DL ; On-farm application loss
CL(%) ; Conveyance loss

Table 1.3 EFFECTIVE RAINFALL EMPLOYED IN PRESENT OPERATION AND MAINTENANCE PLAN

Unit: mm

Name of System	Year	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Bonga Pump #1	1982	?	?	?	?	?	?	?	?	?	?	?	?	
	1983	0	0	0	3	50	153	140	167	189	40	24	6	772
	1984	0	3	3	3	43	135	124	183	192	43	24	6	759
	1985	0	0	3	6	59	129	118	186	174	40	3	6	724
	1986	0	0	0	6	53	147	105	192	171	50	18	3	745
	1987	0	0	0	6	74	147	105	245	171	50	15	3	816
	Average	0	1	1	5	56	142	118	195	179	45	17	5	763
Bonga Pump #2	1982	?	?	?	?	?	?	?	?	?	?	?	?	
	1983	0	0	0	0	133	215	254	177	224	77	38	0	1,118
	1984	3	3	3	21	130	186	233	192	213	84	30	3	1,101
	1985	3	3	6	18	133	189	217	198	195	74	30	3	1,069
	1986	0	3	3	15	121	198	192	239	189	81	30	0	1,071
	1987	3	3	0	15	136	192	183	260	189	81	27	0	1,089
	Average	2	2	2	14	131	196	216	213	202	79	31	1	1,090
Bonga Pump #3	1982	?	?	?	?	?	?	?	?	?	?	?	?	
	1983	6	0	0	18	115	165	195	257	228	68	51	0	1,103
	1984	6	0	0	15	99	150	177	254	216	65	51	0	1,033
	1985	6	0	0	15	109	141	155	276	198	56	39	0	995
	1986	3	0	0	12	99	159	136	307	180	62	33	0	991
	1987	3	0	0	12	118	147	136	322	180	62	36	0	1,016
	Average	5	0	0	14	108	152	160	283	200	63	42	0	1,028
Alcala-Amulung	1982	?	?	?	?	?	?	?	?	?	?	?	?	
	1983	?	?	?	?	?	?	?	?	?	?	?	?	
	1984	?	?	?	?	?	?	?	?	?	?	?	?	
	1985	?	?	?	?	?	?	?	?	?	?	?	?	
	1986	?	?	?	?	?	?	?	?	?	?	?	?	
	1987	?	?	?	?	?	?	?	?	?	?	?	?	
	Average	?	?	?	?	?	?	?	?	?	?	?	?	
Solana	1982	15	7	25	36	145	102	168	204	147	198	174	64	1,285
	1983	14	7	21	44	152	98	150	201	155	175	189	73	1,279
	1984	22	6	23	39	138	92	135	183	152	175	189	73	1,227
	1985	23	6	26	56	144	128	138	172	115	182	171	67	1,228
	1986	21	6	24	62	127	156	128	190	134	197	171	67	1,283
	1987	13	4	9	32	31	35	33	68	32	67	92	32	448
	Average	18	6	21	45	123	102	125	170	123	166	164	63	1,125
Libmanan-Cabusao	1982	11	0	0	64	98	82	210	137	144	124	182	131	1,183
	1983	91	97	4	51	107	95	182	126	147	145	224	137	1,406
	1984	92	78	3	41	90	87	224	117	146	184	207	132	1,401
	1985	110	82	19	39	94	105	211	130	144	197	192	154	1,477
	1986	122	78	24	53	87	112	214	119	144	197	203	154	1,507
	1987	110	82	19	39	94	105	211	130	144	197	192	154	1,477
	Average	89	70	12	48	95	98	209	127	145	174	200	144	1,409

Table 1.4 Ev/Ep,Et/Ev,and Et/Ep RATIOs

Name of System	Ev:mm/day		Ep,A-Pan:mm/day		Ev/Ep Ratio		Et(mm/day)		Et/Ev Ratio		Et/Ep Ratio	
	(1) Dry	(2) Wet	(3) Dry	(4) Wet	(1)/(3)	(2)/(4)	(5) Dry	(6) Wet	(5)/(1)	(6)/(2)	(5)/(3)	(6)/(4)
Bonga Pump #1	5.07	5.07	6.52	5.86	0.78	0.87	6.20	6.20	1.22	1.22	0.95	1.06
Bonga Pump #2	5.07	5.07	6.52	5.86	0.78	0.87	6.20	6.20	1.22	1.22	0.95	1.06
Bonga Pump #3	5.40	5.40	6.52	5.86	0.83	0.92	6.35	6.35	1.18	1.18	0.97	1.08
Alcala-Amulung	4.00	4.00	4.51	5.14	0.89	0.78	5.00	5.00	1.25	1.25	1.11	0.97
							7.00	7.00	1.75	1.75	1.55	1.29
Solana	5.00	5.00	4.51	5.14	1.11	0.97	6.00	6.00	1.20	1.20	1.33	1.17
LIbmanan Cabusao	4.23	3.85	4.35	4.68	0.97	0.82	4.09	3.52	0.97	0.91	0.94	0.75
	-	-					-	-				
	4.37	4.15			1.00	0.89	4.21	3.78	1.00	0.98		

Ev : Evaporation rate adopted for irrigation plan
Ep : Pan evaporation

Table 1.5 DAILY PANEVAPORATION (Class A-Pan)

Unit : mm/day

Station	Period	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN Dry Season Period	Ep	Wet Season Period	Ep	Annual	Name of System
Laoag	70-'74	6.60	6.51	6.97	6.81	6.40	6.34	5.37	5.34	5.39	6.29	5.84	6.40	Nov-Apr	6.52	May-Oct	5.86	6.19	Bonga #1,#2,#3
APC*	80-'87	2.68	4.05	6.33	6.90	6.93	5.55	4.66	4.20	4.15	3.65	2.93	2.25					4.52	(Alcala-Amulung,Solana)
Tuguegarao**	74-'85	2.6	4.2	5.2	5.8	5.8	5.2	5.1	4.2	3.3	3.3	2.6	2.0					4.11	(Alcala-Amulung,Solana)
Alimanao**	57-'76	4.9	5.5	6.6	7.8	7.5	6.4	6.0	5.5	5.8	5.3	4.5	4.4					5.85	(Alcala-Amulung,Solana)
(Average)		3.39	4.58	6.04	6.83	6.74	5.72	5.25	4.63	4.42	4.08	3.34	2.88	Nov-Apr	4.51	May-Oct	5.14	4.83	Alcala-Amulung,Solana
Naga	'56-'65	4.45	4.76	5.10	5.90	5.50	5.11	4.35	4.27	4.08	3.67	4.15	3.96	Oct-Mar	4.35	May-Sep	4.68	4.52	Libmanan-Cabusao

