As the collection of irrigation fee which is conducted by the responsibility of MW is the most important role of the system together with irrigation service, it must be monitored by the top management staff time to time by means of updated collection status on WM Division level.

2.4.6. Income and Expenditure

(1) Status of Income and Expenditure

Actual income and expenditure of the MRIIS for 1985 operation and maintenance is summarized in the following table.

Actual Income and Expenditure for 1985 O/M

(unit: '000 pesos)

Particulars of Income	Head Office	Four Districts	Dam & Res. District	Total Amount
Irrigation Fee	11	29,507	-	29,518
NPC Cost Share	-	-	3,036	3,036
Electric Bill	99	-	-	99
Equipment Rental	385	71	-	456
Other Income	1,743	243	316	2,302
Total	2,238	29,821	3,352	35,411

Particulars of Expenditure	Head Office	Four Districts	Sub Total	Dam & Res. District	Total Amount
Personnel Service	2,474	15,196	17,670		
Maintenance & Others	3,041	4,668	7,709		
Power Cost for Pump	-	5,167	5,167		
Total	5,515	25,031	30,546	14,561	45,107

As shown in the above table, income and expenditure as of 1985 made balance in the Head Office and four District Offices. However, the total balance in the MRIIS level inclusive of the Dam and Reservoir District made a big deficit.

(2) Income

Irrigation Service Fee

The collection status of District level in 1985 is shown in the following table, which shows a different rate of collection efficiency between 77.8 to 58.1 percent of District I and IV respectively.

Irrigation Fee Collection in 1985

(unit: ₱'000)

District	Collectible	Collected	Efficiency (%)
I	10,803	7,561	77.8
II	14,991	9,235	68.5
III	12,851	6,984	60.5
IV	10,953	5,728	58.1
Head Office	-	11	-
Total	49,598	29,519	66.1

NPC Cost Share

NIA and NPC made an agreement on cost allocation for O/M of the Magat dam and reservoir on April 29, 1985 and NPC has shared the part of O/M expenditures in accordance with the agreement.

The rate of cost allocation between two agencies by the agreement is 50 by 50 on the specified items in which most of facilities of Magat dam and reservoir are included. However, actual amount paid by NPC for 1985 expenditure was 3.0 million pesos against 14.6 million pesos of total expenditure, corresponding to only 21 percent.

Baligatan Power Generation

The Baligatan hydroelectric power plant under construction is to be operated by the MRIIS organization in the near future. The generated power will be utilized for the MRIIS pump irrigation systems within Service Area and the surplus power is to be sold to NPC.

The annual output of power to be generated at the full development is estimated to be 17.7 GWH, and the amount is 18.6 million pesos estimated by a unit price of 1.05 ₱/kw as selling price to NPC.

Electric Power Bill

ISELCO-I has been operating two mini-hydroelectric power plants, Magat "A" and "B" by using irrigation water in Maris main canal and has paid the water service charge to the MRIIS Office in the name of electric bill at the rate of 1.23 centavos per kilowatt hour on monthly basis. The amount of the service charge paid to the MRIIS in 1985 was about 99 thousand pesos.

As the two mini-hydroelectric power plants are not so profitable for the ISELCO-I in the operation status due to fluctuated discharge corresponding with irrigation requirement and low efficiency of these plants, income of the MRIIS from the ISELCO-I will not be increased more than present level.

(3) Expenditure

Personnel Services

The personnel service includes all personnel expenditures for the MRIIS employee as well as expenditures for IAs, BAs and individuals work for the O/M by contract.

As shown in the previous table, personnel expenditures occupy the major part in the O/M expenditures, and it means that budget allocation for maintenance of facilities is extremely controlled, especially for irrigation facilities managed under the District Offices.

Maintenance and Other Services

The maintenance and other services include general O/M expenditures such as travelling expenditures, office supplies and materials, fuel and oil for vehicles/equipments, building maintenance, insurance, collection expense, equipment repair and spare parts, etc.

The insufficient budget allocation makes difficult to conduct maintenance works for irrigation system. On the contrary, the Magat dam has properly maintained by the Dam and Reservoir District Office, supported financially by the NIA Central Office.

Power Cost for Pump

The pump irrigation systems have been operating under the MRIIS organization and the power cost is paid to NPC by NIA Central Office at the account of the MRIIS O/M expenditure.

As the result of 1985 operation, about 2,900 ha of paddy field was benefited by the pump irrigation service, and 5.2 million pesos of power cost was paid to NPC. The power cost of 1,800 pesos per hectare (5.2 million pesos/2,900 ha) is equivalent to 10 cavans per hectare.

The current rate of irrigation service fee of 12 cavans/ha for the wet and dry crops is considered not so high compared with the actual power cost requirement mentioned above. As the power cost will be increased corresponding with the irrigation development, the

MRIIS should take any practical countermeasure to control power requirement paying attentions in increase in collection efficiency, cropping pattern, crop diversification and other farmer assistance program.

Other Expenditure

The others includes special O/M works requested by District. Major subject to be included in the item will be rehabilitation of irrigation and drainage system, road maintenance, on-farm facilities development and major repairs of heavy equipment.

2.5. Agriculture, Agro-Economy and Agricultural Institution

2.5.1. Land Use and Soil

(1) Present Land Use

The area distribution of land use in the Project Area measured on the topographic maps scaled at 1:25,000 (see O/M Drawing No.6) is as follows;

Paddy Field	:	92,700 ha
Upland Field	:	21,600
Grassland, Woodland	:	22,000
Residential Area	:	5,600
Road, River Course	:	6,400
Canal, Creek	:	3,900
Others	:	12,600
Total		164,800 ha

The Project Area except for the southern part of the area is occupied mostly by paddy field and covered with the irrigation system. The upland fields are mostly found on the flood plains along the Magat river and used for corn and bean production. The rolling and undulating areas are mainly used for grassland and woodland.

(2) Soils

According to the results of the soil survey conducted by the Bureau of Soils of the Ministry of Agriculture during the project planning stage and also by the Study Team, the Project Area consists of the following four land types. The characteristics and conditions of soils in each area are summarized as follows:

Flood Plain Area

The land of this area is located mainly along the Cagayan, Magat and Siffu river course and consists of well-drained and fertile silty loam textured soils. Area formed by this soil type is most suitable for upland crop plantation and about five percent of the Project Area is occupied by this area.

Recent Alluvial Terrace Area

The land of this area is distributed along the right bank of the Magat river and consists of clay loam textured soils with well-drained and fertile characteristics. About ten percent of the Project Area is formed with this soil type and suitable for both plantations of rice and upland crops, corresponding to the Dual class land.

Intermediate Alluvial Area

The land of this area is spreaded widely in the Project Area and consists of clay to sandy clay loam textured soils in the upper layer and heavy clay textured soils in the lower layer with impermeable characteristics. The areas with this soil type occupy about 60 percent of the Project Area and include much unirrigated area. The soil presents very hard and solid conditions in the dry season due to dry shrinkage phenomenon, so that tilling works are rather difficult without saturation of soil by irrigation water. In addition, the areas with this soil type always suffer from drainage problems because of poor drainage soil character.

In this connection, only rice plantation which utilizes much irrigation water in land soaking period of the dry season is suitable for the area with this soil type and upland crop plantation would be avoided.

Rolling Upland Area

This area is found at the rolling and undulated hilly area located along the east and south boundary of the Project Area. The land of this area consists of impervious or semi-pervious clay soils and its layer depth is fairly shallow. About 20 percent of the Project Area is covered with this soil type and is presently cultivated with rice plantation, where the proportion of unirrigated area is the largest.

The details on the soil characteristics and the items to take into account for land development and soil management is shown in Annex B and O/M Drawings No.48.

(3) Land Classification

Land classification study in the Project Area had been made in the MRMP Feasibility Study stage. In accordance with the land classification map of 1/100,000 prepared in the Feasibility Study, the land of the MRIIS Service Area is classified as follows;

Land Class	MRIIS Service Area (ha)
- Rice Land	
1R	53,900
2R	25,400
3R	10,800
Sub-total	90,100
- Diversified Crop Land (1R - 3R)	-
- Dual Class Land	7,300
Total	97,400

Note: The details of land classification are shown in the O/M Drawing No.49.

The class 1R lands and the class 2R lands are located mostly in the central parts of the District II, III, IV and the northern part of the District I. Most of class 3R lands are found in rolling and undulating terraces such as the southern part of the District I, and the pumping irrigation areas of the District III and IV.

The followings should be taken into account for development of the undeveloped area and proper land use in the Project Area;

i) Most of undeveloped areas seem to belong to the 3R class lands. Then it is necessary to examine the soil profile status for land development because some soils of the 3R class lands frequently are shallow in top soil depth and require considerable investments to prepare the land for irrigation, or result in low yield of rice or high production cost.

ii) The lands in the three pump irrigation areas are classified into 2R or 3R class. The subsoil of these soils is very fine textured and very firm. The internal drainage is very poor while the surface drainage is excessive with rather coarse texture soils. The soils are strong acid in reaction and deficient in plant nutrients. So these soils can not be valued highly for the introduction of diversified crop production.

iii) Most parts of the flood plain area are not classified as 2R or 3R class paddy land in the "MRMP Feasibility Report", although it is observed that these lands are usually medium to coarse textured and well drained. However, according to the soil survey, they are excessively drained for paddy fields to require large amount of irrigation water and reclassified into the first class land for diversified crops. Therefore, it is advisable to use these lands for diversified crops

production, although some irrigation facilities should be constructed in the related areas.

2.5.2. Agricultural Households and Land Ownership

(1) Agrarian Reform

Since 1972, the Philippines Government has pursued a program of agrarian reform for transfer of ownership of paddy and corn lands to the tenant farmers. The Ministry of Agrarian Reform (MAR) controls this program.

According to the data of MAR, accomplishment of the program of the Operation of Land Transfer (OLT) for more than seven hectares of cultivated land in the MRIIS is 54 percent and 61 percent of Leasehold Operation (LHO) for less than seven hectares of cultivated land as shown in Annex J.

Accomplished ratio in each District shows that District I shows the highest at the rate of 65 percent and others being less than 50 percent, 49 percent for District II, 45 percent for District III and 47 percent for District IV.

As of 1986, 397 Agrarian Reform Beneficiaries Associations (ARBA) which are composed of the beneficiaries of this program are organized with 17,227 members in the Project area. Many ARBAs are organized in Districts II and III with a few in District IV. District IV is in the natures of a smaller number of ARBA than other Districts due to the existence of large-scale land owners and slow organization performance of ARBA.

(2) Land Tenure

Based on the data obtained from the MRIIS District Offices, the proportion of cultivators by tenure status in the Service Area is as follows;

The Proportion of Cultivators by Tenure Status

Land Tenure	Percent (%)
1. Owner	46.6
- Owner	32.0
- Amortizing Owner with CLT 1/	10.7
- Amortizing Owner under Verification of CLT	3.9
2. Tenant	53.4
- Lessee	56.1
- Sharing Tenant	17.3
Total	100.0

Source: The MRIIS Office, NIA (see the O/M Drawing No.50)
1/ Certificate of Land Transfer

The number of owner cultivators including the amortizing owners under the MAR agrarian program is about 47 percent of the total in the Service Area. One of the causes may be that the agrarian program has not progressed sufficiently. According to the data on 1986 agricultural households and population, there are about 13,000 of landless farm laborer households except above cultivators.

The characteristic feature of land tenure and its problem is summarized as follows;

i) About one third of owner cultivators are the amortizing owners who have to pay for amortization cost of lands. But few amortizing owners pay for amortization cost because their incomes are inadequate.

ii) The number of landless farm laborer households amounts to about 20 percent of total households in the Service Area. These households supply the labor forces in the busy farming seasons for transplanting and harvesting works and have no stable income sources and no benefit from the agrarian program.

iii) The rate of tenant farmers in District III and IV is relatively big indicating more than 50 percent.

iv) In the area where there are many tenant cultivators living in other disbursed area, it is difficult to organize the farmers.

(3) Farm Size

The average size of wet season paddy planted area in 1985 is estimated at 1.9 ha on the basis of the farm economic survey conducted by the Study Team and the 1980 agricultural census as shown in Annex J, while an average land holding size is estimated at 2.9 ha/landowner.

The following data on the distribution of farms by the size of irrigated area show that the number of paddy farms with the size 1.0 to 2.0 ha has the largest share;

The Number of Paddy Farm by Size

Size (ha)	Less than 1.0	1.0 - 2.0	2.0 - 3.0	3.0 - 5.0	More than 5.0
No.of Farm (%)	12.8	33.9	24.7	19.4	9.2

The District-wise characteristic of farm size is as follows;

i) District II consists of farmers with the smallest size of average operated area, where they have irrigated land for the longest time, and the farm size has been reducing.

ii) In Districts III and IV, a few land owners possess the land in large scale and the proportion of the tenant farmer is rather higher than those in other District areas.

iii) The ratio of area cropped with paddy to the total paddy field is small in acreage in Districts I and IV. It is considered that one of the major reasons is poor irrigation conditions. To overcome this problem, it is required to strengthen the operation and maintenance of irrigation systems for better water management.

2.5.3. Paddy Cultivation Practices

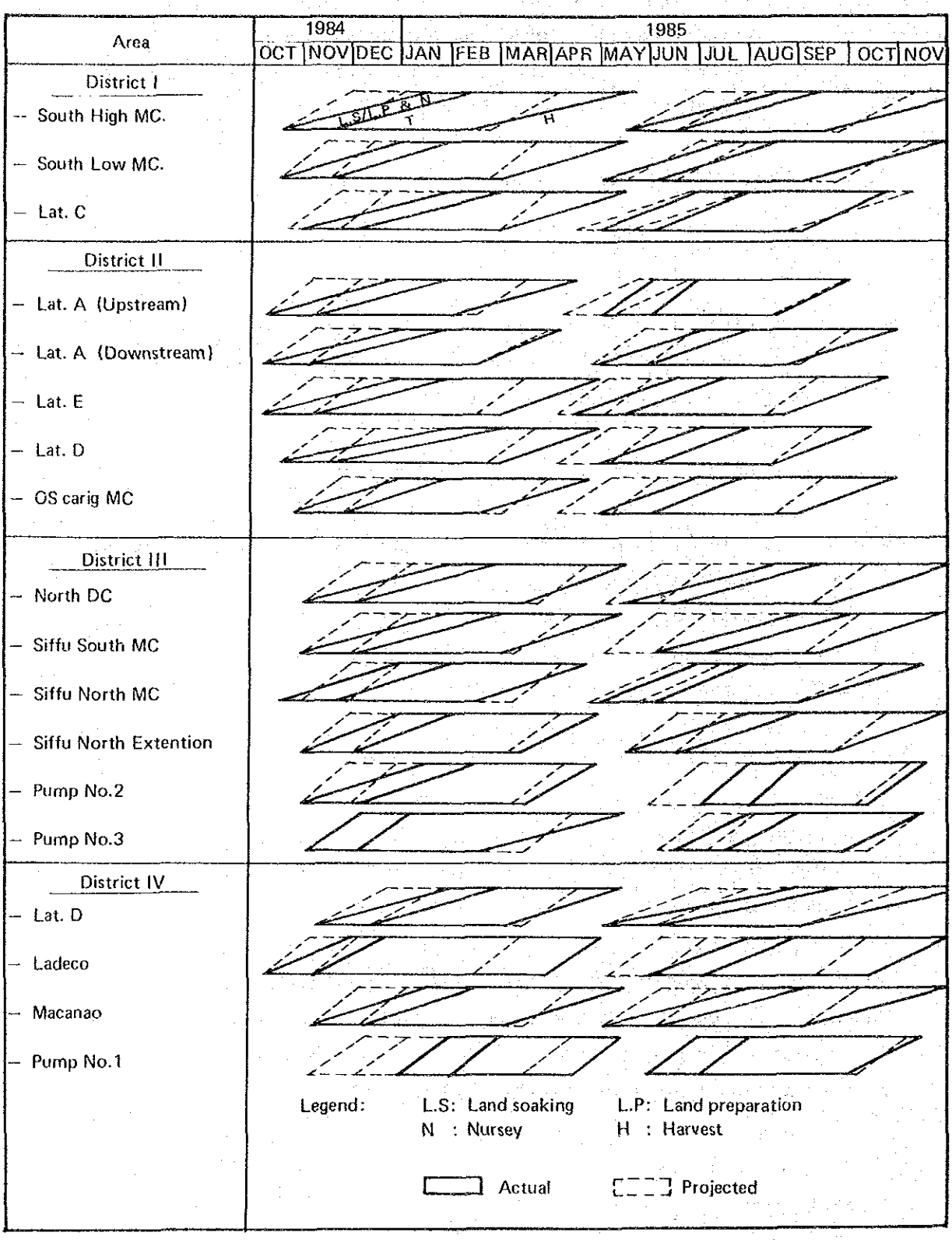
(1) Cropping Pattern and Calendar

According to the MRIIS O/M Office, the total projected Service Area in the MRIIS is 97,400 ha, but actual irrigation area of the MRIIS as of the end of 1985 is about 71,000 ha.

The double cropping of paddy is planned to be introduced throughout the Service Area as indicated in the "MRMP Project Design Report". In 1985, as described previously, paddy is cropped under irrigation only in the area of about 65,500 ha in the wet season and 65,700 ha in the dry season and 200 ha for the third crop with the annual cropping intensity of 148 percent for 71,000 ha of actual irrigation Service Area (see Figure 2-2).

The difference of annual planting area between the target and the actual is derived from the less irrigation Service Area and also less cropping intensity in the irrigation Service Area. The cropping intensity in terms of paddy planting area to the actual Service Area is as high as more than 175 percent in the upstream areas of the MRIIS, while that in the downstream area is 95 percent on average, by 23 percent at the lowest. Very low cropping intensity is recorded in the pump irrigation areas because the pump irrigation areas are located at the downstream of the MRIIS area and pump operation is costly for the farmers.

FIGURE 2-2. PROJECTED AND ACTUAL CROPPING CALENDAR (C/Y 1984 - 1985)



It is considered that the main reason why the cropping intensity is high in the upstream areas is due to the timely water distribution with adequate amount so as to ensure stable cropping. Such management rule to distribute irrigation water equitably between the up and downstream areas has not been established yet. Thus a tendency of the higher cropping intensity in the upstream area resulted from preferential water intake throughout the Service Area.

The aforesaid irrigation status had been prevailing in the whole Service Area because the river flow type water management still remains, although the Magat dam with a large reservoir capacity was constructed.

Paddy plantation in the downstream area is delayed by about one to two months as compared with the projected cropping calendar, then the time lag in the cropping calendar is as long as two to three and half months, while that of the MRIIS projected calendar is only one and half months. As a result cropping calendar seems to take year-round which brings such problems as i) increased pest infection due to the availability of host plants of paddy pests throughout year, ii) decreased soil bearing capacity which make inefficient the farm operation, iii) poor paddy quality of delayed harvest in the wet season, and iv) waste of irrigation water by the prolonged irrigation period of land preparation from land soaking to final harrowing.

The MRIIS O/M Office intends to improve gradually this present cropping calendar to the standard one by means of a proper and stable water supply from the Magat reservoir. However, the comprehensive improvement of operation and maintenance in the MRIIS is indispensable to attain the amendment of the present cropping calendar.

(2) Farming Practices

Although most farmers in the Service Area have enough experience on paddy cultivation, cultivation practices with insufficient amount of farm inputs is prevailing except for the upstream areas of the MRIIS.

The general farming conditions prevailing in the Service Area are as follows;

- Cultivation lands; Average farm size of paddy field is 1.9 ha. More than half of the total cultivators has paddy fields at one place (parcel) and the remaining farmers at more than two places (parcels).
- Number of farm labor force; 1.7 person/farm household on average.
- Draft animals and farm machinery; About 70 percent of total farms owns one draft animal on average and 18 percent of the total farms owns one unit of power tiller or four-wheel tractor per farm.

