

3. IMPROVEMENT OF OPERATION AND MAINTENANCE IN THE MRIIS

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3.1. Development of Irrigation Area

The present irrigation area in the MRIIS is about 71,100 ha in 1986 and the achievement ratio of development is about 73 percent of the target irrigation area of 97,400 ha.

It is the most urgent and important subject to fully develop the target irrigation area of 97,400 ha at the earliest stage by improving the existing unirrigated area of about 26,300 ha, which remain mostly undeveloped without on-farm facilities. Otherwise, the project benefit of the MRIIS will not be generated any more and incremental collection of irrigation fee as the fund for O/M services can not be expected.

The land development works should be carried out by farmers themselves in principle; however, since most of the present undeveloped area is located in the service area in undulated topography, the land development works will be rather difficult for farmers and require a long time to be completed.

NIA and MRIIS O/M Office should help the related farmers to carry out the land development works through IA by the following manners;

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

The successful implementation of the above land development will require the following governmental assistances and supports;

- Administrative cooperation should be rendered by such governmental agencies concerned as Ministry of Agrarian Reform (MAR), etc. to allocate the land to farmers.
- Financial support by government for the land development should be given to the farmers' activities.
- Assistance should be given for establishment of the IA by NIA and other governmental agencies concerned to carry out the farm land development smoothly.

On the other hand, the on-farm facilities at the terminal fields of 20 to 30 ha on an average are provided by farmer's institution, according to the NIA criteria. However, the areas lacking on-farm facilities have been increased since 1985, due to the following reasons;

- The on-farm facilities are not properly constructed by farmers' institution due to the lack of technical and financial support by NIA. Therefore, some facilities constructed does not function to deliver irrigation water from lateral canals to terminals and are easily broken after releasing 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 the farmers' institution has no technique nor fund for the constructing the facilities.
- The farmers' institution such as IA has not sufficiently been established yet in the whole Service Area.

In order to exercise rationalized water management and farm management at the on-farm level, the on-farm facilities even in the irrigated areas should be improved or constructed in accordance with the assistance by NIA. Namely, NIA and MRIIS O/M Offices should extend the technical assistances for construction of the on-farm

facilities by supplying O/M equipment, materials and necessary operator on the repayment basis in the same way as those works in land development.

3.2. Improvement of Water Management

(1) Request and Allocation Procedures of Irrigation Water

The present procedures of request and allocation of irrigation water are not properly made because of the reasons that i) Irrigation area and schedule to be requested by the farmers can not be estimated accurately by Water Master (WM), ii) Estimation of irrigation water by Divisions can not be made quickly and accurately, iii) Exact allocation of irrigation water on the weekly basis at each check and head gate is very hard, and iv) Allocation of irrigation water at each division in considering an effective rainfall is not properly made. And these facts have caused shortage of irrigation water and inundation in the downstream area.

Under the situation, improvement of the procedure of request and allocation of irrigation water is most important and fundamental subjects, in order to execute proper water management for supplying irrigation water to the Service Area. In this connection, the followings are proposed to improve the procedures for request and allocation of irrigation water.

Preparation

- The irrigation flow diagram in the canal system shall be prepared and the Irrigation Block (IB) shall be formulated in taking into account the area commanded by major check and head gates and Division boundary.
- The service area to be irrigated is accurately estimated on the turn-out basis (FIG basis) by using cadastral maps and summarized on the IB basis. This work will be made by the Water Master (WM) coordinating with IA, FIG and farmers. This area becomes the base for request and allocation of irrigation water.

Plan for Request and Allocation

- The request and allocation plan of irrigation water shall be prepared about one month before starting cropping season in each main canal system. IA shall prepare the irrigation area and make schedule by FIG or the member farmers to submit to the Water Master (WM). WM shall check the schedule to make adjustment and shall arrange the schedule by IA and summarize it on the IB basis.
- The irrigation area and schedule on the 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 gates 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 O/M Head Office manager shall determine the allocation plan of irrigation water supply to 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 instructions to MW 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 in the manner as specified in the plan on the weekly basis.
- The operation may be revised slightly to the plan because of some differences in conditions by actual irrigation area, delay in irrigation schedule by farmers, delay in irrigation water to reach farm areas due to defect of irrigation canals or misoperation of 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 available at the District Offices and then the final water allocation will be made by 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.