* : Agricultural Pilot Center

** : The Master Plan Study on The Cagayan River Basin Water Resources Development

Table 1.6 DIVERSION WATER REQUIREMENT FOR IRRIGATED AREA

Unit ; mm

	Bonga Pump #1		Bonga Pump #2		Bonga Pump #3		Alcala-Amulung		Solana		'Libmanan-Cabusao	
	DWR(wo/Br)	DWR(w/Br)	DWR(wo/Br)	DWR(w/Br)	DWR(wo/Br)	DWR(w/Br)	DWR(wo/Br)	DWR(w/Br)	DWR(wo/Br)	DWR(w/Br)	DWR(wo/Br)	DWR(w/Br)
dry'82/83	1515	1508	1503	1177	1555	1533	?	?	1389	1130	1841	1194
wet'83	1565	855	?	?	1691	683	?	?	1441	608	1501	669
dry'83/84	1607	1591	1768	1717	1540	1521	?	?	1201	951	1799	1383
wet'84	1515	849	1742	595	1514	577	?	?	?	?	1715	704
dry'84/85	1422	1504	1884	1822	1821	1766	1301	?	?	?	2075	1273
wet'85	1422	721	1468	582	1473	598	1098	?	?	?	1711	610
dry'85/86	1503	1417	1515	1470	1332	1309	1495	?	1392	949	1575	796
wet'86	1270	788	1780	673	1750	773	1223	?	?	?	1893	560
dry'86/87	?	1255	2052	1925	1352	1342	1548	?	?	?	?	?
wet'87	?	?	?	?	?	?	?	?	?	?	1620	633

wo/Br ; No effective rainfall is considered.
w/Br ; Effective rainfall is considered.

Table 1.7(1/2) REQUIRED CANAL CAPACITY IN PRESENT ROTATIONAL DISTRIBUTION

Name of Pump Irrigation System	Rotational Block Name	Area(ha)*	Rotation Interval (days)	Pump Operating Hours(hr)	Unit Diversion Water Requirement (l/s/ha)	Name of Canal	Required Canal Capacity** (m3/s)	Designed Canal Capacity (m3/s)	Sufficiency of Canal Capacity
Bonga Pump #1	A	39	4	12	1.43	MC	0.45		
		114	4	12	1.43	Lat-B	1.30	0.08	no
		(153)				MC	1.75	1.00	no
	B	44	4	12	1.43	MC	0.50	1.00	ok
	C	101	4	12	1.43	MC	1.15	1.00	no
Bonga Pump #2	6 & 11	16	3	12	1.43	Lat-B2	0.14	?	?
		16	9	13	1.43	Lat-B	0.38	0.89	ok
		(32)				MC	0.52	2.59	ok
	6,8 & 10	16	3	12	1.43	Lat-B2	0.14	?	
		26	9	14	1.43	Lat-B1	0.57	0.16	no
		61	9	14	1.43	Lat-B	1.34	0.89	no
		(103)				MC	2.05	2.59	ok
	6 & 9	16	3	12	1.43	Lat-B2	0.14	?	
		31	9	12	1.43	Lat-B	0.80	0.89	ok
		(47)				MC	0.94	2.59	ok
	4 & 16	43	9	12	1.43	Lat-B	1.10	0.89	no
		13	9	19	1.43	MC	0.21		
		(56)				MC	1.31	2.59	ok
	1,2 & 3	23	9	12	1.43	Lat-A	0.59	0.17	no
		2	9	12	1.43	MC	0.05		
		87	9	12	1.43	Lat-B	2.23	0.89	no
		(112)				MC	2.87	2.59	no
	5	29	9	12	1.43	Lat-BBx	0.74	0.10	no
	7 & 14	5	9	12	1.43	Lat-B1	0.13	0.16	ok
		170	9	14	1.43	MC	3.74		
		(175)				MC	3.87	2.59	no
	12 & 13	21	9	20	1.43	MC	0.32		
		11	9	12	1.43	Lat-C	0.28	0.18	no
		(32)				MC	0.60	2.59	ok
	15	130	9	19	1.43	MC	2.11	2.59	ok
Bonga Pump #3	I	120	1.6	13	1.55	MC	0.55	0.90	ok
	II	19	2.7	14	1.55	MC	0.14		
		36	2.7	14	1.55	Lat-A	0.26	0.08	no
		23	2.7	14	1.55	Lat-B	0.16	0.08	no
		(78)				MC	0.56	0.90	ok

* ; Service area
** ; Required canal capacity for the service area

Table 1.7(2/2)   REQUIRED CANAL CAPACITY IN PRESENT ROTATIONAL DISTRIBUTION

Name of Pump Irrigation System	Rotational Block Name	Rotational Block Area(ha)	Rotation Interval (days)	Pump Operating Hours(hr)	Unit Diversion Water Requirement (l/s/ha)	Name of Canal	Required Canal Capacity (m3/s)	Designed Canal Capacity (m3/s)	Sufficiency of Canal Capacity
Alcala-Amulung	I,II,IV & VI	431	3.5	19	1.56	MC	2.97		
		94	2.3	19	1.56	Lat-B	0.43	0.52	ok
		100	1	19	1.56	Lat-C	0.20	0.24	ok
		(625)				MC	3.60	2.86	no
		460	3.5	19	1.56	Lat-A	3.17	1.47	no
	II,IV & V	94	2.3	19	1.56	Lat-B	0.43	0.52	ok
		100	1	19	1.56	Lat-C	0.20	0.24	ok
		348	1.75	19	1.56	Lat-D	1.20	0.85	no
		(542)				MC	1.83	2.86	ok
	III,IV & V	130	2.3	19	1.56	Lat-B	0.59	0.52	no
		100	1	19	1.56	Lat-C	0.20	0.24	ok
		348	1.75	19	1.56	Lat-D	1.20	0.85	no
		(578)				MC	1.99	2.86	ok
Solana	I	73	3.5	14	1.50	MC	0.66		
		234	3.5	14	1.50	Lat-ABx	2.11	1.08	no
		(307)				MC	2.77	5.33	ok
	III	253	3.5	14	1.50	MC	2.28	5.33	ok
	II	165	3.5	14	1.50	MC	1.49		
		83	3.5	14	1.50	Lat-A	0.75	0.48	no
		(248)				MC	2.24	5.33	ok
Libmanan-Cabusao	1	263	7	15	1.52	Lat-D	4.47	0.83	no
						MC	4.47	6.05	ok
	2	100	7	15	1.52	Lat-A	1.70	0.12	no
						MC	1.70	6.05	ok
	3	352	3.5	15	1.52	Lat-B	2.99	1.43	no
						MC	2.99	6.05	ok
	4	2403	2.3	15	1.52	Lat-c	13.41	3.13	no
						MC	13.41	6.05	ok