The details on the prevailing farming practices are shown in Annex J, and the related major problems on the cultivation practices which cause low yield, poor paddy quality and relatively high production cost are as follows;

i) Farmers produce their own seeds except for progressive ones who can afford to buy quality seeds. Then, the average seeding rate is as high as 85 to 100 kg/ha of main paddy fields. Thus, it is difficult to raise vigorous seeding with keeping variety pure. High yielding varieties (HYV) such as IR-64, 62, 58, 56 and 36 are popularly grown in the MRIIS area.

ii) Extensive paddy cultivation is prevailing in the middle and downstream areas of the MRIIS, where paddy production conditions are not stable with insufficient amounts of

farm inputs. For an example, the average amount of applied nitrogen of about 40 kg/ha is less than the recommended amounts of about 80 kg/ha except for the upstream areas in the District II.

iii) It often takes more than three to four days from reaping to threshing, especially when threshing is made manually. The low intensity of farm roads is one of the reasons why powered threshers are not used efficiently in the Service Area. Although the moisture content of paddy has to be reduced to at least 18 percent immediately after reaping in the wet season, the weather conditions and the prevailing farming practices do not allow to keep such paddy moisture content.

iv) About 60 to 80 percent of farms sell their products without drying during the wet season, when the weather does not permit sun drying almostly. Even during the dry season, about 30 to 60 percent of the farmers do not dry the threshed paddy before selling. The delay of plantation in the wet season paddy is the reason that farmers can not dry up paddy production properly. Drying paddy on the paved national roads are prevailing due to lack of dry pavements. No mechanical dryers are introduced at farmers level in the Service Area. This causes contamination of paddy with foreign materials, hulling of paddy and traffic disturbance.

v) Aside from the problems of paddy quality, the rate of post harvest losses seems to be high. Reportedly, the estimated rate of post-harvest losses in the Philippines is 10 to 20 percent. Eventually the losses of mechanical threshing increase as moisture content of paddy/straw is high. Moreover, the losses in drying is large in the conditions that the wet season paddy is mostly dried with inadequate drying facilities.

2.5.4. Crop Diversification

In most of upland fields along the Magat river, being the outside of the Service Area, corn is mostly planted twice a year without irrigation from May to November. The other crops like tobacco, peanut, beans and vegetables are grown in the areas. The total harvested area of upland crops is estimated at about 35,200 ha, which consists of 18,900 ha of corn, 6,800 ha of tobacco, 4,200 ha of peanut, 3,100 ha of beans and 2,200 ha of other crops.

The soils of upland fields in the District III and IV along the Magat river mentioned above are reclassified as the first class land for diversified crops as described previously. Such upland fields seem to be suited for diversified crops.

The farm income per hectare is roughly estimated for the typical cropping pattern of diversified crops which are grown in the well suited lands for the crops, comparing with that for double cropping of paddy as follows;

Estimated Income by Cropping Pattern

Cropping Pattern (Wet Season + Dry Season)	Farm Income (1,000 ₱/ha)
Upland Crops	
- Corn + Corn	12
- Corn + Peanut	13
- Corn + Mungbean	15
- Corn + Barley, Tobacco	10
Double Cropping of Paddy	10

Note: (1) Cost of family labor is excluded in the estimation of the farm income.
(2) The details of the estimation are shown in Annex J.

The income level for crop diversification is mostly equal or larger than that of double croppings of paddy. This may correspond to the situation that there are few farmers who convert the upland fields into paddy fields.

2.5.5. Crop Productivity and Production

(1) Paddy

High yield of paddy is attained only in the upstream areas, where the average paddy yields in terms of the converted yields to dry paddy for the wet and dry season crops are 4.0 to 5.0 tons/ha. On the other hand, in the downstream areas belonging to District IV, the paddy yields are registered as low as less than 2.0 tons/ha (see Figure 2-3). An average paddy yield in the whole Service Area is 3.2 tons/ha as follows;

Paddy Unit Yield (1985)

(unit: ton/ha)

District	Average			Highest			Lowest		
	Total	Wet	Dry	Total	Wet	Dry	Total	Wet	Dry
I	3.2	2.9	3.4	3.4	3.3	3.7	2.9	2.4	2.8
II	3.5	3.3	3.6	4.9	5.0	5.0	2.4	1.7	2.6
III	3.0	2.7	3.3	3.4	3.3	4.7	2.3	2.0	2.2
IV	3.0	2.7	3.3	4.0	4.2	3.9	2.6	1.6	2.6
Mean	3.2	3.9	3.4	4.9	5.0	5.0	2.3	1.6	2.2

Note: Converted yield at 14% moisture content

The total paddy production in 1985 is estimated at about 420,000 tons, 193,000 tons for wet season paddy and 227,000 tons for dry season paddy, respectively as shown below.

Estimated Crop Production (1985)

Items	Harvested Area (ha)	Yield (ton/ha)	Production (ton)
1. Inside of the MRIIS Service Area			
- Irrigated Rice, Wet Season	65,500	2.9	192,800
- Irrigated Rice, Dry Season	65,700	3.4	226,400
- Irrigated Rice, Third Crop	200	2.6	400
Sub-total	131,400	3.2	419,600

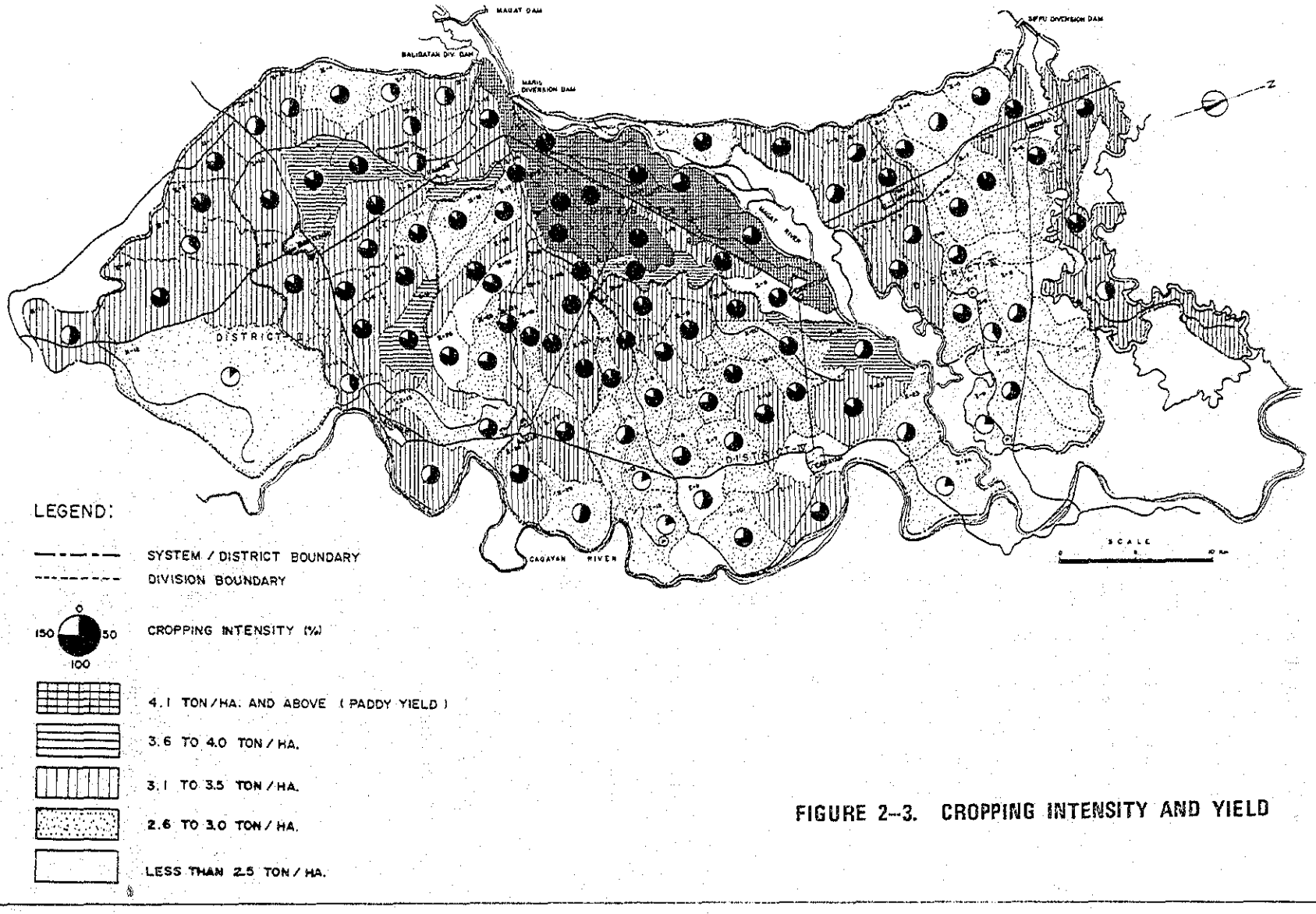


FIGURE 2-3. CROPPING INTENSITY AND YIELD

2. Outside of the MRIIS Service Area

- Rain-fed Rice, Wet Season	3,890	2.0	7,780
- Corn, Wet Season	14,200	3.0	42,600
- Corn, Dry Season	4,600	3.0	13,800
- Peanut	4,200	0.7	2,940
- Leguminous Crops	3,100	0.5	1,550
- Tobacco & Others	9,000	1.5	13,500
Sub-total	38,990		82,170

Source: (1) The data for the inside of the MRIIS Service Area ..... The MRIIS O/M Office

(2) The data for the outside of the MRIIS Service Area ..... BAEcon, Isabela and 1980 Census of Agriculture

The following characteristics for paddy production are observed based on the O/M Drawings No.51.

- Paddy Production at the upstream area of about 7,000 ha along the Laterals "A" and "B" in the District II reaches 4.9 tons/ha at the maximum, which already achieved to the target yield of 4.0 tons/ha, because the area consists of fertile Dual class land and lies on the advantageous location being able to introduce the irrigation water easily and start the cultivation of wet season paddy in May to June.

- The upstream and middle stream areas of about 40,000 ha produce the paddy yield of 3.5 tons/ha in the dry season and 3.0 tons/ha in the wet season. Since this area consists of a little hard clay soil and can start the wet season paddy at the middle of June to the end of July due to delay of irrigation water supply, the paddy production is a little lower than that of Dual class land.

- The downstream area of about 22,000 ha presents considerable low productivity as 3.0 to 2.5 tons/ha in the dry and wet seasons, especially the area of about 8,200 ha in the District IV drops its productivity less than 2.5 tons/ha.

- Since the cultivation of the wet season paddy in the downstream area starts in July to August, the paddy growth is rather delayed due to many clouded days and deep inundation in the field caused by heavy rainfall during the crop vegetation period. In addition, the harvesting time meets the middle of October and November presenting continuous heavy rainfall, so that harvested paddy has a high moisture content and becomes low quality.

(2) Diversified Crops

The total production of corn, peanut, leguminous crops, and tobacco and others in the Service Area are estimated at about 56,000 tons, 2,900 tons, 1,500 tons and 13,500 tons respectively as shown in the above table.

2.5.6. Quality of Harvested Paddy

As increasing paddy farmers cultivating paddy cropping with two times or more in a year, one crop is harvested during the wet season, resulting in delays in drying the harvested paddy by traditional "sun-drying" practices. Such delays in drying paddy lead to deterioration of paddy qualities, especially the wet season crops harvested during late October to November.

According to the result of laboratory analysis for paddy samples which are collected as in-kind irrigation water fee from farmers in the MRIIS area, the paddy quality classified by NFA standard is very poor, where the percentage of foreign matters, damaged kernels and discolored kernels on the weight basis are 11, 8 and 20 percent on an average. It is considered that the paddy quality in the MRIIS area seems to be poor in general although the above sample paddy is not necessarily the representative for the whole MRIIS paddy (see Annex J). Improvement of paddy quality is very important because low paddy quality reduces farmers' income.

The Isabela State University (ISU) is conducting a research on post-harvest aiming at a) determination of the most suitable post-harvest paddy handling system for a typical village cooperative, b) establishment of post-harvest grain centers within the cooperative area, c) verification of the introduced system's economic, social and technical adaptability.

The results of the study are as follows; i) The utilization of mechanical threshers was satisfactory in terms of profitability,

reduction of losses and improvement of paddy quality for the wet season crops. ii) Although the paddy quality is improved by employing a mechanical dryer, it is not profitable to operate even during the wet season. iii) One of the major problems encountered with the use of powered thresher is the poor mobility due to poor field drainage and the lack of farm roads.

Based on these findings, the followings are suggested:

i) Improvement of drainage conditions and construction of more farm roads to help accessibility for the introduction of mechanized post-harvest system,

ii) Construction of drying pavements to allow enough space for paddy sundrying when the weather is favorable,

iii) To supplement the sundrying practice, mechanical dryers must also be used, provided that farmers' groups can manage and operate these dryers economically.

2.5.7. Livestock and Inland Fishery

(1) Livestock Production

The outline of raising livestock in the Municipalities concerned with the Project Area is shown as follows;

Outline of Livestock in the Project Area

Animal	Percent of Raisers to Total Farms (%)	No. of Livestock Poultry (head/raiser)	Total Heads (head)
Water Buffaloes	70.9	1.6	69,600
Cattle	11.2	2.4	16,700
Swine	64.9	2.2	87,800
Goats	2.2	3.1	4,200
Chicken	77.2	15.5	726,100

Source: 1980 Census of Agriculture

Only water buffaloes are mainly used as draft animal in the Project Area. However, there are about 30 percent of the total farms which have no water buffaloes. Two or three heads of cattle per farm on an average are raised for beef production by about 11 percent of the total farms.

Since the average number of raised swine and poultry per farm is few, it seems that there are few farms raising them on the commercial scale.

(2) Inland Fishery

Aside from fish catch in the Magat reservoir, ponds for irrigation pumps, canals and natural rivers, fish culture production is developed rapidly in the Project Area. There are two types of fish culture, namely fish cage culture in the Magat reservoir and fish pond culture which are scattered in the Project Area.

Fish culture in the Magat reservoir is operated by about 420 fishermen with 659 units of fish cages (a total net occupancy is about 46,000 sq.m. The number of fishermen has increased by two times from December 1985 to June 1986. It is estimated that the fingerling requirement by the fish cage operators is around five million pieces per cropping. About three million pieces are annually required for seeding the fishponds within the Project Area.

Some private fishpond operators and the Bureau of Fisheries and Aquatic Resources (BFAR) hatchery stations which are capable of producing one million fingerlings per year are the sources of fingerlings at present. These local sources can not cope with the actual requirement for fingerlings in the area, so that the fish cage operators have to buy fingerlings from other Provinces and suffer from the high cost and high mortality rate of fingerlings during handling and transporting stages.

The total fish production in 1985 in the Project Area is estimated at about 950 tons as follows;

- Fish cage culture in the Magat reservoir	56 tons
- Fishpond culture	108 tons
- Fishing in the Magat reservoir	790 tons
Total	954 tons

2.5.8. Supply and Demand of Agricultural Products

(1) Rice

The supply and demand of rice on the whole country basis are mostly balanced with 5.4 and 5.7 million tons per annum in 1985 respectively as shown in O/M Drawings No.56. The Region with the biggest supply of rice is II and III located at Luzon Island and the MRIIS Service Area is included in Region II.

The surplus amount of rice reaches about 360,000 tons in Region II and 280,000 tons in Region III, which are mostly supplied to Region IV holding Manila meeting the rice deficit of 810,000 tons in 1985. Other Regions except a few one meet also the rice deficit and have no room to supply the rice to Region IV. This fact presents clearly that the food supply for people living in Manila is supported by the surplus rice of Region II and III. The rice production in both Regions, therefore, should be always stabilized, and increased in accordance with the increased present and future demand of rice in Manila.

However, the production and surplus amount of rice in Region III dropped in 1984 and 1985 compared with those in 1982 and 1983 as shown in the following table. On the other hand, the production and surplus amounts in Region II are remarkably increased in 1985, because of the completion of the MRIIS irrigation water supply, although that in 1984 drops a little due to the dry year.

The surplus amount in the MRIIS area occupies about 50 percent of that in Region II in CY 1984/1985 and covers 13 and 23 percent of the rice deficit in Region IV. The MRIIS area is the most stabilized base not only in Region II but in whole country to supply the surplus rice in Manila at present.

Supply and Demand Balance

(unit: '000 ton)

Item	1981	1982	1983	1984	1985
Whole Country					
- Production	5,020	5,279	5,040	5,128	5,363
- Demand	5,089	5,080	5,071	5,586	5,343
- Surplus	- 69	19	- 31	- 458	- 380
Region IV					
- Production	503	482	519	563	599
- Demand	1,269	1,244	1,276	1,371	1,408
- Surplus	- 766	- 762	- 757	- 808	- 809
Region III					
- Production	876	1,040	1,100	777	927
- Demand	565	575	588	622	647
- Surplus	311	465	512	155	280
Region II					
- Production	480	545	608	485	680
- Demand	263	173	256	292	315
- Surplus	217	372	352	193	365
MRIIS Area					
- Production	133	178	170	232	273
- Demand	75	78	81	83	89
- Surplus	58	97	89	149	184

Note: 1/.... 65% of conversion factor is applied to covert rice from paddy.
2/ ... The rice production in 1984 for Region II and III dropped remarkably due to the exceptional dry year. The production of the MRIIS area in 1984 is not influenced by the dry year because of the irrigation

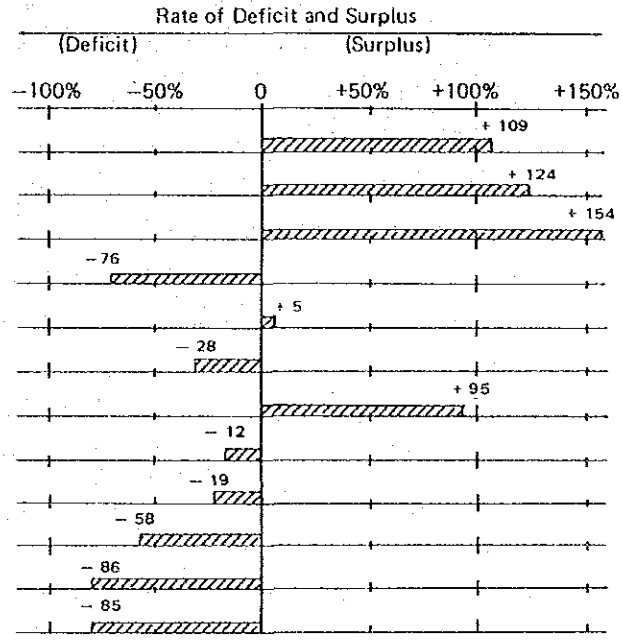
Source: Whole Country and Region ... MAF
the MRIIS Area ..... NIA Production statistics and demand estimate.

(2) Other Agricultural Products

Region II is one of the main productive regions in the whole country. But, the deficit of the other products except grains, sugar and beans in Region II is dependent upon the other Regions. As the deficit amounts of fruit/vegetable and fish are about 214,000 tons and 75,000 tons, there is a great demand in the MRIIS area for these goods.

Supply and Demand Balance of Agricultural Products in Region II (Average of 1982 to 85)

	Amount of Surplus & Deficit (tons)
1. Grains	+ 346
(Rice in Region II)	+ 321
(Rice in MRIIS)	+ 128
2. Fruit & Vegetable	− 214
3. Beans, Peas & Nuts	+ 1
4. Root Crops / Tubers	− 18
5. Sugar	+ 20
6. Beef & Carabeef	− 20
7. Pork	− 5
8. Poultry Meat	− 8
9. Eggs	− 10
10. Fish	− 75



Source: NEDA Region II

Region II including the MRIIS area being located far away from Manila, big market and without industry, aims to accomplish the full supply of all agricultural products. Among these products, livestock development in connection with feed crops' improvement is favorable.

2.5.9. Production Cost and Income of Paddy Farm

(1) Production Conditions and Type of Farming

The MRIIS area is divided into the following three areas according to the conditions of irrigation water use and land productivity, which were obtained based on the field survey and collected data. The farm budget analysis on the farm income and expenditure of paddy cultivation is made for these three areas.

Area A

The area is located around the upstream area of District II, and has the favorable condition of soil (Dual class land) for paddy cultivation, being irrigated firstly in the MRIIS area with the area coverage of about ten percent of the total the MRIIS area. Average paddy yield is high at 4.6 tons/ha.