Estimation Method

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

The proposed plan for the improvement of the said procedures is shown in Figure-3, and Figure-4 indicates the proposed cropping schedule in each irrigation system, which is decided from the viewpoint of farming practices, effective utilization of rainfall and water resources in taking into account the location of the system and irrigation method to be applied.

(2) Water Management of Magat Dam and Diversion Dams

(a) Reservoir Operation and Outflow Control

Since the capacity of the Magat reservoir is not so large as to meet water demand in the critical dry year, the reservoir should be operated in such a way of two purposes confronting each other; i) acceleration of effective water release in response to the request in the Service Area and ii) restriction of water release against the unforeseeable drought. To cope with the above requirement, the storage area in the reservoir was divided into a number of zones corresponding to the respective purposes.

Under the normal condition, the reservoir will be operated so as to keep the Basic Storage Line (BSL). In the event that the actual storage volume sinks below BSL, the Restrictive Release Lines (PRL) may be applied to expect rapid restoration of the storage. Based on the historical record of inflow, BSL and RRL are planned by calculating the required storage-levels for the projected drought,

FIGURE 3. WATER REQUEST AND ALLOCATION RULE

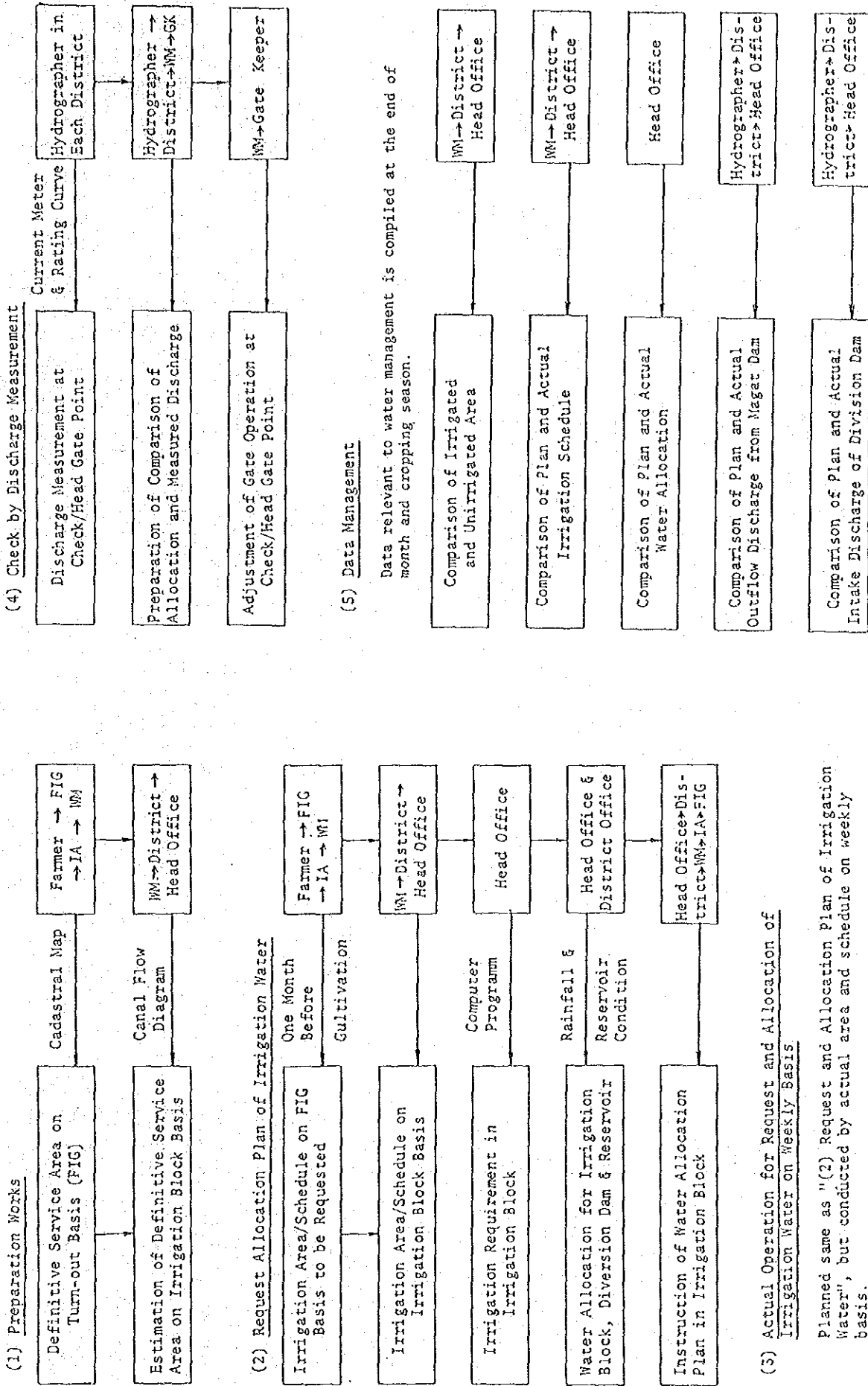
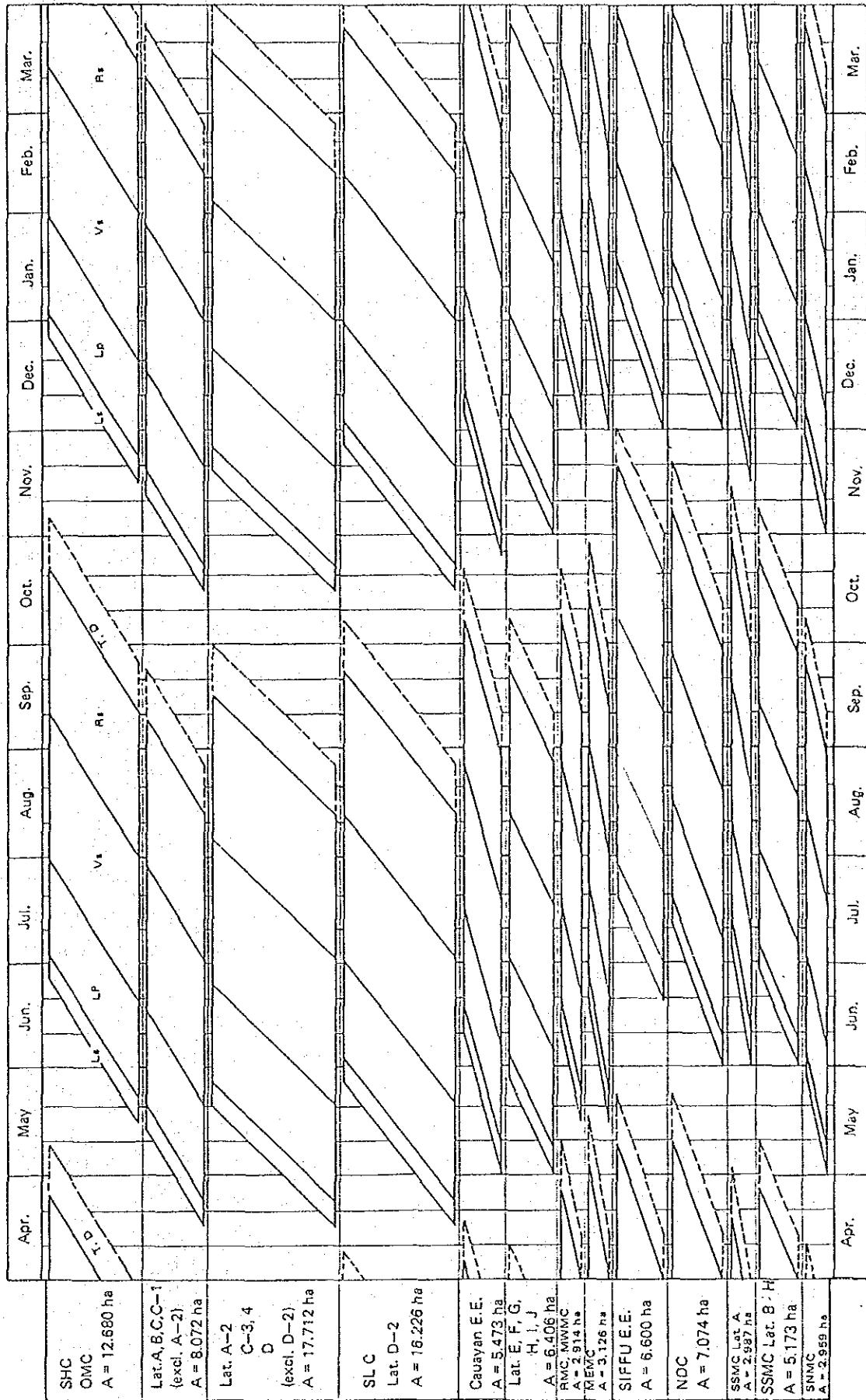


FIGURE 4. PROPOSED CROPPING SCHEDULE



which indicate certain safety probability of the reservoir operation. BSL and RRL finally compose the Storage Operation Rule during dry season (see Figure-5).