* ; Service area
** ; Required canal capacity for the service area

Table 1.8 PUMPING CAPACITY AND POSSIBLY MAXIMUM IRRIGATION AREA

Possibly Maximum Irrigation Area under Present Condition

Name of System	Present Pumping Capacity			Rated Pumping Capacity			Present Maximum Pump Operating Hours	Unit DWR (l/s)*	Possibly Maximum Irrigation Area** (ha)	Possibly Maximum Irrigation Area*** (ha)	Generated Area (ha)	Service Area in 1986 (ha)	Programed Area in 1987 (ha)
	Unit Capacity (m3/s)	Nos. of Unit	Total Capacity (m3/s)	Unit Capacity (m3/s)	Nos. of Unit	Total Capacity (m3/s)							
Bonga Pump #1	0.20	1	0.20	0.63	2	1.26							
	0.34	1	0.34										
			0.55			1.26	18	1.4	287	663	426	298	150
Bonga Pump #2	0.00	1	0.00	0.95	2	1.89							
	0.80	1	0.80	1.58	1	1.58							
	1.00	1	1.00										
			1.80			3.47	21	1.4	1,101	2,128	1,200	674	507
Bonga Pump #3	0.00	1	0.00	0.57	2	1.14							
	0.52	1	0.52										
			0.52			1.14	15	1.5	209	459	?	202	140
Alcala Amulung	1.18	3	3.53	1.18	3	3.53							
	1.21	1	1.21	1.33	1	1.33							
			4.73			4.86	19	1.6	2,406	2,470	2,350	1,840	1,612
Solana	1.42	1	1.42	1.70	4	6.81							
	1.31	1	1.31										
	0.00	2	0.00										
			2.73			6.81	15	2.0	865	2,160	2,865	1,320	800
Libmanan Cabusao	1.43	2	2.87	1.53	4	6.11							
	0.00	2	0.00										
			2.87			6.11	16	1.5	1,260	2,684	4,100	2,195	1,700

* ; Unit Diversion Water Requirement under 24-hour consecutive pumping
** ; Possibly Maximum Irrigation Area under Pumping Capacity as of Oct.'87
*** ; Possibly Maximum Irrigation Area under Original Rated Pumping Capacity

Table 1.9 IRRIGATED AREA BY CROPPING SEASON

Unit; ha

Year	Bonga Pump #1 (D.S.A = ? ; G.A = ?)					Bonga Pump #2 (D.S.A = 1,200 ; G.A = 1,200)				
		Programed Area		Irrigated Area			Programed Area		Irrigated Area	
	S.A	Dry	Wet	Dry	Wet	S.A	Dry	Wet	Dry	Wet
1982	298	?	?	165	-	622	?	?	323	509
1983	298	120	160	95	122	674	330	495	88	-
1984	298	90	150	93	140	674	200	508	224	510
1985	298	?	?	117	125	674	?	?	233	493
1986	298	117	150	187	162	674	233	507	275	450
1987	298	117	150	57		674	275	507	208	
Average	298	111	153	119	137	665	260	504	225	392

Year	Bonga Pump #3 (D.S.A = ? ; G.A = 218)					Alcala-Amulung PIS (D.S.A = 2,350 ; G.A = 2,279)				
		Programed Area		Irrigated Area			Programed Area		Irrigated Area	
	S.A	Dry	Wet	Dry	Wet	S.A	Dry	Wet	Dry	Wet
1982	202	?	?	111	165	-	-	-	-	-
1983	202	110	175	92	150	?	?	?	576	522
1984	202	70	157	36	136	1,840	?	?	1,162	576
1985	202	?	?	78	133	1,840	?	?	1,281	1,139
1986	202	78	140	67	144	1,840	1,350	1,500	1,015	746
1987	202	78	140	62		1,563	1,500	1,612	1,500	
Average	202	84	153	74	146	1,771	1,425	1,556	1,107	746

Year	Solana PIS (D.S.A = 3,600 ; G.A = 2,865)					Libmanan-Cabusao PIS (D.S.A = 4,523 ; G.A = 4,102)				
		Programed Area		Irrigated Area			Programed Area		Irrigated Area	
	S.A	Dry	Wet	Dry	Wet	S.A	Dry	Wet	Dry	Wet
1982	842	?	?	472	679	3,427	2,562	3,427	1,665	2,195
1983	1,320	1,096	1,277	919	932	3,427	2,659	3,427	2,013	1,469
1984	1,320	1,200	1,200	1,019	927	3,427	2,745	3,427	1,357	1,472
1985	1,320	?	?	-	958	3,427	1,790	1,980	1,653	1,632
1986	1,320	1,200	1,000	780	-	2,195	1,790	1,279	960	295
1987	808	600	800	?		2,195	1,700	1,113		
Average	1,155	1,024	1,069	638	699	3,016	2,208	2,442	1,530	1,413

D.S.A = Designed sevice area
G.A = Generated area

Table 1.10 IRRIGATION WATER DIVERTED PER CROPPING SEASON

Unit ; mm

Name of System	dry'86/87	wet'86	dry'85/86	wet'85	dry'84/85	wet'84	dry'83/84	wet'83	dry'82/82
Bonga Pump #1	2,004	383	1,337	556	1,062	1,068	1,099	?	?
Bonga Pump #2	1,494	303	1,310	363	1,790	?	?	?	?
Bonga Pump #3	2,295	567	2,157	722	2,206	?	?	?	?
Alcala Amulung	1,358	1,125	946	812	1,113	?	?	?	?
Solana	0	0	1,519	983	0	1,111	1,157	1,127	1,032
Libmanan Cabusao	?	524	847	945	964	958	?	?	?