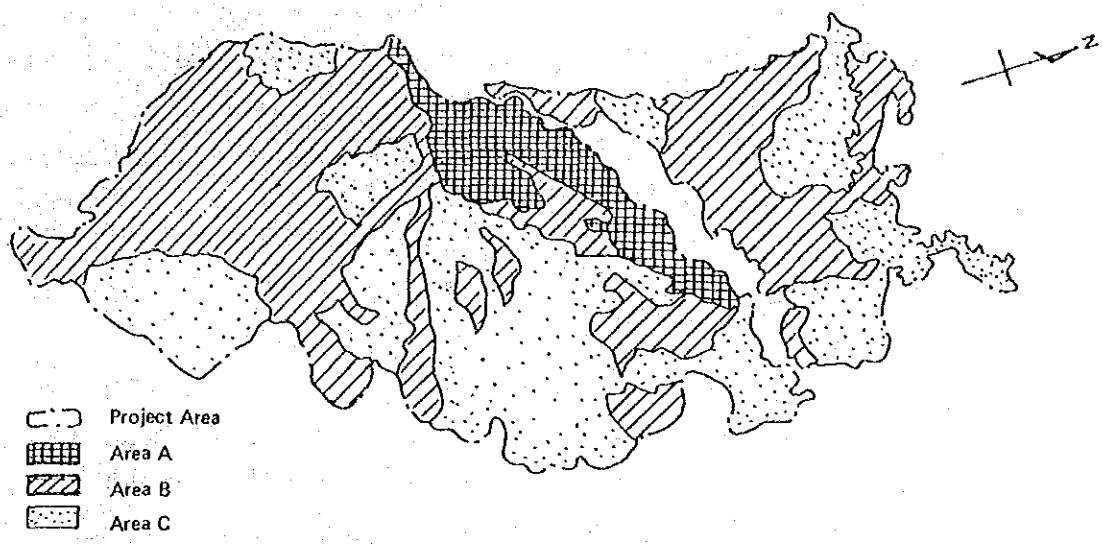
Area B

The area is located around the upstream and middlestream of the MRIIS area, and has the relatively favorable soil productivity for paddy cropping. Most of the paddy fields are reclaimed recently and the area coverage is about 60 percent. Average paddy yield is at 3.2 tons/ha.

Area C

The area is mostly located around the lower reaches of the MRIIS area. Most of the farmers in the area are not able to irrigate on time due to the operation and maintenance problem of irrigation facilities. The area also has a drainage problems in crop cultivation and farming works. The area covers about 30 percent of the MRIIS area. Average paddy yield is low at 2.7 tons/ha.

Classification of the MRIIS Area by Crop Yield



According to the result of the sampling survey, the number of farms planting the double cropping of paddy covers about 84 percent of total farms. The other ten percent of farms are managing with double cropping of paddy and cropping of upland crops like corn, tobacco, mungbeans, etc. And , the remainders are managing with double cropping of paddy and animal husbandry. The main income source of farmers is rice in the whole MRIIS area.

(2) Production Cost

The expenses for machinery and hired labor cost cover about 40 to 50 percent with the largest share of the paddy production cost, except for land rent. The average labor requirement for paddy cultivation amounts 90 to 100 man-days/ha in the MRIIS area. About 60 percent of the total labor requirement is supplied by the hired laborers for transplanting and harvesting works.

The second largest cost is that of fertilizer at 15 to 20 percent of the total cost. As the land productivity is higher, larger amount of fertilizer is applied.

Present Paddy Production Cost
(Average of dry and wet season)

(unit: ₱/ha)

Items	Yield Class (ton/ha) 2.0	3.0	4.0	5.0
Seeds	310	320	340	360
Fertilizer	880	920	980	1,100
Pesticides	480	520	570	610
Hired Labor	710	1,000	1,400	1,700
Machinery, Animals	1,200	1,500	1,700	1,900
Irrigation Fee	440	440	440	440
Others	400	470	540	610
Total (owner Farmer)	4,420	5,170	5,970	6,720
Land Rent	1,400	1,400	1,400	1,400
Total (Tenant Farmer)	5,820	6,570	7,370	8,120

Source: Farm Economic Survey in the Project Area, conducted by Study Team in 1986.

(3) Farm Income and Family Expenditure

Average land holding size of paddy field per farm in the MRIIS area is 1.8 ha. Net agricultural income of paddy farms with the average size is estimated at ₱21,100 in Area "A", ₱12,400 in Area "B" and ₱8,900 in Area "C", respectively, as shown below;

Agricultural Farm Income
(Double Cropping of Rice)

(unit: ₱/Farm/year)

Items	Area A	Area B	Area C
1. Production Yield (tons/ha)			
- Dry Season	4.6	3.6	3.1
- Wet Season	4.5	2.9	2.4
2. Gross Income	44,200	31,600	26,700
3. Production Cost			
- Owner Farmer	23,100	19,200	17,800
- Tenant Farmer	28,100	24,200	22,800
4. Agricultural Income			
- Owner Farm	21,100	12,400	8,900
- Tenant Farmer	16,100	7,400	3,900

The major attributed factors to the above-said different amounts of net agricultural income are as follows; The average paddy yield per hectare is estimated at 4.6 tons in Area "A", 3.2 tons in Area "B" and 2.7 tons in Area "C", respectively. The respective rate of production cost exclusive of land rent is 52 percent in Area "A", 62 percent in area "B" and 68 percent in Area "C". Namely, the difference of gross income is larger than the production cost differential in all three areas.

As for the living expenses, at least ₱10,000 to ₱12,000 per farm is annually required on average based on the estimated minimum annual living expenditure per capita at ₱2,000. For the farmers in the group of "C", the minimum living expenditure is not covered only by the income from paddy cultivation. It is related to the situation that about 60 percent of the sampled farms had other income sources within the farm like pig sales.

2.5.10. Agribusiness and Rice Marketing

(1) Agribusiness

(a) Pre-Harvesting

In the series of farming operations, the public agencies are related to supply of certified seeds, but others operations are entrusted to individual farmers. Certified seeds are produced by the seed grower associations under the control of the Ministry of Agriculture and Food, which produces about 2,400 tons of seeds, equivalent to 160 percent of the demand in the Service Area.

There are registered 118 agricultural inputs dealers dealing with fertilizer and agro-chemicals, 25 agricultural machinery dealers, 136 workshops and repair shops. These dealers stay in the commercial towns like Cauayan, Santiago and Roxas. Negotiations on pricing agricultural inputs, farm machinery and repairing of

machinery between dealers and farmers have made farmers complain to pay high price due to the lack in farmers' capital and the inactive group purchasing work.

(b) Post-Harvesting

In the MRIIS area, there are seven buying stations managed by NFA and 425 private buying stations.

Number of Post-Harvest Facilities

Items	NFA	Private Dealers	Total
- Buying Stations	7	425	432
- Storage House	13	684	697
- Rice Mill	4	389	393

As for the paddy storage and rice milling, farmers had depended on the private warehouses until NFA's warehouse was constructed by the Northern Philippines Grains Complex (NPGC) Project at Echague, but still now dependence on private dealers is very high. The storage capacity of paddy in the Service Area is estimated at 76,000 tons for NFA and 118,000 tons for private dealers, totally 194,000 tons, corresponding to 92 percent of 210,000 tons which is the amount of production in one cropping period. Assuming that paddy is centrally carried into warehouses during about one month of harvesting period and rotation of milling and selling of paddy are well managed, existing capacity of warehouse is considered to be enough. But almost of the existing warehouses and rice mills are already old and deteriorated.

(c) Processing of Agricultural Products

There are four feed mills producing poultry and hog feeds in the Project Area as follows. In the rural area, poultry and hog are fed in a small scale, which indicates a high potential demand for animal feeds.

Municipality	No. of Factory	Capacity (ton/hr)
Cauayan	1	2
Cauayan	1	1
Santiago	1 (Not yet operated)	3-4
Reina Mercedes	1	4

In the Northern Philippines Grain Complex Project by NFA at Echague, the following facilities are projected besides the paddy milling system (capacity: 100,000 tons/year).

Items	Capacity	Remarks
Parboiling Plant	50 tons/day	Not yet constructed
Bran Oil Extra Plant	1,900 tons/yr	- do -
Bran Oil Refinery	860 tons/yr	- do -
Feed Mill	20,000 tons/yr	- do -
Power Plant	2.5 Megawatt	Constructed but not yet operated

(2) Rice Marketing and Price

(a) Rice Marketing

Out of the total paddy production at 420,000 tons in the MRIIS area in 1985, it is estimated that about 140,000 tons (33%) of paddy is used within the Project Area and about 280,000 tons (67%) of surplus paddy is sent and consumed in other Regions. Based on the NFA data, about 30,000 tons and 260,000 tons of surplus paddy were purchased by the Government and merchant like rice miller, wholesaler and others, respectively.

Flow of the MRIIS Paddy

(unit: '000 tons)

Items	1981	1982	1983	1984	1985
1. Total Paddy Production	205	274	261	358	420
2. For the MRIIS Area	115	125	125	128	137
3. For Outside the MRIIS Area	90	149	136	230	283
- by the Government	25	47	35	6	26
- by Merchant	65	102	101	224	257

According to the NFA survey, about 70 percent of the surplus paddy in Isabela Province is milled in Isabela and sent to Manila market. And about 30 percent of the remained surplus paddy without milled is sent to Bulacan near Manila.

A nation-wise network of 60,000 retailers and 22,000 wholesalers handles 90 percent of the trade at the wholesale level and about 99 percent at the retail sales. In the Metro Manila market, a few of big wholesalers controls the market and have Luzon Wide Agent system who could advance the money to the producers and buy the commodities by their indicated prices.

The wholesalers and millers in Central Luzon (Region III) which had been the biggest granary in the country until 1983, come to the Project Area with increase of production after 1983, to purchase the paddy from the wholesaler or the millers in the MRIIS area. The number of paddy wholesalers and millers is increased year by year in the Service Area and their location and capacity are shown in O/M Drawings No.58. The numbers of capacity seem to be enough to treat the paddy production at present. However, purchasing production amount of paddy by NFA is only six percent at present against the total production due to the following reasons;

- Shortage of fund due to the limited budget allocation for NFA.
- Bad performance on the side of farmers vis-a-vis NFA's procurement of paddy.
- NFA limits their purchase only to the dried paddy.
- NFA does not make the transportation service to the door of farmers.
- Farmers are often obliged to sell their products because of borrowing money from the private merchants in advance.
- NFA can not pay the purchasing money at once due to long procedure through the bank.

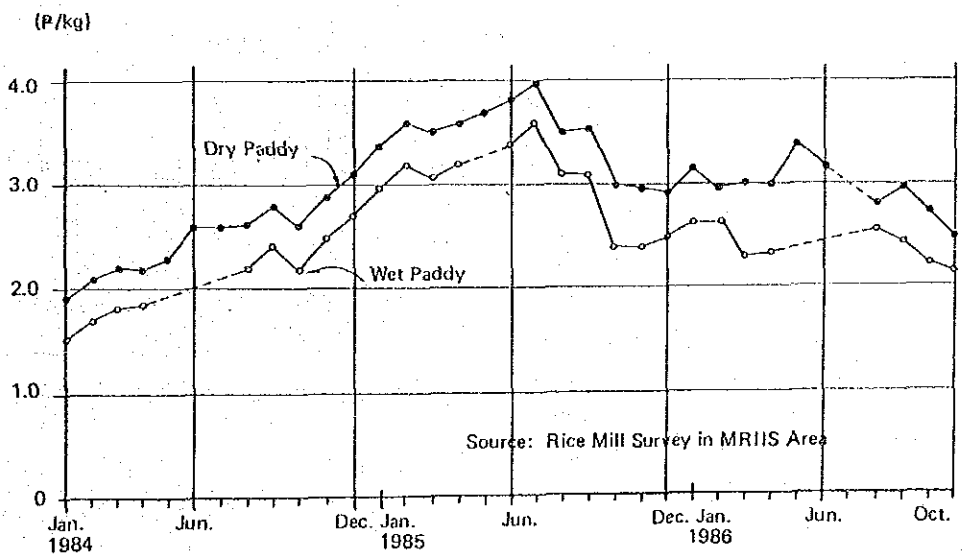
Due to the various reasons aforementioned farmers dispose their products to a large extent of 94 percent to the private dealers.

(b) Paddy Price

According to the three year data (1984 - 1986) on farm-gate price of paddy in the MRIIS area, the farm-gate price was increased month by month from January 1985 to July 1985 and reached to be the highest price of 4.0 and 3.5 pesos/kg for dry and wet season paddy in July 1985, because of shortage of paddy balance in the country. However, afterward the price declined and was kept at almost constant values around 3.0 and 2.5 ₱/kg for dry and wet season paddy, respectively until September 1986, and the price was a little down in October and November 1986, coinciding with the harvesting season of the wet season paddy.

According to the intension survey to the rice miller, 80 percent of dry paddy and 20 percent of skin dry paddy are sold by farmers in the dry season. In other side, in the wet season, 40 percent of dry paddy and 30 percent of skin dry and wet paddy are purchased by rice millers, respectively. The price level of the wet paddy is around 80 to 90 percent of that of dry paddy, therefore drying works of wet season paddy is very essential and important subjects for the farmers in the area.

Farm-Gate Price of Paddy in the MRIIS Area



2.5.11. Farmers' Organization

To achieve the project target like a high degree of effective water use, cropping intensity, adequate yield and irrigation fee collection, full participation of functional water-based farmers' organization (institution)to the water management at on-farm level would be needed. Under the conditions, three kinds of water-based farmers' organizations are established in the Service Area, that is, Farmers' Irrigators Groups (FIG), Irrigators' Associations (IA) and District Federation of IA (DFIA). The present status and problems of these organizations are summarized as follows;

(1) FIG, IA and DFIA

FIG is organized at turn-out level for the operation of maintenance in the area. In 1979, the establishment of IAs is recommended by Agricultural Development Coordination Committee to solve recognized problems; i) inadequate payment of credit and land amortization, ii) declining FIG activity and iii) high interest rates paying to private money lenders. The FIG serves as the basic unit of IA in the area. The IA is registered with Securities and Exchange Commission as a juridical personality of non-stock cooperation within three months after IA officers are elected. The target and present status of FIG and IA organizations are as shown below;

Target and Actual of FIG/IA Establishment

District	Total Cultivator (1985)	Number of IA/FIG				Member of IA (1985)	Percent of IA Members
		Target		Actual(1985)			
		IA	FIG	IA	FIG		
I	12,131	95	783	77	562	6,751	56
II	15,048	80	815	52	343	4,707	31
III	13,191	81	677	76	374	5,620	43
IV	10,398	41	654	32	226	3,016	29
Total	50,768	297	2,929	237	1,505	20,094	40

Note : The actual number of FIG excludes the ones in the areas where IA is not organized.
Source: The MRIIS District Offices, NIA.

As clear in the above table, the organized IA reaches 70 to 80 percent of the target one, but cultivators joining into IA are still low as 30 to 40 percent except District I presenting 56 percent. Since IA without joining many cultivators can not fulfill properly, the IA function to carry out the water management and collection of irrigation fee, the MRIIS O/M Office, especially IDD-MRIIS shall accelerate the farmer's participation to IA.

The area coverage of FIG is 30 ha on an average. Each IA is organized to cover about 300 ha of service area consisting of about 10 FIGs. However, the present average service area by one IA is about 170 ha, because there are many cultivators who do not join in IA. In the MRIIS area the existing IA covers about 40,760 ha or about 40 percent of the whole MRIIS Service Area.

In 1981, a lateral turnover program was introduced in the MRIIS area to promote participation of farmers in water management and operation and maintenance of irrigation facilities. As of July 1986, 150 IAs including 13,200 members out of existing 237 IAs accepted lateral turnover contracts covering 27,300 ha, 66 percent of 40,760 ha, with about 600 km stretch of canal. Status of the lateral turnover from 1981 to 1985 is shown in the O/M Drawings No.54, which indicates that turnover program is the most advanced in District I and the lowest in District IV.

The result of the evaluation survey of the existing 237 IAs, which was conducted by the MRIIS O/M Office and the Study Team to find the actual conditions of IA activities, shows that 57 percent of IA is relatively active. Excluding District I, one half of the IA in the three Districts is appraised inactive.

The DFIA is established in each District, however their functions are limited because the member of IA is scattered in each District area and full participation of cultivators is not attained in most IA, which are substructure of DFIA.

(2) Other Farmers' Organizations

Besides the above mentioned water-based farmers' organizations, there are various farmers' organizations like the Samahang Nayon (SN), the Rural Improvement Club (RIC), the Agrarian Reform Beneficiaries Association (ARBA), etc. As most of the MRIIS cultivators are members of several organizations mentioned above, it has been resulted in diminishing farmers interests in their activities. However, IA organization are most vital and functional organizations in the Service Area.

There were once Farmers Cooperative Marketing Association (FACOMA) and Area Marketing Cooperative (AMC) which previously played their own roles in marketing of agricultural products and farm inputs for the farmers. However, they have presently stopped activities. The interruption of these marketing cooperative's activity may have resulted in being compelled farmers to borrow money from private money-lenders at a high interest rate. Under these circumstances, it is considered necessary to establish a cooperative to support farmers in farming activities and to increase their incomes.

The grower association controlled by the Ministry of Agriculture and Food to produce certified seeds has 108 members in the Service Area.

2.5.12. Governmental Supporting Agencies

(1) Ministries concerned to Agriculture

(a) Ministry of Agriculture and Food

Under the Ministry of Agriculture and Food, there are six Bureaus as follows;

- Bureau of Agricultural Extension (BAEx)
- Bureau of Plant Industry (BPI)
- Bureau of Animal Industry (BAI)
- Bureau of Soils (BS)
- Bureau of Cooperative Department (BCD)
- Bureau of Fisheries and Aquatic Resources (BFAR)

The Regional Office of the MAF is located in Tuguegarao and the Provincial Office at Ilagan and Cabarroguis. Under the control of the Provincial Offices, there are 23 Municipal Agricultural Offices which undertake the activities on agricultural extension and improvement of living by the staffs as shown in Annex J.

4 to 15 technicians are assigned by BAEx, BPI, BAI, BCD, etc. to each municipality under one Municipal Agricultural Officer and among them, the production technician is in charge of agricultural extension. Although large differences are observed in the number of farmers and the serving area per personnel, it is estimated that a production technician covers about 400 farmers or 600 ha on an average. This means the lack of production technician. Additionally, there is lack in i) number of motor cycles and vehicles which are indispensable for extension activities, ii) communication network among Municipal Agricultural Offices, iii) number of training staffs and iv) visual aids for training.

BS conducts soil analysis and survey and also has a responsibility to recommend the method and rate of fertilizer application. In this connection, the Central Office of BS is undertaking the survey on crop zoning in Isabela Province, of which the result of survey may be referred to the land use plan in the Service Area. BAEcon serves as a data bank on agriculture. BAI has one breeding station to multiply calves, piglets, etc. for distribution to farmers. As described in the above, the BFAR has one of the provincial fishery stations for the production and supply of fish seeds and also for extension of fish culture technology in the Project Area.

There exist following two experimental institutions to contribute to the agricultural in the Project Area. Activities of them are as follows;

- BPI Cagayan Valley Experiment Station

  - ° Testing and/or researching for improved varieties of rice and other cereals,
  - ° Production of foundation and registered seeds of paddy and other cereals,
  - ° Collection, multiplication and distribution of fruit trees, ornamental and medicinal plants,
  - ° Coordination and assistance for local and provincial officials in the implementation of agricultural productivity programs.

- Isabela State University (ISU)

  Asides from various research activities concerned with the agricultural development in the Service Area, the Cagayan Valley Integrated Agricultural Research System is conducting the investigations to cover following items;

  - ° Yield tests on fiber crops, root crops, vegetables, forage crops,
  - ° Experiments on swine, poultry, water resources, soil resources,
  - ° Applied rural sociology.

(b) Ministry of Human Settlement (MHS)

The Ministry of Human Settlement has been implementing many kinds of KKK Program (Kilusang Kabuhayan at Kaunlaran - Organization for Livelihood and Progress), in order to raise farmer's living standards in the rural area. One of the KKK programs is the loaning for the post-harvest facilities like powered threshers and warehouses through IA in the Service Area. However, these programs are not expanded mainly due to lack of fund.

(c) Ministry of Agrarian Reform (MAR)

The Regional Office of the Ministry of Agrarian Reform is located in Tuguegarao and the Provincial Office at Cauayan, and additionally there are 17 Municipal Offices in the Project Area to implement land transfer and other programs of the agency. The plan and accomplishment status of the agrarian reform are described previously.

(2) NIA (MRIIS O/M Office)

NIA is responsible for irrigation water supply, operation and maintenance of the irrigation facilities and water fee collection. Institutional development such as IA and FIG is also implemented by NIA, and Institutional Development Division (IDD) is in charge of it. Totally 16 advisors and coordinators are assigned for the purpose. The number of full-time officials of ADD has been decreased from 49 in 1979 to 23 in 1986. Therefore, the increase of staffs is expected to strengthen and develop water users associations.

(3) NFA

The major activities of NFA is to supply enough foods stably to the people and to contribute to social economy by procuring and marketing paddy. In pursuit of its goal, followings are the policy of NFA;

i) To maintain and implement a supporting price,

ii) To manage sufficient buffer stocks,

iii) To assist in making appropriate food commodities to nutritionally deficient consumers,

iv) To adopt such processing systems to minimize costs, reduce food losses and improve quality,

v) To limit government participation in the areas where the private sector has no capability to enhance industry development adequately,

vi) To coordinate with government policies involved in the development of the food industry,

2.5.13. Agricultural Credit

According to the data on "Intensified Rice Production Loan in the Isabela Province" published by MAF, the total amounts of paddy production loan by the government through the banks and NFA were 61 million pesos in crop year 1984/1985 as shown below, and it could be considered that about 80 percent of these amounts were used for the farmers in the MRIIS area. An average amounts of loan per farm and hectare are about ₱6,300 and ₱2,600, respectively. However, the rate of debt payment is very low at 62 percent for dry season and 45 percent for wet season.

Loan Amount of Intensified Rice Production Program

Items	Nov.1984 - Apr.1985 (Dry Season)	May 1985 - Oct.1985 (Wet Season)	Total
1. Number of Borrowed Farms	4,052	5,713	9,765
2. Planted Area of Borrowed Farms	9,101	14,559	23,660
3. Total Loan Amount (₱'000)	22,828	38,624	61,452
4. Amount of Repayment (₱'000)	14,257	17,460	31,717
5. Loan Condition			
- Loan Amount per Farm (₱/farm)	5,630	6,760	6,290
- Loan Amount per Hectare (₱/ha)	2,510	2,650	2,600
- Rate of Debt Repayment (%)	62	45	52

Source: MAF, Isabela Province

An average loan amounts per farm are shown as follows depending upon the different farm size, that is, about ₱3,000 for the farms with area less than 1.0 ha, about ₱6,300 with area of 2.0 to 3.0 ha, and about ₱17,000 with area of more than 3.0 ha, as shown below. On

the other hand, an average loan amounts per hectare by size of planted area are estimated at about ₱2,000 to ₱ 3,000 per hectare, which is equivalent to 40 to 50 percent of the production cost.

Farmers Loan for Paddy Production in the MRIIS Area

Items	Size of Planted Area: below 1.0 ha	1.0-2.0 ha	2.0-3.0 ha	more than 3.0 ha	Total & Average
1. Total Sample Farm	51	126	61	55	293(100)
2. Farmers Borrowed					
- from Informal Source 1/	24	65	37	20	146(50)
- from Banks & NFA	6	25	12	18	61(21)
Total	30	90	49	38	207(71)
3. Average Amount of Loan					
- Loan per Farm (₱/farm)					
° from Informal Source 1/	2,370	4,140	6,250	16,400	6,630
° from Bank	3,020	4,350	6,290	17,400	7,990
- Loan per Hectare (₱/ha)					
° from Informal Source 1/	2,840	2,430	2,350	2,920	2,600
° farm Bank	3,100	2,620	2,240	3,280	2,860

Note : 1/ including merchant, land owner, relative and others.
Source: Farm economic survey in the Service Area, 1986.

According to the farm economic survey in the MRIIS area conducted by the Study Team, paddy production loan is supported by public financial institute as well as by informal sources. It is observed that majority at 70 percent of the sample farms has the debt during both dry and wet seasons. And, 70 percent of these borrowers is getting credit from informal sources, and the remaining 30 percent of farms is from banks and NFA.

The banks' interest rate by production loan is 15 to 18 percent per annum, but the interest rate by informal sources is 35 to 45 percent per one cropping season (three to four months). This high interest rate by informal sources is a burden to the borrower farmers.

According to the data of MAF and banks in the MRIIS area and the result of farm economic survey, it is estimated that the total amounts of production loan are 160 to 200 million pesos from official, 100 to 140 million pesos from informal sources.

2.5.14. Social Infrastructure

(1) Economic Infrastructure

(a) Road Condition and Transportation

Isabela Province has the longest road in Region II, particularly the barangay roads are more developed than the other provinces. However, the MRIIS area suffers from the shortage and bad conditions of the farm roads. National, Provincial, Municipal and Barangay roads also need much rehabilitation and continuous maintenance.

Road Conditions

(unit: '000 km)

Road Category	Region II	Isabela Province
- National	2,234	391
- Provincial	1,885	580
- Municipal	913	355
- Barangay	7,305	2,493
Total	12,337(100%)	3,818(31%)

Transportation of farm products is greatly affected by the poor road and transportation conditions, and in case of paddy cultivation, farmers carry it by hand in a long distance or use bull carts, small tractors and tricycles which have insufficient loading capacities.

For the passengers in daily life, tricycle, auto-bus, mini-bus, jeepney are popularly used in the area. Truck and trailer are employed mainly for long distance transportation.

(b) Electricity

In each District of the Project Area, about half of the populace enjoy electric lighting, but there are other Barangays which need electrification urgently.

The cost of electricity is high (quadruple) as compared with that of Manila, since the generated power in Magat hydroelectric power station is transferred to the Luzon Grid through which electric power is distributed to the Project Area. NIA also suffers from shortage and high cost of electricity for their operation, particularly for that of pumping stations in District III and IV.

As a reference, electricity price in the Project Area is higher by 35 percent than that of Metro Manila in 1985, as average of all sector.

(c) Telecommunication and Postal Services

NIA utilizes the radio micro-wave for their operation, and the administrative organization also has the same facility to transmit message from Provincial Government Office to each Municipality Office. Through the private telecommunication companies' stations in Cauayan, Santiago and Echague, domestic and international communication are made possible.

Inhabitants in the Project Area receive radio broadcast through the radio broadcast station, three in Santiago and two in Cauayan. A few number of them enjoy television broadcast of two channels. Post offices are located in all of the Municipalities, near the Municipality Office.

(2) Social Infrastructure

(a) Potable Water Supply

Although there is no potable water supply system in the area except for the commercial town of Santiago, inhabitants could easily take potable water from underground through pump wells of about six to ten meters depth with comparatively good quality. However, the result of domestic water quality test in the poblacion

shows the necessity of purification like boil in 80 to 90 percent of wells. The subject of examination is mainly the existence of disease germ and there exists no mineral per poison in the underground water.

(b) Education Facilities

The number of the different learning institutions is superior to other Provinces in Region II, but inferior to the average number of the Philippines. In Echague, Isabela State University is located which attends to both high school and college education but educational apparatus and equipment are insufficient at present. At elementary, middle and high school levels, there is also a shortage in number of teachers as well as school rooms.

(c) Health and Social Welfare Development

The number of hospitals by Municipality in Isabela Province is comparatively high as compared with the average in Region II. Inhabitants in the Project Area, however, are not satisfied with the actual conditions of hygiene due to shortage of the number of doctors and clinics.

Other social facilities such as sports center, municipal hall, etc. are also the subjects that the inhabitants eagerly wish to obtain. It is difficult to fix the index of satisfaction level of inhabitants for social welfare in the Project Area, but it will be noted that there remain many infrastructure facilities to be provided in the near future.

CHAPTER III. IMPROVEMENT OF OPERATION AND MAINTENANCE IN THE MRIIS

CHAPTER III. IMPROVEMENT OF OPERATION AND MAINTENANCE IN THE MRIIS

3.1. Development of Irrigation Area

3.1.1. Land Development

As stated in the Paragraph 2.1.3 "Irrigation Service Area", the present irrigation area in the MRIIS is about 71,100 ha in 1986 and the achievement ratio in development is about 73 percent of the target irrigation area of 97,400 ha.

It is the most urgent and important subject to achieve the development target of the irrigation area of 97,400 ha at the early stage by improving the present unirrigated area of about 26,300 ha; otherwise, the project benefit of the MRIIS will not be generated any more and increment of irrigation fee collected as the fund for O/M services in the MRIIS area, can not be expected.

An unirrigated area is mostly caused by an area undeveloped and without on-farm facilities. The improvement status for those areas from 1985 to 1986 is shown in the following table;

Progress of Unirrigated Area

(unit: ha)

Item	District I	II	III	IV	Total
- Undeveloped Area					
1985	5,760	790	2,950	5,410	15,090
1986	4,330	1,080	2,940	4,870	13,220
Decreased Area	-1,430	+ 290	- 10	- 540	-1,870
- Lack of On-Farm Facility					
1985	670	1,070	1,460	1,730	4,930
1986	310	1,270	2,660	2,460	6,700
Decreased Area	- 360	+ 200	+1,200	+ 730	+1,770

* Reasons for the increase of the undeveloped area or the lack of on-farm facilities can be referred to Annex, page C-3 to C-5.

3.1.2. Achievement Program

(1) Land Development

Although undeveloped area of 15,100 ha in 1985 was decreased to 13,220 ha in 1986, it still occupies a large portion of about 50 percent of the unirrigated area of 26,300 ha. In this connection, it is the most important improvement subject in the MRIIS O/M to accelerate the land development and to reduce the undeveloped area. Such land development works should be carried out by farmers themselves in principle; however, since the present undeveloped area is mostly located in the service area with undulated topography, the land development works will be rather difficult for farmers and require a long period to complete.

NIA and the MRIIS O/M Office must help the related farmers to carry out such land development works through Irrigators' Association (IA) by the following manners;

- Planning and designing for the land development are to be made by the MRIIS O/M Office.
- Construction equipment and operators for the land development should be lent to IA on the repayment basis.
- The MRIIS O/M Office should make annual schedule in each Division of District for the land development and accelerate the farmers' development works in order to achieve the target irrigation area of 97,400 ha. Land development program shall be planned in five-year plan for District I, III and IV, and two-year plan for District II.

In order to successfully implement the above land development, the following governmental assistances and support will be required;

- Administrative cooperation will be rendered by the governmental agencies concerned such as Ministry of Agrarian Reform (MAR), etc. to allocate the land to the farmers.

- Financial support by Government for the land development should be given to the farmers' activities.

- Assistance will be given for establishment of the farmers Irrigators' Associations by NIA and other governmental agencies concerned to carry out the farm land development smoothly.

(2) Provision of On-Farm Facilities

According to the NIA criteria, the on-farm facilities at terminal fields covering an area of 20 to 30 ha on an average are generally provided by the farmer's institution, although NIA had a responsibility to provide on-farm facilities inclusive of supplementary farm ditch before 1983. However, as indicated the previous table showing the progress of unirrigated,the areas with on-farm facilities, but does not function well, have been increased since 1985. The reasons are as follows;

- The on-farm facilities are not properly constructed by farmer's institution due to the lack of technical and financial support by NIA. Therefore, some facilities constructed does not function to deliver the irrigation water from lateral canals to terminals and are easily broken after releasing the irrigation water, especially at the facilities located in undulated hilly area.

- The on-farm facilities are not constructed, while the undeveloped areas are converted to paddy fields, because farmer's institution have no techniques and fund for the construction of facilities.

- Farmer's institution such as Irrigator's Association has not fully established yet in the whole Service Area.

In order to exercise rationalized water and farm managements, the on-farm facilities should be provided in accordance with the NIA criteria. The construction of on-farm facilities should be carried out in principle by Irrigators' Association. However, NIA and the MRIIS O/M Office should carry out technical assistant to construct the on-farm facilities by supplying O/M equipment, materials and operator on the repayment basis, in the same way as those works in land development.

The MRIIS O/M Office, furthermore, shall prepare the annual programs in each Division for the works and management of farmer's activities. It is also necessary to carry out the proper maintenance of the completed on-farm facilities, so that the MRIIS O/M Office can study the farmers' maintenance method and give proper advices and helps to farmers.

3.2. Improvement of Water Management

3.2.1. Diversion Water Requirement

(1) Standard Unit Irrigation Requirement

The criteria for estimation of the unit irrigation requirement are shown in the present O/M Manual prepared by the MRIIS O/M Office in 1985. The estimated unit irrigation requirement based on the criteria is also presented in the O/M Drawings No.10.

This unit irrigation requirement is estimated on the basis of farm water requirement, farm losses at fields and conveyance losses, but not on the effective rainfall and system operation losses. It was proved in this study that present unit irrigation requirement deems to be reasonable to apply the irrigation area of above 71,000 ha, but it would be necessary to review it in future based on the irrigation results for the proposed irrigation area of 97,400 ha in the following considerations:

Unit Irrigation Requirement in Dual Class Land Area

The Dual class land area of about 10,400 ha covered with Lateral "A" and "B" of Maris and Macanao west (MW) main canal systems present a considerable large unit irrigation requirement as shown below;

Unit Requirement in Dual Class Land Area

Item	Land Soaking Period (l/sec/ha)	Paddy Growing Period (l/sec/ha)
Average Value in Lateral "A" and MW	5.5 - 7.5	3.0 - 3.5
A-3, A-5 and A-5 Extra Area	8.0 - 10.0	4.5 - 6.5

It seems that the unit irrigation requirement was estimated at 2.0 to 2.5 l/sec/ha in the stage Ia project constructed in 1976, but it was increased gradually depending on the actual irrigation results and finalized to the present value presented in the present O/M Manual. It is considered, however, that this requirement may include much irrigation losses caused from poor water management at on-farm level. In this connection, the present unit irrigation requirement will be reviewed on the condition of proper water management by saving operation losses at the turn-outs and on-farm level.

In the case that the irrigation demand in Dual class land could be reduced, water distribution control in the Maris canal to supply equally irrigation water to the service area will be easily made compared with present conditions using much water in the upstream area.

Unit Irrigation Requirement in Newly Developed Area

Only one unit irrigation requirement has been applied to the large service area of about 7,900 ha commanded by the South Low, 12,700 ha by South High, 5,500 ha by Cauayan East Extension and 13,600 ha by North Diversion canals, respectively. The soil characteristics and permeability are a little different between the upstream and downstream areas along the above mentioned canals, and therefore the unit irrigation requirement for each area will be reviewed by the classification of soil permeability and actual irrigation result under proper water management. Such review will be made year by year after collecting accurate irrigation data for a few years.

Effective Rainfall

Effective rainfall is also estimated in the present O/M Manual, but its value is rather high in comparison with rainfall data in the Project Area. Study Team has studied the effective rainfall based

on the long term rainfall records observed at Ilagan station which presents a little bigger rainfall value than that of the Project Area.

The comparison between the values quoted in the O/M Manual and the revised values estimated by the Study Team is as follows;

Effective Rainfall

Item	Wet Season Paddy (mm)	Dry Season Paddy (mm)	Total (mm)
Value in O/M Manual	518	409	927
Revised Value			
For Rice Class Land	457	123	580
For Dual Class Land	268	560	828

(2) Diversion Water Requirement by Proposed Irrigation Schedule

Diversion water requirement for the target Service Area of 97,400 ha was estimated based on the proposed irrigation schedule for the major canal systems, on which details are described in the subsequent paragraph. The estimation results on the 10-days interval basis in the major canals are shown in the O/M Drawings No.13.

The irrigation demands for the wet and dry seasons are summarized as shown in Table C-5 in Annex. The Total water demand for the area of 97,400 ha is 3,067 MCM corresponding to the unit irrigation requirement of about 3,150 mm/annum (1,570 mm for wet season and 1,580 mm for dry season paddy).

3.2.2. Irrigation Schedule

Since the run-off of the Magat river is considerably abundant in the typhoon season while very scarce in the dry season, the Magat reservoir capacity is not always sufficient to store a rich run-off in the wet season and to use it during the dry season.

Therefore, the shortage in irrigation water will take place in the Service Area of 97,400 ha when the reservoir operation is made according to staggered irrigation schedule prevailing at present.

It is quite essential to improve the proper cropping pattern and irrigation schedule from the viewpoint of the most effective and efficient use of the rainfall and river run-off as water resources.

The Study Team has made study on the improvement of cropping pattern and irrigation schedule taking into account the effective water utilization in each canal system as shown in Figure 3-1.

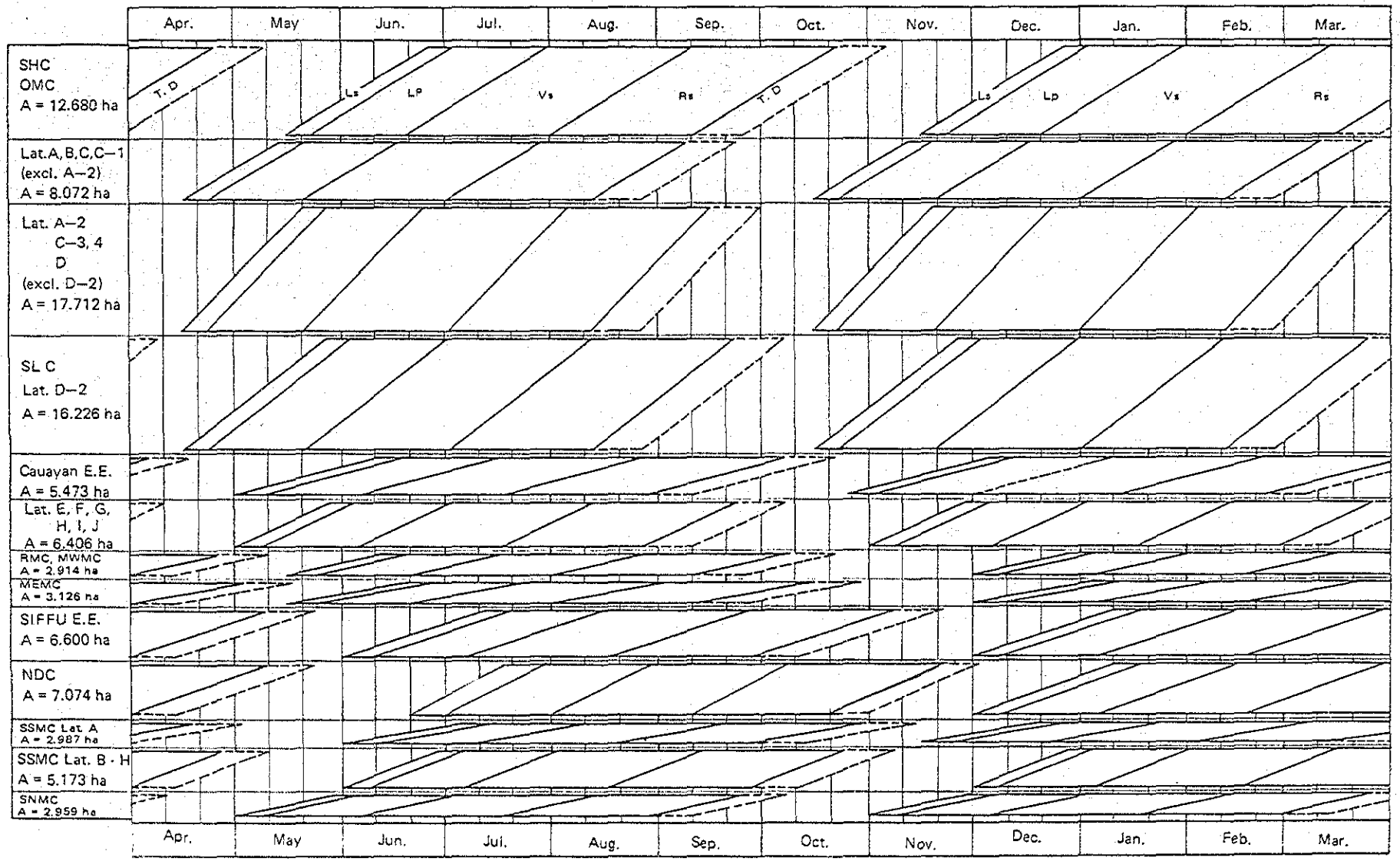
(1) Upstream Area of Maris Canal System

The cropping calendar for the service area of about 42,000 ha covered by the Lateral "A", "B", "C", "D" and South Low main canal in Maris canal system is planned so as to start land soaking for the wet season paddy between the middle of April and the end of May and the harvest is to be practised from the middle of August to the end of September.