Table 1.11 (1/5) EFFECTIVE RAINFALL IN PRESENT WATER MANAGEMENT

Bonga Pump #1 Irrigation Service Area

Dry'86/87	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	0.0	0.0	0.0	0.0	0.0	0.0	-
RE 1 (mm)	0.0	0.0	0.0	0.0	0.0	0.0	-
RE 2 (mm)	0.0	0.0	0.0	0.0	0.0	0.0	-

Wet'86	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	88.0	355.9	1146.1	514.7	57.7	59.7	2222.1	-
RE 1 (mm)	23.1	190.2	230.8	225.9	40.3	0.0	710.3	32.0
RE 2 (mm)	0.0	184.8	206.9	155.2	34.5	8.6	589.9	26.5

Dry'85/86	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	2.2	16.5	0.1	0.0	0.0	540.6	559.4	-
RE 1 (mm)	1.5	11.5	0.1	0.0	0.0	0.0	13.1	2.3
RE 2 (mm)	0.0	37.2	0.0	0.0	0.0	0.0	37.2	6.6

Wet'85	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	1069.5	41.3	1015.4	134.9	327.4	23.8	2612.3	-
RE 1 (mm)	60.8	28.9	197.9	94.3	35.0	0.0	416.9	16.0
RE 2 (mm)	164.6	95.4	215.5	129.3	77.6	0.0	682.4	26.1

Dry'84/85	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	0.0	0.0	0.0	0.0	0.0	184.0	184.0	-
RE 1 (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE 2 (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Wet'84	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	248.7	197.4	716.3	60.4	14.3	10.8	1247.9	-
RE 1 (mm)	23.8	136.4	172.0	42.2	10.0	0.0	384.4	30.8
RE 2 (mm)	123.4	157.1	189.6	77.6	8.6	0.0	556.4	44.6

Dry'83/84	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	4.0	0.0	0.0	0.0	285.2	178.2	467.4	-
RE 1 (mm)	2.8	0.0	0.0	0.0	0.0	0.0	2.8	0.6
RE 2 (mm)	0.0	0.0	0.0	0.0	8.6	60.3	69.0	14.8

Note

RE 1: Assumed effective rainfall in present water management,corresponding to difference of calculated diversion water requirment without rainfall and actually diverted irrigation water

RE 2: Estimated effective rainfall on the basis of NIA's irrigation suspension schedule

Table 1.11 (2/5) EFFECTIVE RAINFALL IN PRESENT WATER MANAGEMENT

Bonga Pump #2 Irrigation Service Area

Dry'86/87	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	59.7	0.0	0.0	0.0	0.0	0.0	0.0	59.7	-
RE 1 (mm)	8.4	0.0	0.0	0.0	0.0	0.0	0.0	8.4	14.1
RE 2 (mm)	5.7	0.0	0.0	0.0	0.0	0.0	0.0	5.7	9.5

Wet'86	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	88.0	355.9	1146.1	514.7	57.7	59.7	2222.1	-
RE 1 (mm)	61.5	169.2	254.5	258.7	40.3	21.0	805.2	36.2
RE 2 (mm)	41.1	154.7	206.9	155.2	34.5	46.0	638.4	28.7

Dry'85/86	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	2.2	16.5	0.1	0.0	0.0	540.6	559.4	-
RE 1 (mm)	0.0	11.5	0.1	0.0	0.0	0.0	11.6	2.1
RE 2 (mm)	0.0	37.0	0.0	0.0	0.0	17.2	54.3	9.7

Wet'85	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	41.3	1015.4	134.9	327.4	23.8	1542.8	-
RE 1 (mm)	28.9	175.5	94.3	139.9	0.0	438.6	28.4
RE 2 (mm)	119.4	212.0	129.3	77.6	8.6	546.9	35.5

Dry'84/85	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	0.0	0.0	0.0	0.0	0.0	184.0	184.0	-
RE 1 (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE 2 (mm)	0.0	0.0	0.0	0.0	0.0	8.6	8.6	4.7

Note

RE 1: Assumed effective rainfall in present water management,corresponding to difference of culculated diversion water requirment without rainfall and actually diverted irrigation water

RE 2: Estimated effective rainfall on the basis of NIA's irrigation suspention schedule

Table 1.11 (3/5) EFFECTIVE RAINFALL IN PRESENT WATER MANAGEMENT

Bonga Pump #3 Irrigation Service Areea

Dry'86/87	Nov	Dec	Jan	Feb	Mar	Total	RE/R (%)
RAIN (mm)	59.7	0.0	0.0	0.0	0.0	59.7	-
RE 1 (mm)	27.3	0.0	0.0	0.0	0.0	27.3	45.7
RE 2 (mm)	5.8	0.0	0.0	0.0	0.0	5.8	9.7

Wet'86	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	88.0	355.9	1146.1	514.7	57.7	59.7	2222.1	-
RE 1 (mm)	61.5	58.7	240.6	249.0	40.3	5.6	655.7	29.5
RE 2 (mm)	0.0	175.4	224.4	168.3	37.4	3.6	609.1	27.4

Dry'85/86	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	16.5	0.1	0.0	0.0	540.6	557.2	-
RE 1 (mm)	0.0	0.1	0.0	0.0	0.0	0.1	0.0
RE 2 (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Wet'85	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	1069.5	41.3	1015.4	134.9	327.4	23.8	2612.3	-
RE 1 (mm)	0.0	28.9	192.3	94.3	35.7	4.9	356.1	13.6
RE 2 (mm)	164.6	133.6	233.6	140.3	84.2	9.4	765.5	29.3

Dry'84/85	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	0.0	0.0	0.0	0.0	0.0	184.0	184.0	-
RE 1 (mm)	0.0	0.0	0.0	0.0	0.0	32.2	32.2	17.5
RE 2 (mm)	0.0	0.0	0.0	0.0	0.0	9.4	9.4	5.1

Note

RE 1: Assumed effective rainfall in present water management,corresponding to difference of calculated diversion water requirment without rainfall and actually diverted irrigation water

RE 2: Estimated effective rainfall on the basis of NIA's irrigation suspention schedule

Table 1.11 (4/5) EFFECTIVE RAINFALL IN PRESENT WATER MANAGEMENT

Solana Pump Irrigation Service Area

Dry'85/86	Feb	Mar	Apr	May	Jun	Jul	Total	RE/R (%)
RAIN (mm)	44.6	24.9	24.4	76.4	92.2	326.6	589.1	-
RE 1 (mm)	0.0	0.0	15.1	47.4	14.3	0.0	76.8	13.0
RE 2 (mm)	58.8	16.6	20.4	56.8	71.0	0.0	223.5	37.9

Dry'83/84	Jan	Feb	Mar	Apr	May	Jun	Total	RE/R (%)
RAIN (mm)	1.4	4.7	19.6	166.8	135.4	282.6	610.5	-
RE 1 (mm)	0.9	0.0	0.0	2.0	89.8	0.0	92.7	15.2
RE 2 (mm)	0.0	0.0	14.4	76.8	99.4	0.0	190.6	31.2