On the other hand, the dry season paddy cropping is planned for the period from the end of October to the middle of March. These proposed cropping calendars are 0.5 to 1.0 month earlier than the present one shown in the O/M Manual because of the following reasons;

- Some outflow for the power generation will be required in the middle of April to meet the NPC demand for the Magat hydroelectric power plant. In this connection, the paddy cropping by Maris canal system is planned to be started in the middle of April in the better use of the power outflow for irrigation; otherwise, the power outflow will be wasted through Maris diversion dam to the Magat river without serving for irrigation.
- In downstream area of South Low main canal and Lateral "D" canal, the cultivation of the wet season paddy is started from the end of June and last to July or August, and

FIGURE 3–1. PROPOSED CROPPING SCHEDULE



harvest is practised in a period from October to November, which falls on a heavy wet season. Consequently, the farmers in the downstream area have always suffered from heavy rainfall and inundation in the harvesting season and faced difficulties in paddy cultivation.

The starting time of the wet season paddy, therefore, shall be shifted a little earlier in order to finish harvesting works before such heavy wet season.

- The present dry season paddy cropping in the downstream area is started from December and last to January due to delay in paddy harvest in the wet season paddy cropping and the irrigation will last by the end of March and April. Consequently, much irrigation requirement will be needed because cultivation will be made in the dry months, and farmers always bring the water shortage problem in the dry season.

  A little early start of cultivation of the dry season paddy cropping at the end of October to early November shall be made in order to use available rainfall as much as possible for the end of October to December and to save the irrigation water amount from the Magat reservoir.

- The irrigation water supplied to the Lateral "A-2" and "B" covering the area of about 5,800 ha is about 10 cu.m/sec on an average during the irrigation season and reaches the annual amount of about 300 MCM, about 45 percent of which will be released to Macanao and Gaddanan creeks as the return flow and used for irrigation area of about 6,000 ha through Macanao and Ladeco weirs on the Macanao creek.

- The present wet season cropping in the Macanao and Ladeco areas is started for a period from July to August due to water shortage in May and June which is caused by delay of return flow, and results in delayed harvesting in the heavy wet season of October/November.

  And the cultivation of the wet season paddy in the area irrigated by Lateral "A" and "B" shall be started for a period from the middle of April to May in order to get sufficient return flow available from the end of May to June and to carry out early cultivation of the wet season paddy in the Macanao and Ladeco areas.

(2) Downstream Area of Maris Canal System

The wet season paddy cropping in the service area of about 11,900 ha covered by Lateral "E" to "J" and Cauayan East Extension

located in the downstream of Maris main canal is presently started in a period from July to August due to delay irrigation water supply from the upstream canal and result in delayed harvesting in the wet season in October/November. In this regard, the starting of cultivation shall be earlier with the improvement of water management for a period from May to June by 0.5 to 1.0 month delay to the cultivation at upstream area mentioned above.

(3) South High and Oscariz Main Canal System

In the service area of about 12,700 ha by South High and Oscariz main canals, the wet season paddy cropping is presently carried out in a period from July to November, and the dry season cropping from December to April brings same problems as mentioned in the above (1) and (2). The cropping calendar, therefore, shall be improved with the wet season paddy for the middle of May to September and the dry season paddy for the middle of November to April by the following reasons;

- The irrigation water is supplied through the Baligatan outlet of the Magat dam and does not contribute to Magat hydroelectric power generation for NPC. Therefore, the irrigation schedule for the wet season paddy cropping shall be made with start at the middle of May so as to use rainfall in May to June and to finish harvest works before November.

- The Baligatan hydroelectric power plant with the proposed maximum installed capacity of 6,000 KW will be operated at the outlet in the near future in order to get NIA's own power for pumping operation of No.1, No.2, and No.3 in the service area. The irrigation schedule in these pumping service areas shall be planned to render services from June to October for the wet season paddy and December to April for the dry season paddy.

(4) North Diversion and Siffu South Main Canal

For the service area of bout 21,800 ha in North Diversion and Siffu South main canals, irrigation is presently started in July for the wet season paddy and in the period from December to January for

the dry season paddy. This schedule brings also some problems on harvesting on November in the wet season of November.

The irrigation schedule for the wet season paddy shall be improved in the periods from June to October. The reason to start irrigation in June which is a little delay compared with the other canal system areas is that the service area can use much run-off of the Siffu river and much rainfall in June for land soaking works. In addition, pump operation cost can be saved by using rainfall for land soaking works at the pumping areas.

(5) Siffu North Main Canal

Since the irrigation area served by Siffu North main canal is small in acreage of about 3,000 ha and irrigated by diverted water through Siffuris diversion dam, the irrigation schedule is planned to cover from May to the middle of September for the wet season paddy and from November to March for the dry season paddy. The Siffu river can supply sufficient water to cover the area of about 3,000 ha at any time.

3.2.3. Request and Allocation Procedures for Irrigation Water

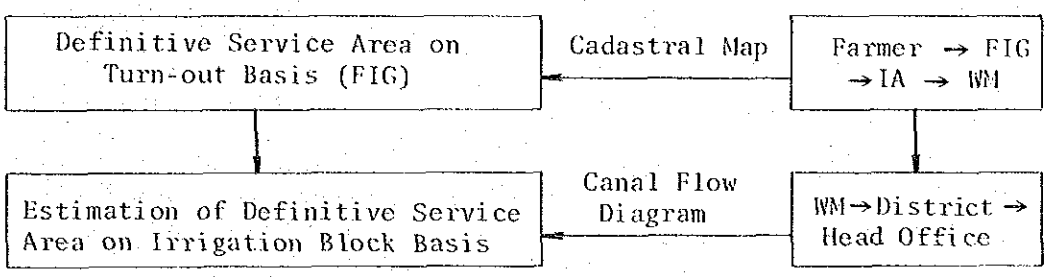
The study on improvement of the procedures for request and allocation of irrigation water was made as shown in Figure 3-2, and the procedures as shown below are to be followed in each stage;

Preparation

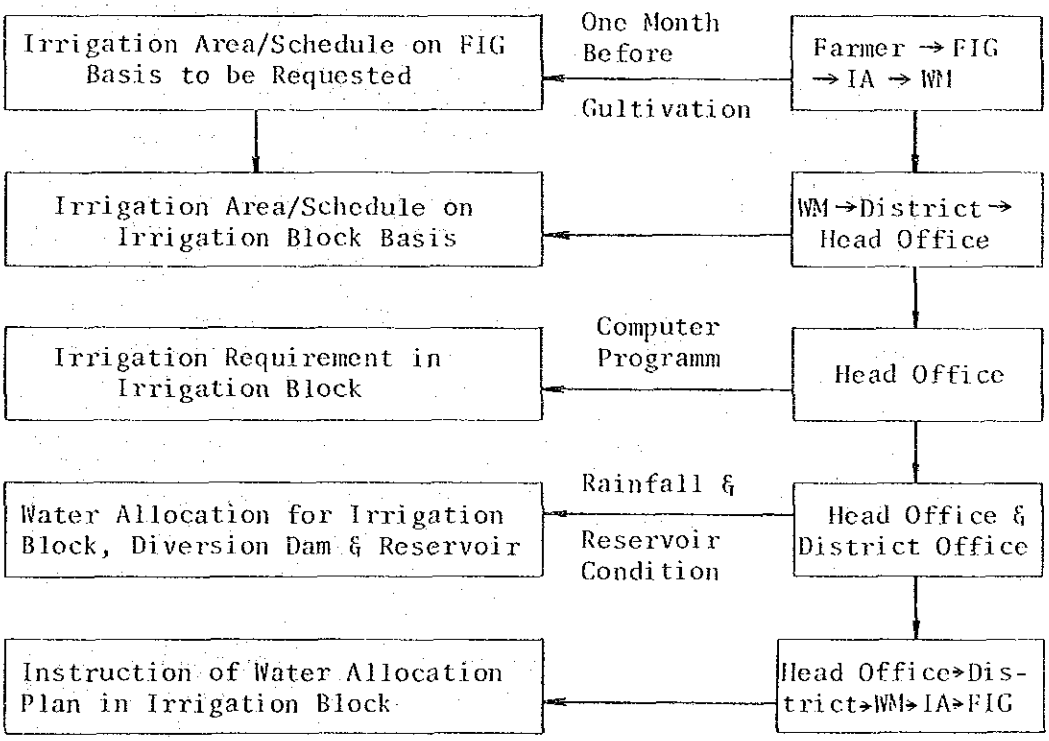
- The irrigation flow diagram in canal system shall be prepared as shown in the O/M Drawings No.23 to No.26 and the Irrigation Block (IB) shall be formulated taking into account the area commanded by major check and head gate points and Division boundary.
- The service area to be irrigated is accurately estimated on turn-out basis (FIG basis) by using cadastral maps and summarized on IB basis. This work will be made by the Water Master (WM) coordinating with IA, FIG and farmers. This area becomes the basis for request and allocation of irrigation water.

FIGURE 3-2. WATER REQUEST AND ALLOCATION RULE

(1) Preparation Works



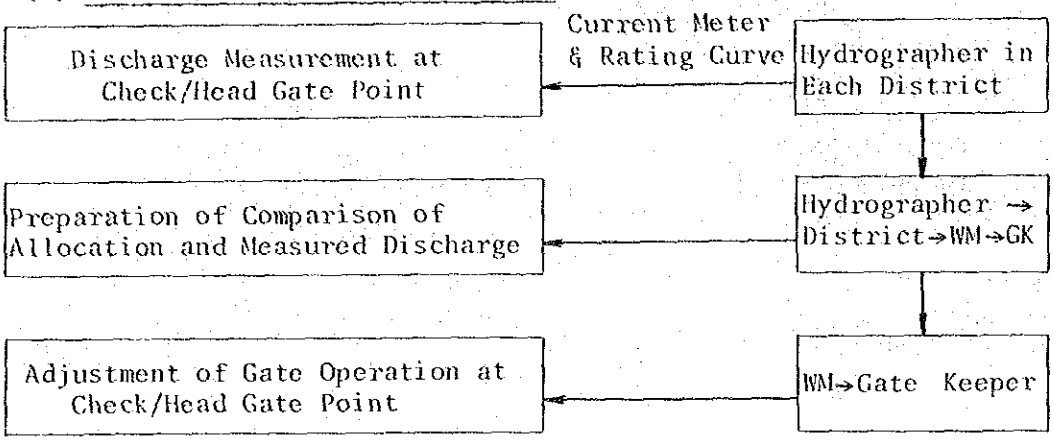
(2) Request Allocation Plan of Irrigation Water



(3) Actual Operation for Request and Allocation of Irrigation Water on Weekly Basis

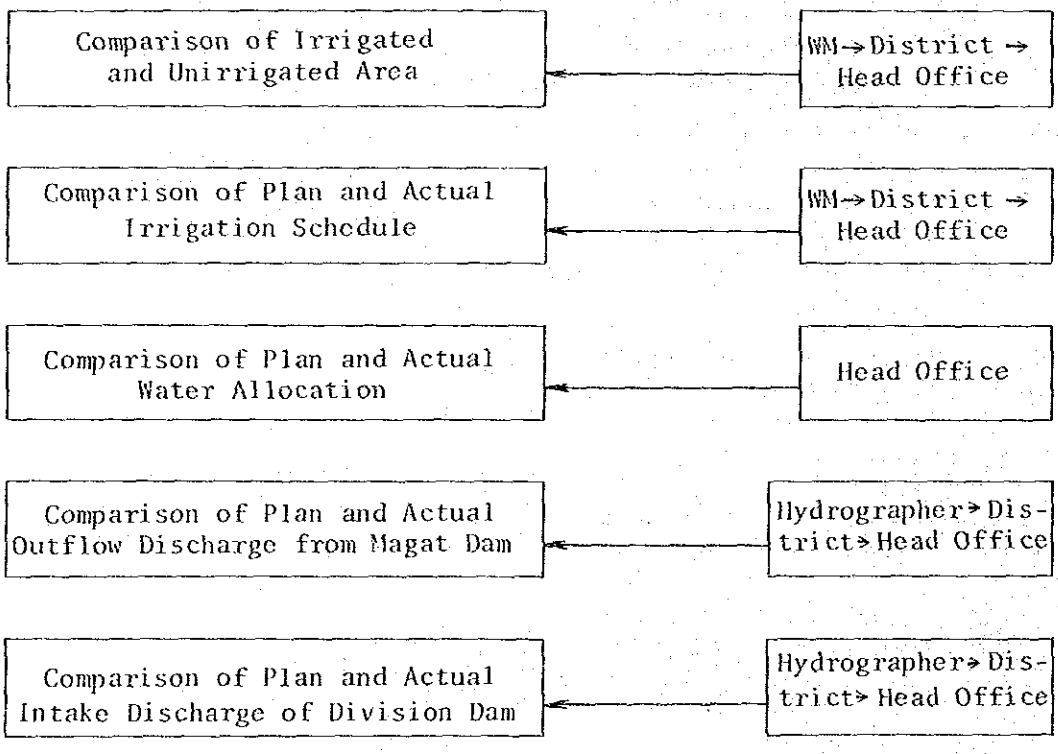
Planned same as "(2) Request and Allocation Plan of Irrigation Water", but conducted by actual area and schedule on weekly basis.

(4) Check by Discharge Measurement



(5) Data Management

Data relevant to water management is compiled at the end of month and cropping season.



Plan for Request and Allocation

- The request and allocation plan of irrigation water shall be prepared at about one month before starting cropping season in each major main canal system. IA shall prepare the irrigation area and schedule by FIG or member farmers to submit to the Water Master (WM). The WM shall check and adjust the area and make arrange schedule by the IA and summarize it on IB basis.

- The area and schedule on IB basis shall be submitted to the Water Control Coordination Section (WCCS) in the MRIIS O/M Head Office. WCCS shall estimate promptly and accurately the irrigation requirement on the IB basis for the major check and head gate points by using computer. WCCS shall adjust the estimated irrigation requirement taking into account the available effective rainfall and storage water conditions in the Magat reservoir before starting paddy cultivation.

- In accordance with the above estimation and adjustment, the MRIIS Head Office manager shall determine the allocation plan of irrigation water supply on IB and outflow from reservoir and diversion dams, and give instructions to each District manager. This allocation plan is prepared on the weekly basis.

- The District manager shall give instruction to WM and IA so as to keep the above allocation of irrigation water as the expected irrigation schedule in the cropping season.

Actual Operation for Request and Allocation

- Actually, the procedures for request and allocation of the irrigation water shall be followed to the manner as specified in the plan on the weekly basis.

- Actual operation may be revised slightly to the plan because of some differences in condition of actual irrigation area, delay in irrigation schedule by farmers, delay in irrigation water to farm areas due to defect of irrigation canals and mistakes in gate operation, conditions of rainfall available, storage condition in the Magat reservoir, etc.

- These variable factors are carefully studied on the weekly basis by WCCS with collected data and information at the District Offices and then the final water allocation will be made by the MRIIS O/M Head Office manager and given to each District manager.

- The control of irrigation water supply will be practised by check and head gate keepers under WM according to the instruction on the water allocation.

The estimation of irrigation water allocation will be made by computer.

3.2.4. Reservoir Operation in Magat Dam

(1) Water Resources of the MRIIS

Water resources of the MRIIS for irrigation are the Magat and Siffu rivers, and return flow from the Macanao and Minante creeks.

The Magat river flows down to the damsite gathering the runoff of three major tributaries of the Alimit, Ibulao and Matuno in a large catchment area of 4,143 sq.km at the Magat damsite. Average annual runoff is reported at about 6,550 MCM in the past 30 years, presenting remarkable fluctuations of monthly and annual runoffs. The biggest annual runoff ever recorded is about 13,000 MCM in the year 1971-72, reaching about four times of the smallest annual runoff of 3,300 MCM observed in 1983-1984. Seasonal variation of the runoff is also remarkable, showing the average monthly runoffs of 700 to 1,500 MCM in wet season from July to December and 50 to 300 MCM in dry season from January to June. Therefore, in order to expect the most efficient utilization of the river water for dual purpose of irrigation and power generation, it is inevitably requested to control the runoff at the Magat reservoir. The water operation in the Magat reservoir shall be made under the application of the optimal rule for reservoir operation, in due consideration of the runoff characteristics represented by a big fluctuation of seasonal discharge and a small amount of river water during dry months.

Having the catchment area of 627 sq.km, the Siffu river produces an average annual runoff of about 880 MCM presenting similar characteristics as reported for the Magat river. The

biggest and smallest annual runoffs in the past are 2,100 MCM and 300 MCM, respectively. The Siffu river runoff is being used only for irrigation in the service area of about 14,800 ha covered by the Siffu North and South main canals. About 400 MCM of river water is diverted at the Siffuris diversion dam in wet season irrigating the entire service area along the Siffu river. In contrast in dry season, about 370 MCM is diverted from the river to irrigate the service area together with additional water supplemented from the Magat reservoir. The surplus runoff of about 260 MCM per annum is accordingly spilled through the crest of the dam to the downstream of the river, which is mostly characterised as flood water in the wet season.

A considerable amount of return flow is observed in the Macanao creek and expected to be re-used for the irrigation at the downstream area of the existing macanao and Ladeco weirs in the Macanao creek. This return flow is flowing down from the service area of about 5,800 ha located along Lateral canals of "A-2", "A-4" and "B" under the Dual class land with a high permeability. The return flow discharge is estimated to be about 5.0 to 10.0 cu.m/sec on an average, which is corresponding to about 45 percent of the supplied irrigation water in the upstream service area.

(2) Allocation of Magat and Siffu River Water

The irrigation water in the service area of about 3,000 ha controlled with the Siffu North main canal is to be introduced from the Siffu river with the first priority, because its service area has no water source for irrigation except the Siffu river.

The irrigation water for the area of about 8,200 ha will be served by the Siffu river in case the river has excess water after river water to the Siffu North canal area is diverted. The Siffu river will have much allowance in the wet season, but in the dry season less allowance to supply water to the Siffu South canal area is only expected.

An additional irrigation water for the Siffu South canal area is supplied by the Magat reservoir through the North Diversion main canal, in case the Siffu river has no allowance to supply the river water for irrigation.

All Service Areas in the MRIIS except the above areas served by the Siffu river are irrigated by the Magat river water controlled in the Magat reservoir and supplementary by the return flow of the Macanao and Gaddanan creeks.

Water allocation chart of the Magat and Siffu river including the Macanao creek is shown in Figure 3-3.