Wet'83	Aug	Sep	Oct	Nov	Dec	Jan	Total	RE/R (%)
RAIN (mm)	115.3	187.8	336.2	55.8	4.2	1.4	700.7	-
RE 1 (mm)	0.0	7.4	83.6	37.3	2.8	0.9	132.0	18.8
RE 2 (mm)	144.75	78.12	165.5	49.7	66.9	0.0	504.9	72.1

Dry'82/83	Jan	Feb	Mar	Apr	May	Jun	Total	RE/R (%)
RAIN (mm)	68.4	1.4	23.8	7.6	65.4	46.8	213.4	-
RE 1 (mm)	45.4	0.9	0.0	5.0	43.4	29.8	124.5	58.3
RE 2 (mm)	57.6	0.0	20.9	7.1	42.6	35.48	163.7	76.7

Note

RE 1: Assumed effective rainfall in present water management,corresponding to difference of culculated diversion water requirment without rainfall and actually diverted irrigation water

RE 2: Estimated effective rainfall on the basis of NIA's irrigation suspention schedule

Table 1.11 (5/5) EFFECTIVE RAINFALL IN PRESENT WATER MANAGEMENT

Libmanan-Cabusao Pump Irrigation Service Area

Wet'86	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	53.4	239.2	183.6	266.2	163.5	360.5	190.9	1457.3	-
RE 1 (mm)	0.0	148.4	113.9	165.1	101.4	180.5	80.6	789.9	54.2
RE 2 (mm)	0.0	175.8	113.6	115.6	102.0	149.6	68.0	724.6	49.7

Dry'85/86	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total	RE/R (%)
RAIN (mm)	337.8	137.0	69.4	78.7	39.4	36.8	109.2	808.3	-
RE 1 (mm)	49.0	85.0	43.1	48.8	0.0	22.8	0.0	248.7	30.8
RE 2 (mm)	171.5	67.5	65.1	37.0	29.6	37.0	0.0	407.5	50.4

Wet'85	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	RE/R (%)
RAIN (mm)	101.0	132.4	287.6	46.4	261.8	337.8	137.0	1304.0	-
RE 1 (mm)	19.2	82.1	110.4	0.0	79.4	152.6	56.5	500.2	38.4
RE 2 (mm)	94.7	148.6	180.6	54.9	122.4	115.6	54.4	771.2	59.1

Dry'84/85	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	RE/R (%)
RAIN (mm)	377.5	261.8	86.7	96.3	70.6	66.0	67.0	101.0	1126.9	-
RE 1 (mm)	35.4	162.4	53.8	59.7	43.8	40.9	0.0	18.6	414.6	36.8
RE 2 (mm)	168.3	175.4	79.7	81.3	44.4	66.5	44.4	94.7	754.6	67.0

Wet'84	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	RE/R (%)
RAIN (mm)	147.5	23.6	78.8	103.3	252.2	217.2	168.3	377.5	261.8	86.7	1716.9	-
RE 1 (mm)	0.0	0.0	19.1	65.7	64.8	138.1	20.3	90.3	17.8	1.3	417.4	24.3
RE 2 (mm)	0.0	24.1	95.4	67.8	127.8	141.3	93.4	160.2	126.8	33.4	870.1	50.7

Note

RE 1: Assumed effective rainfall in present water management,corresponding to difference of calculated diversion water requirment without rainfall and actually diverted irrigation water

RE 2: Estimated effective rainfall on the basis of NIA's irrigation suspension schedule

Table 1.12(1/3) FARMER'S INTENTION FOR WATER MANAGEMENT

(unit: %)

Description	Bonga #1	Bonga #2	Bonga #3	Alcala-Amulung	Solana	Libmanan-Cabusao
1.Farmer's view on water management system						
a.very much satisfied	0	0	20	35	14	0
b.satisfied	20	57	20	41	71	0
c.slightly satisfied	20	43	20	19	7	56
d.not satisfied	20	0	0	0	7	44
e.others	40	0	40	3	0	0
2.Reason behind farmer's discontent						
a.inadequate supply of irrigation water	20	29	0	38	7	67
b.detective irrigation facilities	0	14	0	19	14	67
c.lack of information dissemination	0	14	0	11	0	6
d.high irrigation fee	0	0	0	16	7	17
e.lack of responsibility and duties of NIA staff	0	0	0	3	0	6
f.complicated procedure	0	0	0	3	0	0
g.unjust policy in granting exception	0	0	0	0	0	0
h.weak policy in granting exception	0	0	0	0	7	6
i.others	0	0	0	0	0	0
3.Feeling of farmer's on present irrigation facilities						
a.good	60	71	20	41	36	0
b.fair	0	29	20	43	21	39
c.poor	0	0	20	14	43	61
d.others	40	0	40	3	0	0
4.Problems of irrigation facilities						
a.low embankment	0	0	20	19	43	89
b.silted canal bottom	0	0	20	41	29	33
c.erosion in canal	0	0	20	14	21	39
d.problems in turnouts	0	29	0	24	21	11
e.problems in checkgate	0	29	20	11	7	6
f.no measuring devices	0	0	0	3	0	6
g.lack of terminal facilities	0	0	0	3	0	17
h.others	0	14	0	0	7	0
5.Irrigation time when farmers encounter difficulty						
a.saturation period	0	0	0	24	14	11
b.land soaking period	20	0	0	16	7	22
c.land preparation period	40	86	60	14	29	56
d.normal irrigation period	0	14	0	35	50	11
e.others	40	0	40	11	0	0
6.Condition of flow of irrigation water at the terminal point during irrigation period						
a.abundant flow into the drainage canal	0	14	40	46	14	50
b.no water flowing into the drainage canal	60	71	20	43	86	50
c.others	40	14	40	11	0	0
7.Cause for the low yield of palay						
a.damage by blight and insects	0	29	20	41	21	22
b.tyhoon,strorm nd depression	80	43	80	54	57	61
c.ill drainage	0	14	0	19	21	33
d.poor water management	20	43	40	24	29	67
e.lack of fertilizer	20	0	0	5	21	6
f.irregular topography of the farm	0	0	0	14	14	6
g.others	0	14	20	0	0	0

Table 1.12(2/3) FARMER'S INTENTION FOR WATER MANAGEMENT

(unit: %)

Description	Bonga #1	Bonga #2	Bonga #3	Alcala-Amulung	Solana	Libmanan-Cabusao
8.Frequencey of conflict involved over the use of water						
a.zero	60	71	60	57	50	56
b.one	0	0	0	14	29	33
c.two	0	29	0	0	0	11
d.over three	40	0	0	30	21	0
9.Kind of conflict involved						
a.priority in the use of water	0	0	0	5	7	11
b.schdule of water delivery	0	29	0	22	29	22
c.lack of communication during time of water distribution	0	14	0	16	21	11
d.problem on physical facilities	0	14	0	3	0	0
e.lack of water	0	0	0	5	7	28
f.drainage problem	0	0	0	3	7	11
g.destructin of irrigation facilities	0	0	0	0	0	0
h.others	0	0	0	0	0	0
10.kind of illegal structures farmers constructed						
a.intake by using a pipe or bamboo tube	0	0	0	24	0	0
b.intake by cutting canal embankment	0	0	0	14	0	11
c.illegal check	0	0	0	0	7	0
d.others	0	0	0	3	0	0
11.Reason for construction of illegal structures						
a.irregular topography	0	0	0	3	0	0
b.size of farm	0	0	0	3	0	0
c.length of farm ditch	0	0	0	0	0	0
d.insufficient water supply	0	0	0	30	7	11
e.poor irrigation facilities	0	0	0	3	0	0
f.others	0	0	0	5	0	0
12.Warning of demolition for such illegal structures						
a.there it was	0	0	0	16	7	6
b.there it was not	0	29	0	24	0	6
c.others	0	0	0	0	0	0
13.Necessity of rotational method of irrigation to upgrade the present water distribution						
a.yes	60	86	60	89	93	83
b.no	0	0	0	5	0	11
c.don't know	0	14	40	3	7	6
d.others	40	0	0	3	0	0

Table 1.12(3/3)   FARMER'S INTENTION FOR WATER MANAGEMENT

(unit: %)

Description	Bonga #1	Bonga #2	Bonga #3	Alcala-Amulung	Solana	Libmanan-Cabusao
14.Farmer's attitude towards original farming activities NIA schedules						
a.willing to follow	60	100	60	70	93	83
b.unwilling to follow	0	0	0	11	0	11
c.case by case	0	0	0	14	7	6
d.others	40	0	40	5	0	0
15.Reason why farmers follow original farming activities						
a.to avoid water wastage	20	57	60	65	100	67
b.to follow NIA's schedule oarder	40	100	40	46	29	33
c.to get sufficient water	20	29	40	27	21	67
d.to be afraid of water-off	40	86	20	16	7	17
e.to harvest at same time	20	100	60	22	21	44
f.others	0	0	0	5	0	0
16.Reason why farmers do not follow the original farming activities						
a.rotation water is not enough to plant at the same time	0	0	0	27	7	17
b.lack of capital	0	0	0	5	0	0
c.no available labor and farm machinery	0	0	0	5	0	0
d.person's willingness to plant ahead	0	0	0	3	0	0
e.different rice varieties	0	0	0	3	0	6
f.others	0	0	0	0	0	0

Table 2.1 PRESENT CONDITION ON EQUIPMENT OF HYDROLOGICAL MEASUREMENT

(unit:No.)

Name of System	Rainfall station		Discharge Measurement Devices					
	Standard Raingage		Staff Gage		Parshall Flume		Current Meter (Price-Type)	
	Functional	Not Functional	Functional	Not Functional	Functinal	Not Functional	Functional	Not Functional
Bonga pump #1	1	0	1	0	0	0	1	0
Bonga pump #2	1	0	0	0	0	0	1	0
Bonga pump #3	1	0	0	0	0	0	1	0
Alcala-Amulung	1	0	0	0	1	0	1	0
Solana	2	0	1	0	0	0	1	0
Libmanan-Cabusao	1	6	0	0	3	6	1	0

Table 2.2 CONDITION OF COMMUNIICATION EQUIPMINT

Name of System	Radio SSB		Radio VHF		Walkietalkie
	No.	condition	No.	condition	No.
Bonga #1	0	-	0	-	0
Bonga #2	0	-	0	-	0
Bonga #3	0	-	0	-	0
Alucala-Amulung	0	-	1	G*	0
Solana	1	G*	0	0	0
Libmanan-Cabusao	0	-	1**	G*	0

* good condition
** furuno vf 25 type

Table 2.3 FARMER'S INTENTION FOR COMMUNICATION

(unit: %)

Description	Bonga #1	Bonga #2	Bonga #3	Alcala-Amulung	Solana	Libmanan-Cabusao
1.Frequency of visit to working station of system office						
a.frequently	40	57	60	32	29	11
b.not so much	0	0	0	41	36	56
c.seldom	20	43	0	24	36	17
d.not at once	0	0	0	3	0	17
e.others	40	0	40	0	0	0
2.Distance from farm to the nearest working station						
a.less than 2 km	20	43	40	70	43	61
b.2-4 km	40	29	20	24	36	22
c.more than 4 km	0	29	0	5	14	11
d.don't know where it is	0	0	0	0	7	6
e.others	40	0	40	0	0	0
3.Frequency of communication with NIA-staff						
a.frequently	20	43	60	27	36	22
b.not so much	20	14	0	59	36	50
c.seldom	20	43	0	14	29	28
d.others	40	0	40	0	0	0
4.Person with whom farmers keep contact						
a.office personnel	0	43	40	40	50	45
b.gatekeeper	0	29	40	27	0	6
c.ditchtender	20	14	20	65	50	28
d.water master	40	57	40	57	43	61
e.others	40	0	0	0	0	6
5.Reason behind farmer's poor communication with NIA-staff						
a.no time	60	57	0	49	43	61
b.poor comprehension of NIA-staff	0	14	0	3	14	22
c.no intention to communicate	0	0	0	8	0	0
d.others	40	29	0	0	14	6
6.Suggestion to NIA-staff						
a.to do their job industriously	0	0	0	5	7	50
b.better supervision	80	29	80	38	50	22
c.to visit farms regularly	20	57	0	46	43	17
d.no difficulties in getting water	0	14	0	3	0	6
e.others	0	0	20	0	0	6