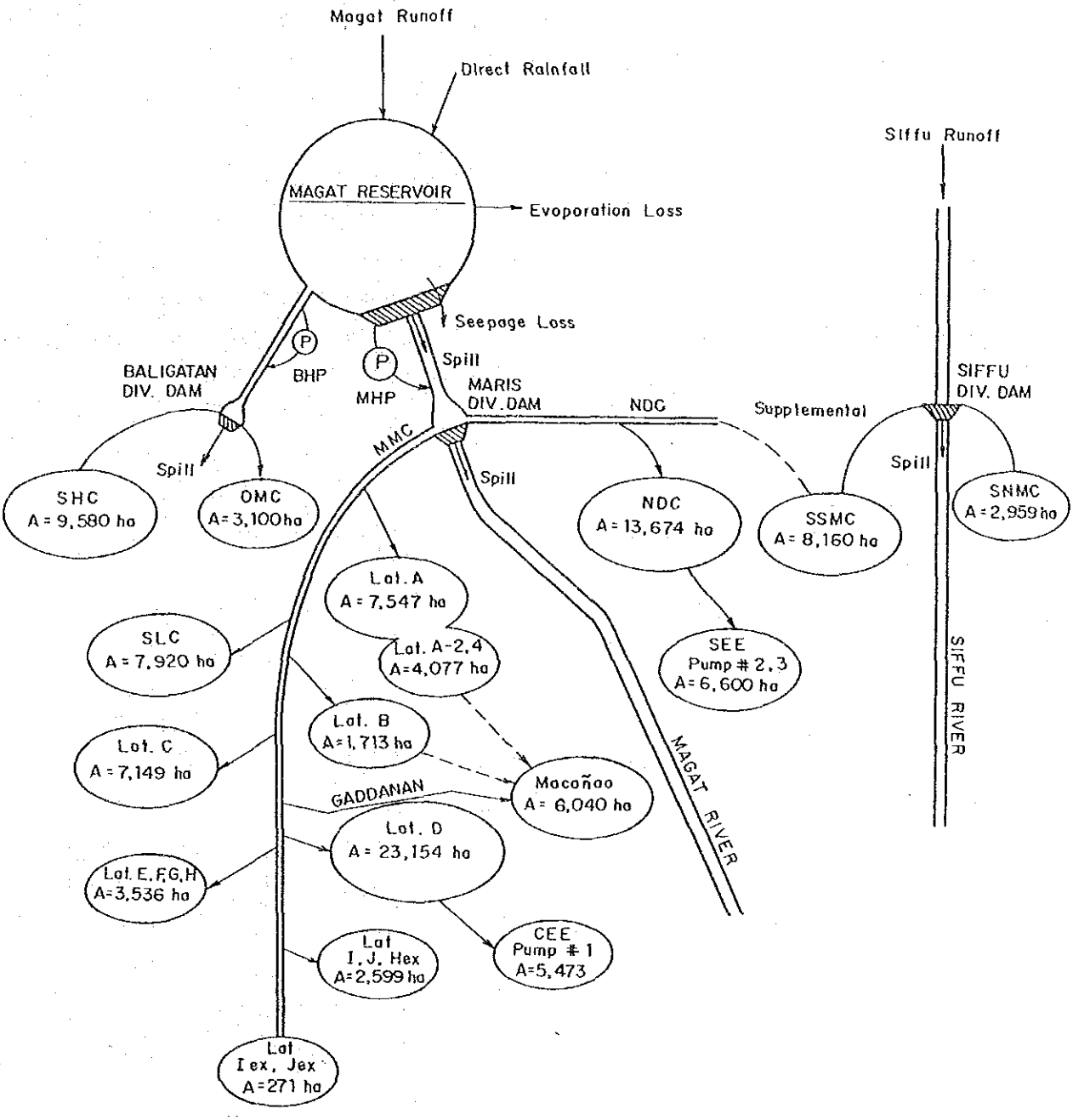
(3) Magat Reservoir Operation

As a basis for formulation and evaluation of the Project, hydrological analysis were conducted placing a great emphasis on the establishment of the optimal operation rule of the Magat reservoir inclusive of runoff estimation and water requirement for irrigation as well as for power generation. All analysis were based on the hydro-meteorological data available mainly from the site of existing Magat Dam, Siffuris diversion dam and Ilagan meteorological station collected for the period of recent 30 years from 1957 through 1985 exclusive of three years from 1973 to 1978.

Method, procedure and basic parameters presented in the existing O/M Manual were fully employed during the course of the study mainly for estimating water requirement for irrigation diversion including effective rainfall computation and various losses for water delivery and distribution, under the given condition of the target irrigation area of about 97,400 ha with a cropping intensity of 200 percent.

With regard to water requirement for hydroelectric power generation, monthly typical loadings prepared in 1985 by NPC was

FIGURE 3–3. WATER ALLOCATION CHART OF MAGAT AND SIFFU RIVERS



carefully reviewed and applied as a basis for constructing a rule of the reservoir operation, especially during the wet season.

Prior to the study, it was pointed out that the reservoir total storage volume at full supply level (FSL) of EL.193.0 m revised in 1980 based on the contour map survey was reported at 1,090 MCM instead of 1,250 MCM, which is given in the project Feasibility Study Report.

The Magat reservoir is operated by the following optimal operation rule, which was proposed through simulation of the reservoir operation in consideration of the combined effect of dimension of the existing dam facilities, available inflow into the reservoir, losses and demand for dual purposes of irrigation and power generation.

Dam Facility

-	Full Supply Level (FSL)	EL.193.0 m
-	Full Supply Capacity	1,090 MCM
-	Lowest Supply Level (LSL)	EL.160.0 m
-	Minimum Storage	270 MCM
-	Effective Storage	820 MCM

Inflow

-	Maximum Annual Inflow	12,530 MCM/yr
-	Minimum Annual Inflow	3,280 "
-	Average	6,550 "

Irrigation Demand

		Area (ha)	Demand (MCM/yr)
-	Direct Service Area	80,243	2,537
-	Supply to Macanao Area	6,040	90
-	Supply to SSMC Area	8,160	62
-	SNMC Area	2,959	-Siffu Runoff-
	Total	97,402	2,689

In order to characterize the combined effect of irrigation demand, inflow and storage capacity of the reservoir, a case of preliminary operation study was conducted without giving any

specific operation rule and with water release just to meet irrigation requirement only. The study revealed the fact that the reservoir capacity would be sufficient enough to satisfy irrigation demand during a critical drought period of 15-year recurrence.

However, since the Magat runoff largely depends on typhoons visiting the drainage basin, and still more due to the fact that much weight in controlling water releases in wet season is given for power generation, there would be frequent occasions where the reservoir will not restore its storage at the end of wet season carrying over such effects in the succeeding cropping season, in case when the inflow is much less than expected.

Various operation rule curves were hence verified by means of trial and error simulation to find the optimal rule of the reservoir operation to meet both the irrigation and power requirement, in consideration of practically possible condition for the actual reservoir operation.

Based on the fundamental values and procedures given in the existing O/M Manual, irrigation water requirement was accumulated by season at the major point of diversion. Since effective rainfall for the standard dry year corresponding to once in five year recurrence interval was employed in the study, seasonal water requirement shows no significant difference from year to year. Only supplemental water supply to the Siffu South main canal area has an annual variation depending on the available discharge in the Siffu river. Monthly estimates of irrigation water requirement to be diverted from the Magat reservoir are then compared with the water demand requested for the Magat hydroelectric power plant by NPC in 1985.

Comparison of Irrigation and Power Demand

Month	Irrigation Demand 1/ (cu.m/sec-day)	Projected Power Generation by NPC 2/ Monthly Loading (MW)	Continuous Loading (MW)	Required Release (cu.m/sec-day)
Jan.	117.0	1,810	75.4	101
Feb.	134.9	1,940	80.8	113
Mar.	89.6	980	40.8	61
Apr.	55.4	750	31.3	50
May	102.2	1,230	51.3	89
Jun.	101.2	1,680	70.0	128
Jul.	139.8	4,080	170.0	241
Aug.	71.5	6,120	255.0	330
Sep.	41.2	8,160	340.0	411
Oct.	27.8	5,400	225.0	256
Nov.	44.8	4,080	170.0	232
Dec.	88.3	2,600	108.3	140

Notes: 1/ Average in 30 years, proposed cropping schedule.
2/ Estimated along the lower mode of operation curve.

As seen in the above table, required water release for power generation during dry period from January through June, with exception of June, would be covered by the irrigation water release so long as the reservoir water level is kept within a normal range of elevation. In other word, when the reservoir level is expected to be around the full water level at the beginning of January, the reservoir during dry season could be operated taking only irrigation aspect into consideration.

Since the reservoir capacity is not sufficiently large enough to meet water demand in the critical dry period, operation of the reservoir should be undertaken in such a way that two purposes confronting each other namely; 1) promotion of effective water release and ii) restriction of release in preparation for unforeseen drought, can be adjusted. To cope with this, it is useful to zone the storage area into two areas corresponding to the respective purpose. Under the normal condition, the reservoir will be operated so as to keep the Basic Storage Line (BSL). In the event when the actual storage volume sinks below the BSL, the Restrictive Release

Line (RRL) may be applied. The BSL and RRL are planned by calculating the required storage-levels for the projected drought which indicate certain safely probability of the reservoir operation. The BSL and RRL finally compose the Storage Operation Rule.

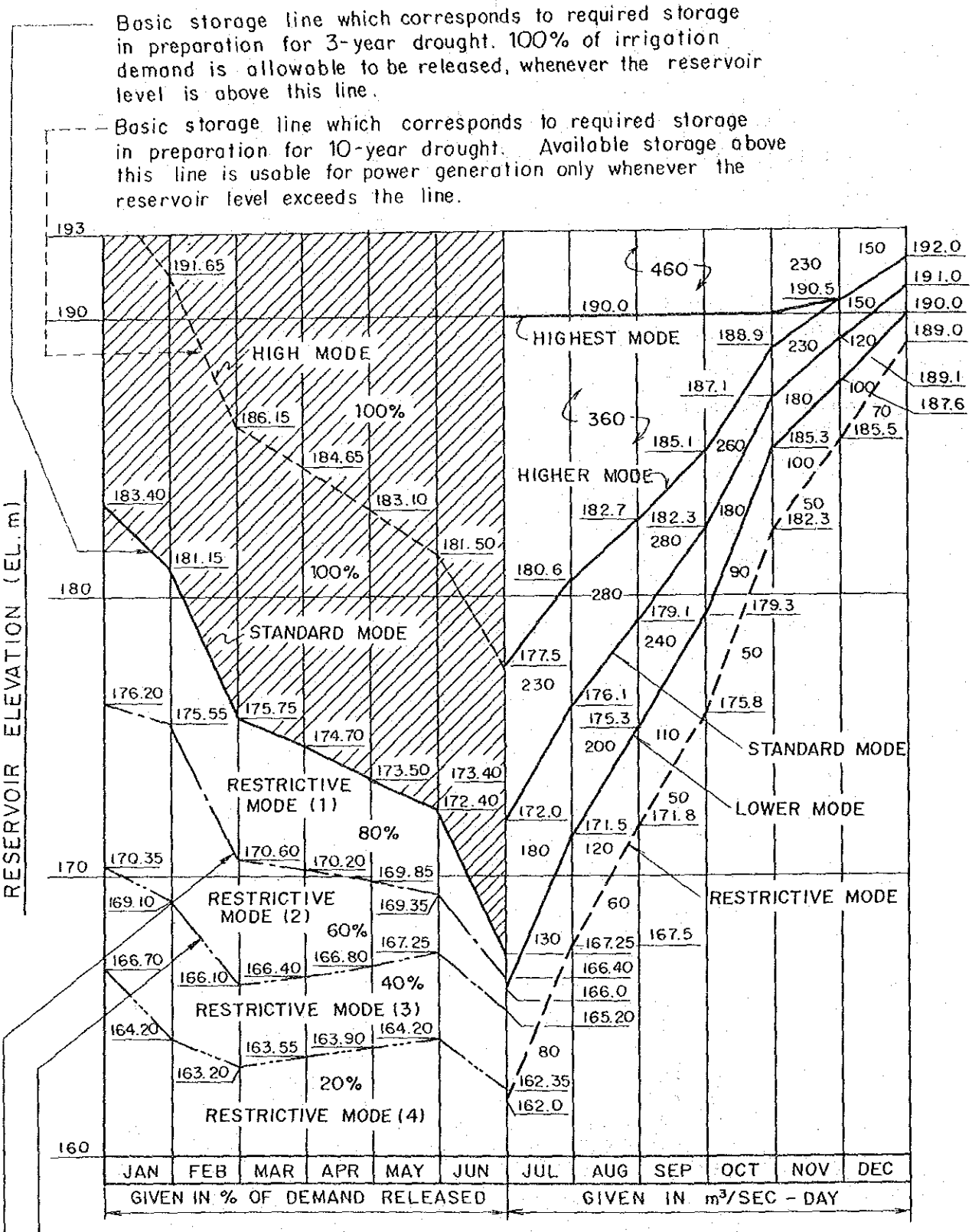
During wet season when inflow into the reservoir largely exceeds irrigation demand under the normal condition, the reservoir should be so operated that i) as much water release as possible be allotted for power generation, ii) as small amount of water as possible be wasted through spillage and iii) reservoir water level be finally recovered to the full water level as frequent as possible at the end of December. The combination of the above two aspects in dry and wet seasons will define the conception of the operation rule curve.

(4) Optimal Rule Curve of Reservoir

The optimal rule curve was determined based on the reservoir operation study result as shown in Figure 3-4. As is clear in Figure 3-4, the proposed rule curve was planned at the lower water level as compared with the present rule curve resulting that much reservoir water could be used for dual purposes of irrigation and power generation. Operation of the reservoir on the basis of the proposed rule curve is briefly explained as follows;

- The reservoir shall be operated so as to restore its water level as much as possible, to the full water level of 193 m at the end of December.
- Under the normal condition when the reservoir maintains storage within a normal range, the reservoir during the period from the end of December to the end of June shall be operated with the "Standard Mode Basic Storage Line (BSL)" as the target. When the reservoir stage exceeds the line, 100 percent of irrigation requirement will be released from the reservoir and the minimum power requirement will be satisfied with this water.

FIGURE 3-4. MAGAT RESERVOIR OPERATION RULE CURVE



- In case when the reservoir stage exceeds even the "High Mode BSL", available storage above this line will be allotted to power generation.

- In case that the reservoir stage lowered the "Standard Mode BSL", one of the "Restrictive Release Line (RRL)" shall be applied in accordance with the magnitude of storage deficit envisaging rapid restoration of reservoir storage.

- During the wet months from July to December where power generation takes the initiative in operating the reservoir, the reservoir shall be operated according to the existing available storage and the rate of allowable water release as defined in the proposed operation rule.

The simulated result of the reservoir operation, inclusive of the case when the reservoir is operated for irrigation purpose only, is summarized in the following. In this connection, estimation of irrigation water requirement was based on the proposed pattern of cropping schedule.

Result of Reservoir Operation

Case	Wet Crop			Dry Crop		
	Demand (MCM/yr)	Deficit (MCM/yr)	Rate (%)	Demand (MCM/yr)	Deficit (MCM/yr)	Rate (%)
Irrigation Only	1,352.2	11.7	0.9	1,306.6	0.0	0.0
Irri. + Power	1,352.2	56.5	4.2	1,306.6	48.0	3.7

(5) Storage Deficit and Irrigation Area Control

The Magat runoff largely depends on typhoons visiting the drainage basin and irregularity is remarkable. In addition the effective storage of 820 MCM is considered too small as compared with the Magat runoff, about 7,400 MCM/year on an average. Judging from the historical runoff record collected at the damsite, there will be many occasions where the storage is rapidly restored with one typhoon, and also frequent cases where disappointing small inflow comes into the reservoir in wet season. Therefore, it is unavoidable to waste almost 880 MCM/year of water through spillways,

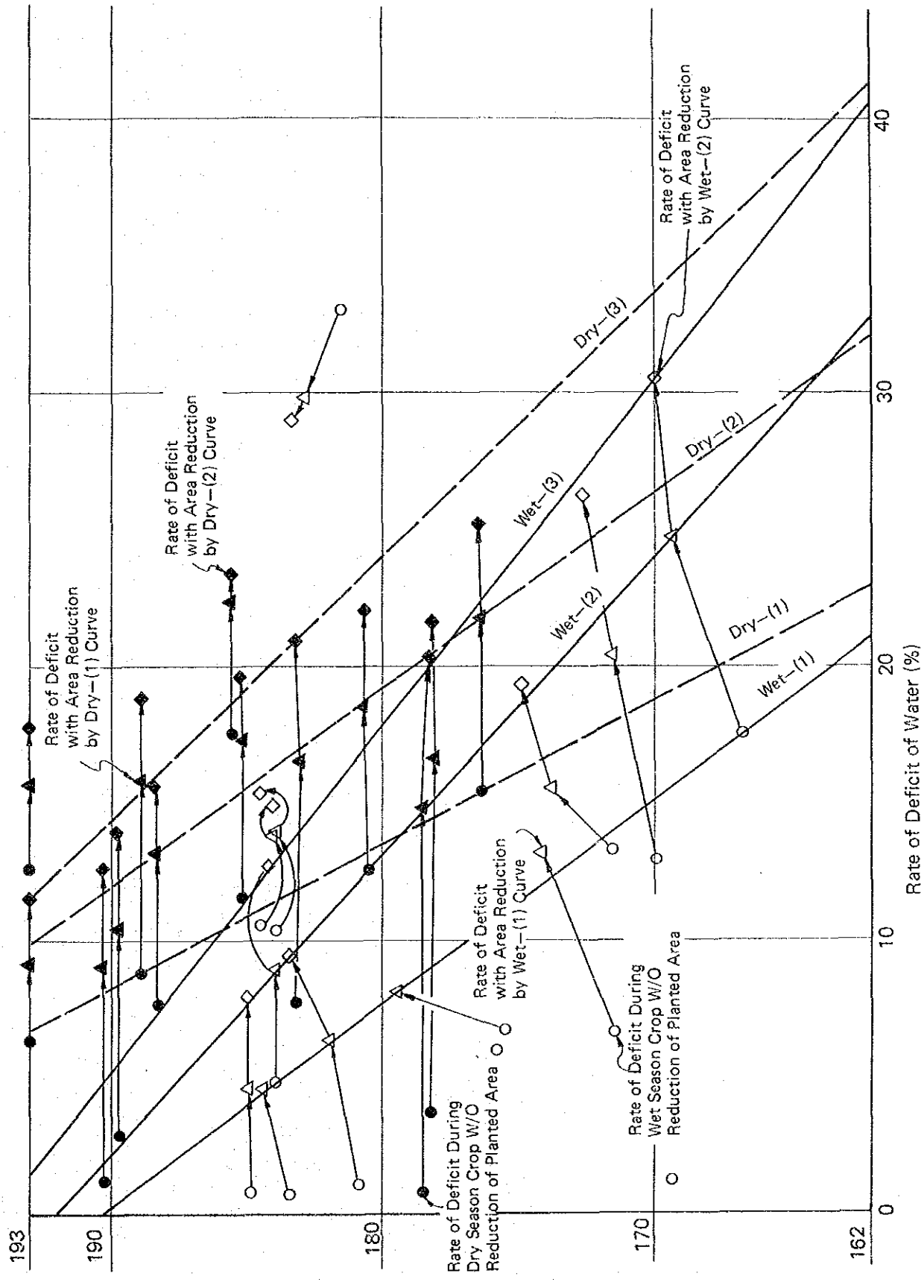
and at the same time it involves much risk for the agriculture side that water supply from the reservoir is interrupted.

At the establishment of the operation rule, careful attention was paid so that water supply from the reservoir was not interrupted at the important and serious period of irrigation, but still more due to the fact that the power generation is given much weight in controlling water release in wet season, the simulated result shows frequent occasions where the reservoir will not restore its storage at the end of wet season carrying over such effects in the succeeding cropping season, in the case when the inflow is much less than expected.

Therefore, if the storage deficit as summarized in the previous paragraph is not acceptable from the agronomic point of view, necessary countermeasure, such as reduction of planting area in the succeeding cropping period on the basis of the available reservoir storage at the critical point of time, will be required in the actual practice of reservoir operation. Although it is desirable to estimate potentiality of irrigation as well as the area to be planted by a reasonable prediction of reservoir inflow combined with the presently available storage, it seems almost impossible to predict the inflow. Accordingly the study was made on the rate of irrigation area reduction based on simple correlation between storage deficit simulated and available storage at the end of March and September, respectively for wet season rice and dry season rice.

Figure 3-5 presents such a correlation. Since the irrigation project generally allows crop damages of once in ten years, three exclusive points (i.e. 3/30 years = 1/10) are eliminated from the study. The remainders produce an envelope curve, which is defined as the "Area Reduction Curve". However in general, reduction of planting area promotes increase of reservoir stage which in turn promotes release of water for power generation, shortage of water for irrigation supply also increases and the correlation is modified. In this study three steps of modification were progressed.