Table 2.4 LIST OF PRESCRIBED REPORTS

	Title	Frequency	Irrigation Systems			
			Alcala-Amlung	Solana (1)	Libmanan-Cabusao	Bonga #1,#2 and #3
Adminis-tration	cash utilization	M	**	**	*	
	status of fund	M	**	**	*	
	report of income and expenses	Q	**	**	*	
	balances of bub-allotment advices	M	*	*	*	
	cost report	M	**	*	**	
	obligation incurred	M	*	*	**	
	summary of disbursement	M	*	*	**	
	report of checks issued and cancelled	M	*	**	**	
	semi annual report of leaves of absences, earned enjoyed and balance	SA	*	*	**	
	monthly report of manpower utlization	M	**	*	**	
	report of emergency purchases	M	*	**	**	
	inventory of supplies and materials	M	**	**	**	
	fuel and electricity consumption	M	**	*	**	
	report of disbursement	M	**	*	**	
	performance rating	SA	*	*	*	
	report of overtime services	M	**	**	**	
	summary of every fifty bills	M	**	**	**	
	evaluation report of fuel consumption	M	**	*	*	
Opera-tion	summary of daily discharge	D	**	**	**	*
	weekly farming activities	W	*	*	*	*
	oprtation and maintenance report	M	*	*	*	*
	hydrometeorological report	M	**	**	**	**
	operation and maintenance monitoring report	Q	*	**	*	**
	harvest report	SA	*	*	*	*
	annual report of irrigated and planted area	SA	*	*	*	*
Mainte-nance	monthly progress report	M	*	**	*	
	quarterly progress report	Q	*	**	**	
	fuel consumption evaluation report	M	*	*	**	
	materials and office supplies report	M	*	**	**	
	monthly equipment utilization report	M	*	*	*	
collect-ion	report of monthly collection	M	*	*	*	*
	collection report and irrigation collection status	W	*	*	**	*

* submitted from system office to regional office
** not used
M:monthly Q:quarterly SA:semi-annually D:daily W:weekly
(1): before turnover stage 3

Table 3.1 PRESENT CONDITION OF O & M EQUIPMENT AND OTHER FACILITIES

(unit:nos)

Item	Bonga #1 Bonga #2 Bonga #3		Alcal- Amulung		Solana		Libmanan-Cabusao	
	A	B	A	B	A	B	A	B
A. Heavy Equipment								
1.Crawler crane,25ton	-	-	-	-	-	-	-	-
2.Truck crane,20ton	-	-	-	-	-	-	-	-
3.Excavator,0.35m3	2	-	2	-	1	1	-	-
4.Wheel excavator,0.5m3	1	1	-	-	-	-	-	-
5.Motor grador,3.7m3	1	-	1	-	-	-	-	-
6.Wheel loader,1.4m3	1	-	-	-	1	-	1	-
7.Dozer 220/143H.P	1	2	1	-	-	1	-	-
8.Forklift	-	-	-	-	-	-	-	-
9.Dump truck,6ton	3	3	1	-	-	-	1	-
10.Cargo truck,6ton	1	-	2	-	-	-	1	-
11.Concrete truck mixer	-	-	-	-	-	-	-	-
12.Concrete skid mixer	1	-	-	-	-	-	-	-
B. Light Equipmint								
1.Pikup	2	1	2	-	1	-	1	-
2.Jeep	1	-	-	-	-	-	-	-
3.Station wagon	-	-	-	-	-	-	-	-
4.Motorcycle	19	-	11	-	9	-	3	4
5.Dredge pump	-	-	-	-	-	-	-	-
6.Booster pump	-	-	-	-	1	-	-	-
7.Weed cutter	-	-	7	-	-	-	-	-
8.Chain saw	-	-	-	-	-	-	-	-
C. Shop Equipment								
1.Welding machine	1	-	-	-	-	-	1	-
2.Air compresser	1	-	-	-	-	-	1	-
3.Bench grinder	1	-	-	-	-	-	1	-
4.Bench drill	1	-	-	-	-	-	-	-
5.Battery charger	1	-	-	-	-	-	1	-
6.Engine generator	1	-	-	1	-	-	-	-
7.Overhead crane	-	-	1	2	-	-	-	-
8.Chain block	1	-	-	-	1	-	1	-
D. Other Facilities								
1.Repairing shop	1	-	-	-	1	-	-	-
2.Warehouse	1	-	1	-	1	-	1	-
3.Field office	1	-	1	-	1	-	1	-
4.Guest house	1	-	1	-	1	-	-	-
5.Gard house	1	-	1	-	-	-	1	-
6.Garage	1	-	-	-	1	-	1	-
7.Training center	-	-	-	-	1	-	-	-
8.Motor pool	1	-	-	-	1	-	1	-
9.Rest house	-	-	-	-	-	-	1	-
10.Pump operator quarter	1	-	1	-	1	-	1	-
11.Water master station	3	-	4	-	1	-	6	-

A: running condition B: poor condition

Table 4.1 STAFFING AND WORK LOAD OF O & M STAFF IN 1988

Name of System	Water master No.	Water master work load	Ditch tender No.	Ditch tender work load	Billing clerk No.	Billing clerk work load	Collection representative No.	Collection representative work load
Bonga #1	1	298	0	-	1	3643	0	-
Bonga #2	1	674	0	-	1	5903	0	-
Bonga #3	1	202	0	-	1	1661	0	-
Alcala-Amulung	2	826	7	6.6	1	3236	1	3236
Libmanan-Cabusao	2	919	0	-	1	1410	0	-

Work load is revealed as the area (ha) managed by one water master, canal length (km) managed by one ditchtender, number of bills managed by one billing clerk and number of lots managed by one collection representative.

Criteria of work load of staff for "small" national irrigation system is as follows: one water management technologist controls 1000-6000 ha, watermaster/assistant watermanagement technician 750 ha at least, ditchtender 3.5 km of canal at least and all gates, billing clerk 3000 bill, and collection representative 3000 lots.

Table 4.2 IRRIGATOR'S ASSOCIATIONS AND GENERAL INFORMATION

Name of System	Name of irrigation association	No of Fig	Member-ship	Turnover stage	Member-ship fee (Pesp/ann.)	Annual due (Peso/ann.)
Bonga #1	Sarrat San Nicolas IA	26	272	2	5	1
Bonga #2	San Nicolas Laoag IA	15	503	2	5	0
Bonga #3	Western IA	37	252	2	5	0
Alcala-Amlung	Amalia IA	16	669	-	5	2
Solana	Solana Cagayan River IA	25	810	3	10	5
Libmanan-Cabusao	not yet	-	-	-	-	-

In the Alcala-Amulung pump irrigation system, targets numbers of irrigator's associations to be established are four. The Amalia IA is one of the targets. In the Libmanan-Cabusao pump irrigation system, ten irrigator's associations are to be instituted.