FIGURE 3-5. ENVELOP CURVE FOR IRRIGATION AREA REDUCTION



(6) Optimal Reservoir Operation

The optimal reservoir operation among several alternatives was studied taking into account the frequency and amount of water shortage for irrigation as well as hydroelectric power generated. In consequence the "Reduction Curve (2)" for irrigation area control is recommendable as the provisional rule for the Magat reservoir operation. As the result of simulation, the cropping intensities for wet and dry season paddy at about 90 percent and 85 percent respectively would be expected in terms of averages in the entire period of simulation of 30 years.

In this connection the operation rule is to be updated periodically on the basis of experiences and achievement of actual reservoir operation, in order to find the final target for controlling the limited water resources.

(7) Power Energy to be Produced in Optimal Reservoir Operation

The power energy at the Magat power plant to be produced in the optimal reservoir operation is estimated as in the following table.

Comparison of Magat Power Output

Month	Projected by NPC in 1985	Actual Achievement Aug/1983-Oct/1986	Estimated by Calculation (MW)	(GWH)
Jan.	75.4	71.7	78.3	58.3
Feb.	80.8	73.1	101.5	68.2
Mar.	40.8	53.2	60.8	45.2
Apr.	31.3	33.2	61.2	44.1
May	51.3	95.0	93.9	69.8
Jun.	70.0	121.5	111.5	80.3
Jul.	170.0	128.1	161.3	120.0
Aug.	255.0	137.6	177.1	131.6
Sep.	340.0	167.4	203.7	146.7
Oct.	225.0	152.1	204.2	152.1
Nov.	170.0	163.0	133.4	96.0
Dec.	108.3	91.4	84.2	62.6
Total	1,617.9	1,287.3	1,471.1	1,074.9

Although it seems that NPC's projection of power generation especially during wet months is to some extent over-estimated when the available Magat runoff and reservoir capacity are taken into consideration, the reservoir would produce power well-distributed throughout a year, as compared with the actual achievement, if the proposed rule of reservoir operation is adopted together with the irrigation area reduction curve (2). In this connection, the spillage would be minimized also to about 880 MCM/year.

In addition, the Baligatan Power Plant newly constructed by NIA produces the following power output, which is expected to be used for the energy of Pumping Plant No.1 to No.3 in the service area.

Power Generation by Baligatan Plant

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
MW	3.6	4.1	3.7	0.8	0.8	3.2	2.3	1.3	1.3	0.5	-	2.8	24.4
GWH	2.7	2.8	2.8	0.6	0.6	2.3	1.7	1.0	0.9	0.4	-	2.0	17.8

3.2.5. Outflow Control at Dam and Diversion Dam

(1) Outflow Control in Magat Dam

(a) Outflow at Power Plant

The irrigation outflow to the Maris diversion dam covering the area of about 75,400 ha is made through the Magat hydroelectric power plant together with the additional outflow for the power plant. Although the total amount of outflow for irrigation and power is determined and instructed to NPC by the MRIIS O/M Head Office on weekly basis, NPC can release at the hydroelectric power plant changing the hourly peak discharge based on the power demand in the Luzon Grid, namely the outflow at the power plant is made with the peak discharge of 480 cu.m/sec to 120 cu.m/sec and with the operation of four to eight hours per day.

The hourly outflow determined by NPC is not informed in advance to the MRIIS O/M Head Office and Dam and Reservoir District, so that the MRIIS O/M Office has encountered the problem for the water control to release the irrigation water re-regulating the power outflow at the Maris diversion dam. The Maris O/M Head Office shall improve the communication method to NPC so as to receive the previous information for the hourly discharge and operation hours of outflow at the power plant, otherwise the operator in the Maris diversion dam cannot judge the re-regulating method of the outflow and can not control the releasing discharge to canal because of difficulty of gate operation against the rapid fluctuation of water level.

(b) Outflow Control at Baligatan Outlet

The outflow control for the irrigation water to the area of about 12,700 ha covered with the South High and Oscariz canals is presently made by Dam and Reservoir District in the MRIIS O/M at the Baligatan outlet. This outflow control is well made at present and has no problems in its operation except the operation suspension due to power failure.

The hydroelectric power generation with the output of 6 MW at the maximum will be made near future at the Baligatan outlet by using the water head of the Magat reservoir. The outflow control, however, is made by the MRIIS O/M Head Office in accordance with the irrigation demand with the same manner as the present one and has no particular improvement. Only the data management for water control and produced power energy will be made properly in Dam and Reservoir District Office.

(c) Outflow Control at Spillway

Outflow control at spillway is made properly at present by the Dam and Reservoir District Office depending on the flood estimated by the observation of rapid increase of water level at full water in

the reservoir. Although the flood forecasting works are planned in order to release some reservoir water through the power plant before the flood enters into the reservoir and to storage the flood in the reservoir so as not to spill the flood from the spillway as much as possible, the actual forecasting works are not made at all due to no function of devices and equipment in the forecasting system and no analysis program for the flood forecasting.

Since the new flood forecasting system will be installed in the near future under the PAGASA project, the flood forecasting works will be made to save the spill at the spillway.

(2) Outflow Control in Diversion Dams

(a) Maris Diversion Dam

The water level of the Maris diversion dam fluctuates considerably due to regulating the peak release from the Magat dam for power generation.

The adequates intake structures and operation mechanism of diversion dam are proposed to operate the gate in corresponding to the fluctuation of water level of the dam.

- A new electric motor systems should be introduced for intake gate operation of the main of the Maris and the North Diversion canal to facilitate operation.
- The automatic gate control system according to water level (discharge) of the main canal should be introduced.
- The water level of the Maris diversion dam and head reach of the main canal should be monitored to keep records at the control office by the dam on the hourly basis.

(b) Baligatan Diversion Dam

In general, the amount of water taken into main canals from Baligatan diversion dams is almost equivalent to the amount of

inflow to the diversion dams. The appropriate diversion, therefore, to the main canal in the South High and the Oscariz main canal has been playing a vital role to control the water intake amount. And the measuring devices for water level and discharge shall be newly provided for successfully accurate operation of the diversion dams.

(c) Siffuris Diversion Dam

It is proposed to make improvement and establishment of operation method for the existing intake facilities so as to meet the fluctuation of water level and discharge of the Siffu river.

- The intake gate operation shall be electrified for taking water to the both main canals of North and South.
- The intake by the Siffuris diversion dam, aiming at water distribution to the areas commanded by both North and South main canals, shall be controlled by a remote operation system.
- Constant monitoring shall be made on the river water level, discharge and amount of intake water.

3.2.6. Distribution Control in Canal System

The following improvement works shall be required for the water management in the canal system;

(1) Discharge Allocation in Canal System

In order to estimate the accurate discharge allocation at the major check, the irrigation block is set up as shown in "Flow Diagram for Irrigation Block" of the O/M Drawings No.23 to No.26. The allocated discharge in each irrigation block and accumulated discharge in the canal system are calculated with computer as described in Paragraph 3.2.3.

The information on the discharge is indicated to Area Engineer, Hydrographer, Water Master, Gate Keeper, Ditch Tender and tour-out operator committed by NIA through District Manager, and discharge control will be made by them.

(2) Discharge Control in Canal System

(a) Discharge Control Rule in Canal

The canal system in the MRIIS is constructed so as to keep the constant water level at each canal section between check gates and to release the allocated discharge to the downstream canal by controlling the check gate. The discharge distributed from the main to the lateral as well as from the lateral to sub-lateral is to be controlled by the head and turn-out gates under the constant water level in front of the gate. The most important rule of discharge control, therefore, is to keep the constant water level and then to operate the gate depend on the allocated discharge.

The discharge to be released to the downstream canal at the check gate point is controlled by the opening degree of the check gate depend on the discharge amount and the water head difference between up and downstream canal, so that the discharge table showing the relation with discharge amount, water head difference and opening degree of gate shall be prepared by Hydrographer and kept by the Water Master.

The discharge at the head and turn-out gates is controlled with the same manner as the check gate operation.

(b) Improvement of Discharge Control

The discharge control works carried by the Gate Keeper under supervision of the Water Master shall be made with the following cares;

- The Gate Keeper shall know the designed water level at each canal section between check gates and check the actual operating water level by the staff gauges installed in the canal. Although number of staff gauges has been installed at about 100 places by the Study Team, additional staff gauges at about 900 places will be required in future to make more adequate water management. Especially, the staff gauges marked out the water level clearly shall be installed at the immediate up and downstream of the check and head gate points, otherwise the discharge control by the water head difference can not be expected.

- The Water Master and Gate Keeper shall know the allocated discharge to be instructed on weekly basis by the O/M Head Office and set up the opening degree of gates depend on the allocated discharge. Since the proper rating curve at some gate positions is not prepared yet, it shall be urgently made by the Hydrographer assigned in each District.

- In case the water level decreases or increases compared with designed one during the discharge operation in canal, it is judged that the less or much discharges compared with allocated one through head and turn-out gates at the canal section between check gates are released. Therefore, the Gate Keeper shall immediately check and adjust the opening degree of gates along the canal system.

- The discharge at the beginning point of the irrigation block as shown in "Flow Diagram for Irrigation Block" of the O/M Drawings shall be checked carefully and often by the Gate Keeper, because this point is the important one to control the discharge covering the downstream area.

(3) Discharge Measurement in Canal System

In order to carry out discharge measurement systematically as a part of O/M activity, periodical discharge measurement at the fixed points in canals should be made, and through this activity the examination of the justification of rating table delivered to the Gate Keepers will be needed.

The discharge measurement should be done in the following manner.

- Study Team has set up the discharge measuring points of about 350 sites in the total Service Area classifying

150 sites for the important control points along the canal and 200 sites for the ordinary points at the head gate covering about 100 ha taking into account the irrigation block, Division boundary and canal system controlled by the Water Master as shown in O/M Drawings No.17.

- One hydrographer group in each District will carry out the discharge measurement at about 40 control points and 55 ordinary points with the following schedule;

At control points (two weekly basis);
(40 points x 8 times) / 5 points/day = 64 days
At ordinary points (one months basis);
(55 points x 4 times) / 8 points/day = 28 days
Total 92 days

92 days / 20 days/month = 4.5 months/cropping season

- The Hydrographer shall carry out the discharge measurement formulating the measuring plan in each District and arrange the data comparing the allocated discharge. The discharge measurement data shall be submitted to the MRIIS O/M Head Office through District manager.

(4) Data Management in Canal System

The item of data management is described in Paragraph 2.2.6., and the forms for data management would be shown in O/M Manual.

3.2.7. Improvement of Water Management at On-Farm Level

(1) Water Management Practice

The water management at on-farm level is so closely related to the cropping pattern that the water management should be executed properly in accordance with the cropping season.

- Water management for land soaking.
- Water management for early stage of plant growth.
- Water management for plant growth stage.

(a) Water Management for Land Soaking

The unit water requirement for land soaking is in a range between 3.2 lit/sec/ha and 4.0 lit/sec/ha for rice class land and 6.4 lit./sec/ha to 8.0 lit./sec/ha for Dual class land.

The on-farm irrigation ditches have been designed on the basis of the aforesaid unit water requirement. Consequently, the on-farm level water management should be conducted as follows according to such design policy.

- In taking the plots covering four to six hectares as the rotational irrigation unit, the land soaking shall be completed with seven days.
- The acreage commanded by turn-out is in a range from 20 to 30 ha (about 5 units) and it will take about one month (35 days) to complete the land soaking for these five units of the fields.

(b) Water Management for the Early Stage of Plant Growth

The water management for this stage will fully depend upon the planting methods. In transplanting method, the water management will be made for constant flooding water, while in the direct seedling method, careful and prudent water management will be required with irrigation and drainage repeated alternately until plant height becomes about ten centimeters.

The water control by diversion dams is to keep water intake constant in its amount. The unit water requirement in this stage is almost as half as that in the land soaking stage.

(c) Water Management for the Stage of Plant Growth

The water management in this stage will be conducted to meet the requirements of such farming works as fertilization, chemicals

spraying, intermittent drainage, etc. Such collective works in a certain area as pest control and intermittent drainage will require successful water distribution to the secondary and tertiary canals.

(2) Improvement of On-Farm Facilities

The present paddy field in the MRIIS is formed with a long strip of 30 to 40 m width and 500 to 600 m length. This field is divided into number of blocks with area of 0.1 to 0.5 ha by farm ridges and irrigated by plot to plot. Since there is no farm irrigation ditches to deliver the water in the field and no farm road to transport farming input and harvested paddy, farmers cannot carry out proper farm management and are forced to be placed on the low productivity conditions.

The paddy field will be improved so as to form a farm block with a short length of 100 to 150 m providing on-farm facilities at each farm block. The farmers/farmers groups shall carry out the construction works of on-farm facilities by themselves as a rule, but will need some assistance by the MRIIS O/M Office for lending construction equipment and supplying construction material.

3.3. Improvement of System Facilities

In order to maintain the present irrigation area and to achieve the target area of 97,400 ha, the improvement Project shall be established to undertake the rehabilitation or improvement of time-worn facilities, construction of new canals for undeveloped area, on-farm development and etc.

3.3.1. Centralized Water Control System

(1) Necessity of the System

The outflow control for the Maris and North Diversion canal at the Maris diversion dam and the water control for the Lateral "A" to "E" at the head gates in the Maris main canal are the most important water management works in the MRIIS, because these discharge control points manage the irrigation water of about 180 cu.m/sec at the maximum covering area of about 75,000 ha and formulate the key station for water management in the MRIIS area.

The present outflow control at the Maris diversion dam meets such problems that the outflow is forced to be released with the hourly and daily fluctuation due to the rapid increasing and decreasing water level at the diversion dam caused by the peak power outflow of the Magat hydroelectric power plant.

The present discharge for irrigation to be released to Lateral "A" to "E" from the Maris main canal presents also a big fluctuation hourly and daily due to the fluctuation of irrigation outflow at the Maris diversion dam and inadequate distribution control at the check and head gates in the canal.

It is very important for establishment of proper water management in the MRIIS that the intake gate control for the outflow at the diversion dam shall be made automatically corresponding to

the fluctuation of water level in the diversion dam and the allocated outflow, and that the operation of check and head gates in Lateral "A" to "E" shall be made with the remote manual under the centralized discharge control system at the control house in the Maris diversion dam, in order to allocate the diversion outflow to each gate positions properly and to control the gates easily and accurately.

Although the mini-hydropower plants of Magat (A) and (B) installed in the Maris main canal are operated presently by the ISELCO-I, this power operation brings problems for distribution control of the Maris main canal, because the water level in the canal is frequently fluctuated which is caused by much or less discharge released at the power plant compared with the allocated one for the irrigation. If possible, the control of discharge supply for the power plant shall be made with remote control by the Maris O/M Office at the control house.

(2) Content of Centralized Discharge Control System

- Maris Diversion Dam

Since the discharge adjustment of the outflow against the fluctuation of water level in the diversion dam could be made with only one large intake gate out of 10 sets of small gate and two sets of large gate at the right bank, and two sets of large gate in the left bank, the automatic control system is to be installed to one large gate at the right and left banks respectively. The other gates are to be operated by remote manual system at the control house.

- Lateral "A" to "E" in Maris Main Canal

The check and head gates at the beginning point of Lateral canals of the South Low, "A", "B", "C", "D", and "E", the head gate at the beginning point of Gaddanan and the check and control gates

at the mini-hydropower plant Magat (A) and (B) are to be operated with the remote manual at the control house in the diversion dam monitoring the water level in canal, opening degree of gates and distributing discharge at each gate position.

- Lateral "A-1" and "A-2"

Only discharge monitoring works are to be made at the head gate positions in Lateral "A-1" and "A-2", because it is a tendency to introduce much discharge at these positions.

(3) Content of Monitoring System

In order to carry out the automatic and remote control, the proper monitoring system shall be required.

- Maris Diversion Dam

The inflow, water level at the diversion dam and the beginning points of the Maris and North Diversion main canals, gate opening degree of all intake gate, outflow by each intake gate and all other gates installed at the Maris diversion dam and outflow at spillway are monitored. All monitoring data are displayed on the graphic panel and recorded by printer. The data are arranged with daily and monthly basis.

- Lateral "A" to "E" in Maris Main Canal

The monitoring items along the Maris main canal are the allocated discharge, water level, gate opening degree, releasing discharge at each measuring positions. In case the water level and releasing discharge are changed by reason, the gate shall be controlled by remote operation at the control house accordingly.

All monitoring data are transmitted and displayed on the graphic panel at the control house and recorded by printer. All monitoring data at gate positions are transmitted by the digital telemeter-telecontrol method by aerial communication cable.

(4) Improvement of Gate Operation Mechanism at Maris Diversion Dam

In order to set up the centralized discharge control system in the Maris diversion dam, the following gate operation mechanism will be improved;

- Double hoist with electrical motor for small gates at right bank (5.5 KW)	10 sets
- - ditto - for large gates at right and left bank (11 KW)	4 sets
- Water table control unit	1 lot
- Emergency diesel power generating set (200 KW)	1 lot
- control panel for hoist	1 lot
- Control house (300 sq.m)	1 lot

(5) Improvement of Check and Head Gates along Maris Main Canal

The check and head gates at lateral "A" to "E" along the Maris main canal are of large in size and control large flows. These gates are manually operated at present and some of them are suffered from torn wire, bent spindle and lost gate body. In order to carry out the gate operation with the centralized discharge control system, the following electrification of gate operation mechanism shall be made together with repair and rehabilitation of defective gates;

- Replacement of spindle, hoist or rehabilitation of defective parts.
- Installation of electrical motor.

- Installation of control panel.

- Power distribution line and wiring.

Number of gates for improvement is as follows;

Canal Name	Check Gate		Head Gate	
Lateral "A"	Radial	6 sets	Sluice Gate	4 sets
-do- "B"	-do-	4	-do-	1
-do- "C"	-		-do-	3
-do- "D"	-		Radial	3
-do- "E"	Radial	2	Sluice	1
South Low	-do-	5	Radial	2
Gaddanan Creek	-		Sluice	2
Total		17		16

(6) Improvement of Check Gate at Mini-hydroelectric Power Plant

The present check gate beside the mini-hydroelectric power plant is manually operated and accordingly it is difficult for precise control at the gate to meet the frequent change of discharge release from the plant. The gate shall, therefore, be improved to be operated automatically depend on the water level fluctuation. Items to be improved are as follows:

Item	At Plant (A) Site (Sluice gate 5 sets)	At Plant (B) Site (Radial gate 3 sets)
Hydraulic Cylinder	5 units	-
Hoist	-	3 units
Hydraulic Unit, 30 KW	1 lot	-
Hydraulic Unit, 18.5 KW	-	1 lot
Control Panel	1 lot	1 lot
Control Room, 30 sq.m	1 lot	1 lot

(7) Improvement for Centralized Discharge Control System

The centralized discharge control system is to be installed at the control house beside the right bank of the Maris diversion dam and managed by the operation staff in the Dam and Reservoir District Office. In addition the data are also transmitted to the MRIIS O/M Head Office. The following items will be required for the system;

- Telemeter and telecontrol devices at canal gate positions, 9 places
- Input and output devices at the diversion dam and canal, 10 places
- Graphic display at the control house in the diversion dam, 1 lot
- Control console display at control house, 4 units.
- Data processor at control house, 1 lot
- Printer at control house, 1 lot
- Lightning rod at gate positions, 10 places
- Communication cable along canal, 13 km
- Gate control panel at diversion dam and canal, 11 places
- Control house at diversion dam, 400 sq.m, 1 unit
- Automatic water level meter, 22 places

3.3.2. Macanao and Ladeco Weirs

Existing Macanao and Ladeco weirs equipped with eight and ten sets of small manual operated sluice gates respectively, are deteriorated in function and cannot be duly operated. Consequently water weeds and trash are accumulated at the weirs, and the flow capacity is restricted to cause inundation in the upstream area.

It, therefore, needs widening of weir crest and/or improvement of gate structure. Enough space cannot be secured for the weirs to be expanded and furthermore big modification of structure will be needed for the widening of weir, so that the modification of gates seems to be more economical.

For improvement of gates, a flap gate seems to be advantageous to maintain required water level and to flash out trash at any time. In addition, repair of revetment is urgently needed at the immediate downstream of the present weir structures, since no protection works seems to be provided there and scouring is now steadily progressing.

Improvement works are composed of provision and installation of gates, modification of structures and construction of revetment.

The improvement works, which will be conducted with two years, are as follows;

Macanao Weir

- Modification of structure	1 lot
- Provision of gate	1 lot
- Installation of gate	1 lot
- Revetment work	1 lot
- Expansion of intake	1 lot
- Widening of main canal	1.2 km

Ladeco Weir

- Modification of structure	1 lot
- Provision of gate	1 lot
- Installation of gate	1 lot
- Revetment work	1 lot

3.3.3. Civil Works in Canal System

Due to the lack of budget for the maintenance and repair of facilities, the damaged facilities have been kept as they are. This will cause the reduction of irrigation area and the inadequate distribution of irrigation water in the area.

Under the conditions, improvement of project facilities would be essential for the MRIIS area. Following gives the content of civil works to be improved with the required construction periods, which was estimated based on the present construction capacity of the MRIIS O/M Office.

(1) Enheightening of Canal Bank

In the flat area, some land subsidence makes canal dike crest lower to cause insufficient free board. Enheightening of canal bank, therefore, will be required and in addition gravel metalling of the dike will be required for the use as service road.

The earth material for the embankment will be collected from the borrow area or desilting spoil bank. Estimated volume for enheightening is expected as 300,000 to 400,000 cu.m in each District and about 1.5 million cu.m in total. The works will be done in the dry season and completed with five-years program.

400,000 cu.m / (20 days x 5 months x 5 years) = 800 cu.m/day

(2) Widening of Canal Cross-Section

Along with expansion of service area and revision of irrigation system, widening for canal cross-section of a part of system is also required to meet the irrigation demand in the target service area.

The widening works will be made after emptying water in the canal at the end of each irrigation season. Since the canal widening quantity is expected to be about 120,000 to 200,000 cu.m in each District, the works will be made with about five years.

200,000 cu.m / (20 days x 2 times/year x 5 years)
= 1,000 cu.m/day

(3) Desilting

Many silt deposits are found at the canal section with the gentle canal slope, especially at the downstream canal, where the silting material is transported from the upstream canal and accumulated.

Desilting works to keep the designed canal cross-section are required. The quantity of desilting works is expected as 200,000 to 240,000 cu.m in each District and reaches to about 820,000 cu.m in total. These works will be made by a backhoe for the small scale canal even in the irrigation season, so that the works will be completed with three-years program.

240,000 cu.m / (15 days x 10 months x 3 years)
≒ 500 cu.m/day

(4) Repair of Scoured Canal

Serious scourings are found at the immediate downstream of structures, especially drops and checks. A lot of scouring places more than 400 places are found at the canals in District I, particularly they are concentrated at laterals of the South High and South Low canals because of their steep slope.

The repairing works for sourcing places will be made of stone gabion or boulder riprap taking into account available boulder in the Magat river, flexible stability against flow energy, easy works under releasing water in canals, etc. The volume of works in District I is 35,000 cu.m, so that the works will be completed with five-years program.

35,000 cu.m / (15 days x 10 months x 5 years)
≒ 50 cu.m/day

The works in the other District requiring 5,000 to 15,000 cu.m will be made within 3 years.

15,000 cu.m / (15 days x 10 months x 3 years) = 30 cu.m/day

(5) Canal Lining

The concrete canal lining will be required at the places which have a seepage problem at canal banks due to high bank and embankment with pervious material. The lining works consist of concrete placing of 3,000 to 5,000 cu.m in each District and will be made after emptying water in the canal at the end of irrigation season, so that the works will be completed within five years.

5,000 cu.m / (20 days x 2 times x 5 years) = 25 cu.m/day
(corresponding to about 300 sq.m/day)

(6) Drainage Canals

There are many inundation problem areas in the downstream service area in the MRIIS area. The drainage canals shall be planned to drain the excess water to the creeks. The works consist of the drainage excavation, embankment of maintenance road by excavated material and gravel pavement on road.

Since the excavation reaches a huge quantity of 400,000 cu.m in District I and II, and 800,000 cu.m in District III and IV, the works will be carried out in the dry season with five-years program.

400,000 cu.m / (15 days x 6 months x 5 years) = 900 cu.m/day
800,000 cu.m / (15 days x 6 months x 5 years) = 1,800 cu.m/day

(7) Other Improvement Works

The following improvement works will be required in addition to the above mentioned one.

- New canal construction to supply the water to newly developed service area.
- Repairing works for related canal structures made by concrete such as drops, crossing structures, culverts, etc.
- Periodical maintenance works of gravel pavement on the service road along the canal and on the access road.

3.3.4. Civil Works of Diversion Dam and Others

Serious scouring of apron is found at the immediate downstream of the Maris diversion dam, however, according to the representative engineer of the MRIIS O/M Office, a depression has not been progressing since completion of former diversion dam in 1957, so that the rehabilitation works of the dam deem to be not urgent program.

On the other hand, due to the construction of Mini-hydroelectric Plant Magat (A) and (B) and their irregular operation, downstream portions of the Plants are scoured, so that ISELCO-I who is the owner of the Plants should owe to pay a part of the repairing cost to be needed. The detail of the works are as follows;

(1) Rehabilitation of Maris Diversion Dam

A large depression is investigated at immediate downstream of apron of the dam. It might be developed by the spilled discharge energy by flood. The extent of depression is roughly estimated at 75 m in width, 40 m in length and four meters in average depth. The scoured depression is usually filled up with silt and sand, but the sand seems to be flashed away during flood times and then the scoured depression seems progressing wider and deeper year by year.

Since the dam was re-structured into bucket-type when the dam crest was elevated in 1979, the protection block as present type may be again washed away if so repaired. Taking advantage of rock foundation along river bed, reinforcement of cut-off of the apron and construction of a sub-dam with about two meters drop for energy dissipator shall be carried out. At the downstream of proposed sub-dam, a protection rip-rap with concrete block of about 70 m in length will be effective for the transition. Construction period will require two dry seasons, because the work will be done in the river and needs temporary coffer dam and dewatering. The work volumes roughly estimated are as follows;

Item	Quantity	Remarks
Rock excavation	5,000 cu.m	Cut-off and pit excavation for sub-dam.
Concrete "A"	7,750 cu.m	Cut-off and sub-dam.
Protection rip-rap	14,000 sq.m	Concrete block fabricated at site.

(2) Revetment at Downstream of Magat Mini-hydroelectric Power Plant

Two mini-hydroelectric power plant Magat (A) and (B) have been constructed and operated along the Maris main canal between the head gates of Lateral "B" and Lateral "C". The immediate downstream of these plants is seriously scoured and requires urgent repair.

The cut-off period of irrigation water in this canal is limited, so that an available method under the water shall be undertaken. Gabion method or precast concrete block method would be recommendable as the best way. The estimated quantities of major works are as follows;

Item	Quantity	Remarks
Block revetment	2,400 sq.m	Canal length of 200 m
Sand and gravel	1,200 cu.m	to be improved at (A)
Concrete "A"	400 cu.m	and (B) Plants.
Concrete (Gabion)	2,500 cu.m	
Rip-rap		

(3) Construction of Gaddanan Spillway

For the purpose of avoiding spilled damage over the canal bank caused by excess water released from the mini-hydroelectric power plant or misoperation, a spillway may be required at the head gate of Gaddanan supply. The spillway must be designed as side channel type and dispose the excess water to the Gaddanan creek from the Maris main canal.

3.3.5. Mechanical Works

Gate structures are the life of water management in irrigation system. There are so many gates to be repaired or replaced and newly installed in the system. The repairing works such mechanical facilities will be required urgently for the proper water management in the system. In this connection, only installation costs of gates to be provided in canals are counted in the project, because the MRIIS O/M Offices keep considerable number of such gates at present.

(1) Repair of Check and Head Gates

About 800 check and head gates in total in the whole the MRIIS canal system are installed to regulate/divert irrigation water to the service area. They are manually operated and divided into four grades by the function as follows;

- Grade A : Good functioning
- Grade B : Need repair
- Grade C : Need replacement
- Grade D : Newly installation

The grade "B" gates to be repaired have the defective parts at anchor of hoist for sluice gate, broken hoisting wire, guide or leaf of gate, concrete structures, etc.

Almost all of grade "D" gates have structures to install the gates but no gates presently and operated by such as banana trunk stop log which is hardly removed under water and causes overflow from bank of the canal, and then installation of gate is required urgently.

Numbers of gates to be repaired and installed are about 130 places for District II and IV in which the irrigation facilities have been constructed in early stage, and therefore the works will be completed with five-years program because the implementation will be undertaken at the cut-off periods of irrigation water as follows;

130 places / (2 times x 5 years) = 13 places/season

The works in the other District are limited, and then they have no problem to do it.

The gate body and spare parts such as spindle, hoist anchor, wire, guide leaf etc. are procured by NIA and stocked in the MRIIS O/M Office, and so only installation works of gates will be required.

(2) Rehabilitation of Turn-out Gates

There exists a large number of turn-outs along main and lateral canals for distribution of water to the service area. Out of a total turn-outs of about 2,900, gates of about 700 turn-outs have been defective or lost and the canal water leaks to the creek through field or drainage due to unregulated discharge thereto. This is one of the major reasons why irrigation water can not reach to the downstream terminal plots in a long canal system. Appropriate water management of the service area will not be performed without repair and/or rehabilitation of defective and/or lost turn-out gates. Repair/rehabilitation of turn-outs is one of most critical and urgent issue to be achieved for satisfactory O/M in the MRIIS area.

The number of turn-out gates to be repaired is about 80 places in each District, while the number of turn-out gates to be replaced or newly installed is variable from 50 to 140 places. The gates and their spare parts are also stocked in the MRIIS O/M Office and available at any time in case the installation fund is provided.

(3) Improvement of Intake Gate at Siffuris Diversion Dam

The present operation of intake gates on both banks of the Siffuris Diversion dam is made manually and these gates have difficulties to manage adequate gate adjustment to meet variant water level in the river and water demand in the service area. It shall, therefore, be equipped with self-recording water level gauges at the dam and canal for automatization of gate operation by catching up precise river run-off and intake flow. And a control house shall also be built for monitoring of water level and remote control of gates. Items for improvement are as follows;

- Electrification of hoist (5.5 KW) 3 sets (Right bank)
- Electrification of hoist (5.5 KW) 1 set (Left bank)

- Water table monitoring equipment 1 lot
- Diesel power generating set (90 KVA) 1 lot
- Control panel for hoist 1 lot
- Control house (70 sq.m) 1 lot

(4) Repair of Sand Sluice Gates at Siffuris Diversion Dam

Sand sluice gates on both banks of the Siffuris diversion dam can not be operated as closed condition, while crest of the gates is lower than the dam crest with 30 cm, then it causes difficulties on maintaining required water level due to over flow from the gate crest. Furthermore, upstream area of the dam suffers from inundation damages, when the sand sluice gate cannot be operated in the flood time. Under the situation, the sand sluice gates have to be urgently repaired as follows;

- Replacement of roller gate (2.44 m x 3.60 m) 1 set
- Replacement of wire drum hoist (2.2 KW) 1 set
- Replacement of roller gate (4.89 m x 5.20 m) 1 set
- Replacement of wire drum hoist (3.7 KW) 1 set
- Replacement of roller 1 set
- Control panel with cable 1 set
- Repair of gate piers 1 set

(5) Pump Facilities

Three pumping stations had been constructed and are under operation since 1984. However, they are not maintained under good condition for full operation, because of some mechanical defection required repair or improvement. Followings are the subjects of repair/improvement;

- Repair of expansion joints of two pumps in No.2 station
- Repair of air-valve on delivery fitting
- Repair of siphon breaker and reverse revolution prevention unit
- Improvement of sealing mechanism

In addition to these repairs, provision of operation tools or gauges and spare parts for pumps are more effective for the proper operation and maintenance of the pump stations.

3.3.6. Systematization of Data Management

(1) Computerized Data Management Facilities

The MRIIS O/M Head Office has carried out the data management for administrative works, mainly concerning irrigation fee collection and some daily data processings. Computerized data management by the Head Office shall include in future the following subjects;

- Hydrological and meteorological data filing and retrievable system
- Water management data filing and retrievable system
- Publication of monthly and annual reports on hydrology, meteorology, water management and other statistics.
- Management and retrievable system of equipments and materials
- Management and retrievable system of staffs and employees
- Management and retrievable system of agricultural land and cadaster
- Processings for irrigation fee collection
- Various statistical processings
- Cost price analysis and budget control

- Diversion water requirement computation
- Initial scheduling of irrigation water diversion
- Water allocation among sources and demands
- Water level to discharge conversion
- Simulation for periodic updating of optimal reservoir operation rule
- Simulation for optimal cropping schedule
- Hydraulic and hydrological analysis such as non-uniform flow and inundation analysis

In order to fulfill the above-mentioned roles, the following facilities shall be procured and furthermore foreign technical assistance by the experts would be needed to meet the systematized data management.

- Central processing unit	1 lot
- External memory	1 lot
- Peripheral equipment	1 lot
- Terminal equipment	1 lot
- Software	1 lot
- Accessories and spare parts	1 lot
- Engine generator and automatic voltage regulation (AVR)	1 lot

(2) Reinforcement of Communication System

The MRIIS O/M Head Office must collect necessary data from each District Office and process it by the computer in order to obtain appropriate data for water management of the system.

And the Head Office must instruct each District Office accurately and timely depending on the judgement of O/M staff and processed data.

Presently an one-way wireless radio is used for the communication between the MRIIS O/M Head Office and District Offices. It is not enough to transmit the data, so that the reinforcement of radio communication system is keenly required.

The communication system should be improved to have a data transmitting function by using a private channel.

The improvement item of communication system is as follows;

- Work station	5 sets
- VHF transmitter	5 sets
- Repeater station (Antenna, Transmitter, Battery)	1 lot
- Communication control unit	1 lot
- Software	1 lot

3.3.7. Improvement of On-Farm Facilities

Major on-farm facilities consist of turn-outs, main and supplementary farm ditches, farm drains, and farm roads. These on-farm facilities in the existing service area of about 71,000 ha are not provided at all, except a part of area, and average intensities of equipped on-farm facilities are far lower than those of NIA's standard criteria as shown below. Such situation in the area causes to make trouble of adequate and timely water distribution at on-farm level, occurrence of time-lag between up and downstream areas, difficulty for transportation of agricultural crops and production materials.

In order to exercise rationalized water and farm management, on-farm facilities should be provided in accordance with the criteria of NIA's standard mentioned below. The construction of on-farm facilities should be carried out in principle by Irrigators' Associations. However, NIA and other governmental agencies

concerned should assist Irrigators' Associations technically and financially, so as to construct smoothly the on-farm facilities.

NIA's standard criteria of on-farm facilities are as follows;

Farm ditch	:	60 m/ha
Farm drain	:	40 m/ha
Farm road	:	20 m/ha

3.3.8. Construction and O/M Equipments

In order to implement the improvement for civil works to be conducted by force account basis by NIA, land development of undevelopment area and provision of on-farm facilities, which will be carried out by farmers and farmer's institution, following construction equipments shall be procured, and then transferred to each District Office for O/M utilities after completion of the improvement works.

On the other hand, some special O/M equipment shall also be utilized for timely and proper operation and maintenance of the irrigation system. The recommendable equipments are as follows;

Construction and O/M Equipments

Equipment	Specification	Number of Equipment	
		For Construction	For O/M
Backhoe	0.7 m^3	4	-
Backhoe	0.3 m^3	6 (6)	4
Crane/Drugline	0.8 m^3	2	-
Crane	16 t	-	2
Bull Dozer	75 HP	-	4
Bull Dozer	90 HP	19 (11)	-
Dump Truck	11 t	22 (6)	-
Dump Truck	2 t	-	8
Loader	1.1-1.5 m^3	4	-
Motor Grader	125 HP	4	-
Vibration Roller	3 t	4	-
Pick-up (with Mobile Station)	135 HP	8	12
Steak Truck	195 HP	4	-
Shop Truck	9,000 kg	2	-
Concrete Mixer	1 Bagger	5	-
Motor Cycle	125 cc	-	110
Service Car (with Mobile Station)	Station wagon	6	6
Radio Transceiver	5 W	-	80
Weed Cutter		-	120
Current Meter		-	6
Ceodlight		6	-
Level Meter		6	-
Staff	Aluminum	20	-
Water Level Gauge	1.0 m Plate	-	1,000
Automatic Water Level Gauge	Suiken 62	-	5

Note: Figures with parenthesis show the required number of equipments for development of undeveloped area and provision of on-farm facilities.

3.4. Improvement of O/M Activities and Organizations

3.4.1. O/M Activities

(1) Water Management Activity

Present rule of water supply on request basis will be improved to scheduled water supply correspond with proposed cropping calendar prepared by the MRIIS in order to realize equal and stable water supply by the leadership of the MRIIS.

The responsibility for water diversion control at each terminal farm turn-out, part of which is presently transferred to IA members by contract, will be restored to the MRIIS in order to establish adequate water management service by the MRIIS in WM Division level.

The staffing of WM Division will be improved to have more performance on water management practice, which is described in the following paragraph

(2) Maintenance of Facilities

Irrigation System

The routine maintenance works of canal section which is presently in charge of DT and GK will be transferred to organized IAs in accordance with lateral turn-over scheme, and O/M personnel in the WM Division will be utilized for more important works in the WM Divisions.

The status of system facilities should be monitored by Districts as well as Head Office by the inventory data in order to prepare maintenance program and its budgetary requirement annually so as to maximize the use of O/M staff and equipment for effective maintenance works.

Heavy Equipment and Vehicle

The data management system should be introduced by the Equipment Management Division so as to make maximized use of these equipments as well as to practice timely repair and stational adjustment in order to keep these equipments in good conditions.

The maintenance rule for equipments inclusive of stational adjustment and renovation of equipments will be prepared by the Equipment Management Division so as to keep the performance of equipments continuously, and the required budget for the equipment maintenance will be materialized in the annual operation budget.

Dam and Diversion Dams

The Magat dam and appurtenant facilities should be maintained adequately by the responsibility of the MRIIS so as to keep its function and performance as long as possible, and the MRIIS Head Office should monitor the maintenance status and budgetary requirement for specific facilities by proposed data management system.

The maintenance and renovation works for specific facilities should be recorded into the data file and the works for which will be responsible for the Engineering and Operation Division in the MRIIS Head Office.

(3) Institutional Development Activities

The farmer institution development will be one of the most important role of the Districts, in this connection, the accomplishment and status for organized IAs in WM Division level will be monitored and evaluated by the top management staff in the Districts.

The WM and his staff will be in charge of IA organizing and assisting works under the direction of District, because they have much more time to deal with IAs and the members through routine O/M works of their responsibilities.

The territorial boundary for IAs and their federation will be corresponded with the boundary of WM Division, Section and proposed irrigation block, inclusive of adjustment it as required. Proposed territorial size for IA and federated IA (IAF) are as follows;

- Proposed IA will be organized to be associated with commanding area of irrigation block which concept is proposed by the report. And the boundary of existing irrigation block is also to be reviced so as to coordinate with them.
- The territorial boundary for IA federation also will be associated with WM Division as much as possible in view of its advantage on irrigation service to them as well as collection activity conducted by WM Division.

Presentation and demonstration activity to farmers to be organized by means of visual equipment will be one of quite efficient method, in this connection, these equipment will be procured by the system in order to utilize for institutional works, because there are many existing IAs and federated IAs in the Service Area. Those who are well organized and managed successfully which will be the good instances for the purpose of enlightening of unorganized farmers.

(4) Data Management

The function of the MRIIS Head Office on data management will be strengthened in order to manage all Districts adequately in the all kind of O/M activities which comprise many items with great deal of data to be controlled by the Head Office.