Table 4.3 FARMER'S INTENTION FOR FARMER'S ASSOCIATION

(unit: %)

Description	Bonga #1	Bonga #2	Bonga #3	Alcala-Amulung	Solana
1.Organization farmers participate					
a.Farmer's-irrigator's group(Fig)	60	67	80	30	82
b.Communal irrigation association	20	22	0	5	0
c.Agrarian reform beneficiaries association	40	11	0	16	6
d.Compact farm	0	0	0	3	0
e.Kilusang Kabuhayan at Kaunlaran(KKK)	0	0	0	5	0
f.Samahang Nayon	60	33	20	19	18
g.Others	40	22	20	0	12
2.Most appreciated organization by farmers					
a.Farmers-irrigator's group(Fig)	60	11	80	27	82
b.Communal irrigation association	0	0	0	0	0
c.Agrarian reform beneficiaries association	0	0	0	10	0
d.Compact farm	0	0	0	0	0
e.Kilusang Kabuhayan at Kaunlaran(KKK)	0	0	0	0	0
f.Samahang Nayon	0	22	20	3	0
g.Others	20	0	0	0	18
3.Farmer's expectation for better water management					
a.Good irrigation facilities	20	33	20	16	12
b.Sufficient irrigation water	20	22	40	57	53
c.Delegation of responsibility to farmer's organization	40	44	20	3	6
d.Formation of irigator's group	20	0	20	14	24
e.Others	0	0	0	11	6
4.Necessity of irrigator's group					
a.Yes	100	67	100	84	88
b.No	0	33	0	5	0
c.Others	0	0	0	11	12
5.Condition of the irrigator's association					
a.Completely organized	0	56	60	0	53
b.Partly organized	100	22	40	29	20
c.Not yet	0	22	0	71	27
6.Activeness of the irrigator's association					
a.Active	60	78	80	-	65
b.Not so much	0	0	0	-	6
c.Inactive	40	0	20	-	0
d.Others	0	22	0	-	29
7.Farmer's attitude to water scheduling in group					
a.Willing to participate	80	100	100	100	82
b.Unwilling to participate	20	0	0	0	6
c.Others	0	0	0	0	12
8.Farmer's attitude to water control in group					
a.Willing to participate	80	89	100	86	88
b.Unwilling to participate	20	11	0	8	0
c.Others	0	0	0	5	12
9.Proper number of members of one irrigator's group					
a.Less than 25	20	78	40	65	53
b.26-100	20	22	60	35	35
c.Above 100	40	0	0	0	12

Table 5.1 IRRIGATION SERVICE FEE RATE IN 1987

(unit:cavan/ ha)

Name of System	Paddy in wet season	Paddy in dry season	Third crop
Bonga #1	8	12	*
Bonga #2	8	12	*
Bonga #3	8	12	*
Alcala-Amulung	7.5	7.5	*
Solana	14	14	*
Libmanan-Cabusao	6	6	*

* Irrigation service fee rate for third crop is 60% that of the dry season paddy in principle.

Table 5.2(1/2) FARMER'S INTENTION FOR IRRIGATION FEE

(unit: %)

Description	Bonga #1	Bonga #2	Bonga #3	Alcala-Amulung	Solana	Libmanan-Cabusao
1.Irrigation fee payment						
a.no payment	0	0	0	5	0	11
b.partial payment	0	11	0	51	36	83
c.full payment	60	44	60	43	64	0
d.other	40	44	40	0	0	6
2.Reason of non-payment of irrigation fee						
a.inadequate supply of irrigation water	0	11	0	35	7	22
b.lack or delay of information in fee collection	0	0	0	5	0	0
c.incomplete or unclear bills	0	0	0	8	0	0
d.no sufficient net income to pay	0	0	0	3	7	0
e.delay of procedure for exemption from irr. fee	0	0	0	0	0	0
f.no clear arrangement with landowner on payment	0	0	0	0	7	0
g.others	0	0	0	5	14	72
3.Actual patttern of fee payment						
a.landlord pays it to system office	0	22	0	3	21	0
b.farmer pays it to system office	40	44	60	92	50	100
c.farmer pays it landlord	20	0	0	3	7	0
d.others	40	33	40	3	14	0
4.Preference for the pattern of fee payment						
a.landlord pays it to system office	20	33	20	3	0	0
b.farmer pays system office	0	44	20	51	57	78
c.farmer pays landlord	0	0	0	14	0	0
d.irrigator's association collects fee from member farmers and then pays it system office	40	22	40	22	43	22
e.others	40	0	20	11	0	0
5.Person who delivers fee bill and statement of account to farmers						
a.billing clerk	0	0	0	11	0	6
b.collector	0	0	0	32	29	94
c.water master	40	22	0	14	64	0
d.gatekeeper	0	0	0	3	0	0
e.ditchtender	0	0	0	32	7	0
f.chairman of irrigatio's group	0	22	0	0	0	0
g.chairman of irrigator's association	20	0	60	0	0	0
h.others	40	56	40	8	0	0
6.Person to whom farmers pay irrigation fee						
a.collector	20	0	20	65	43	89
b.water master	0	22	0	32	14	11
c.gatekeeper	0	0	0	0	7	0
d.ditchtender	0	0	0	0	0	0
e.chairman of irrigator's association	40	33	40	0	36	0
f.others	40	44	40	3	0	0

Table 5.2(2/2) FARMER'S INTENTION FOR IRRIGATION FEE

(unit: %)

Description	Bonga #1	Bonga #2	Bonga #3	Alcala-Amulung	Solana	Libmanan-Cabusao
7.Form of irrigation fee						
a.in cash	60	56	60	19	43	61
b.in kind	0	0	0	65	57	17
c.both	0	0	0	11	0	11
d.others	40	44	40	5	0	11
8.Willingness on participating maintenance work if the rate of irrigation fee is reduced.						
a.yes	100	100	100	89	100	72
b.no	0	0	0	3	0	22
c.case by case	0	0	0	5	0	6
d.others	0	0	0	3	0	0
9.Effect of irrigation fee payment to system office						
a.no improvement	40	0	0	22	21	11
b.slight improvement	60	67	40	49	14	28
c.highly improved	0	22	20	27	50	61
d.others	0	11	40	3	14	0
10.Effect of withholding irrigation fee payment						
a.no improvement	0	0	0	32	50	61
b.slight improvement	20	22	40	46	21	33
c.improved	0	22	0	19	21	6
d.highly improved	0	0	0	0	0	0
e.others	80	56	60	3	7	0
11.Experience of applicatin for exemption from payment of irrigation fee						
a.yes	0	0	0	49	36	39
b.not yet	60	44	60	22	50	56
c.don't knoow this regulation	0	11	0	19	0	0
d.others	40	44	40	11	14	6