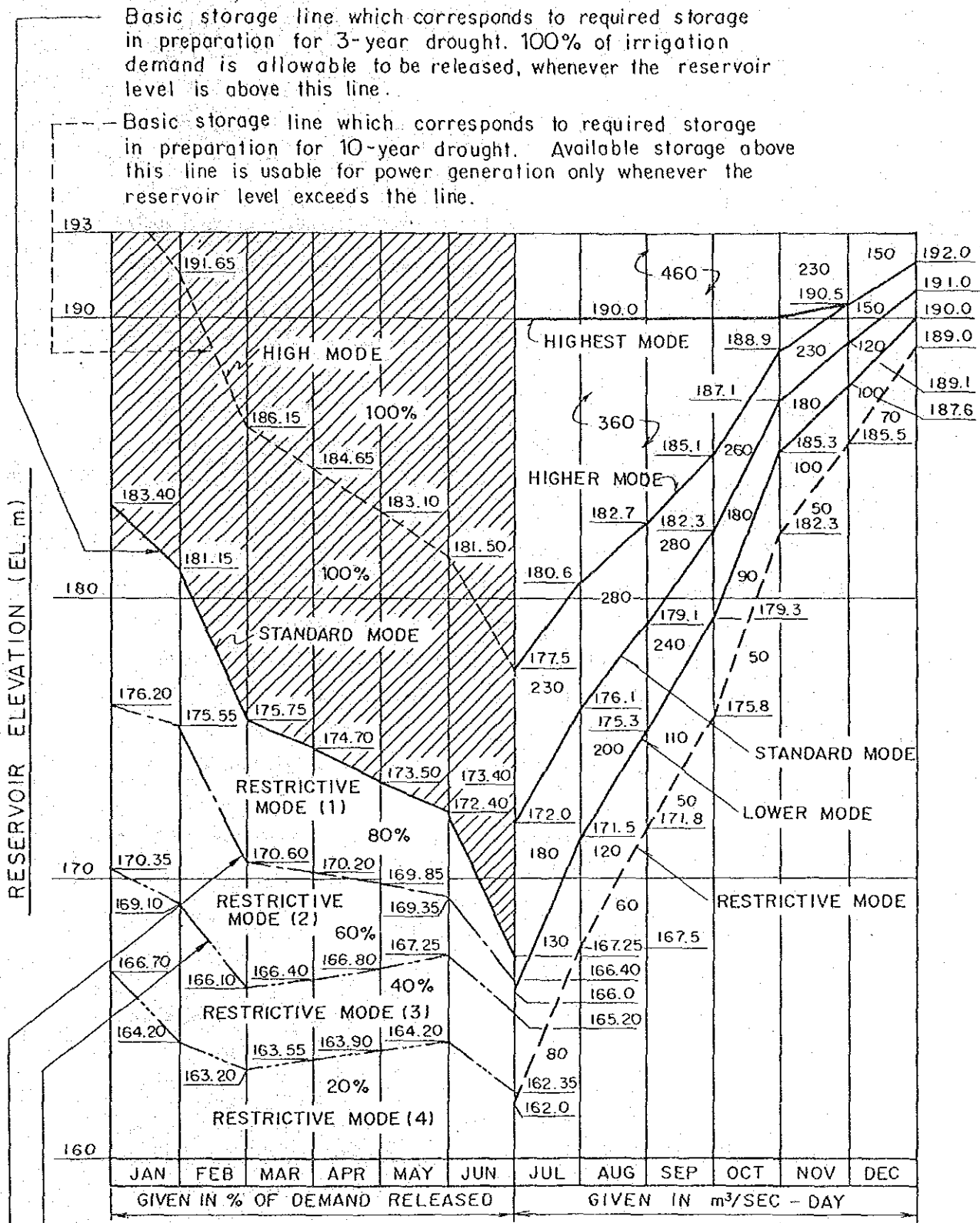
During the wet season when inflow into the reservoir largely exceeds irrigation demand under the normal condition, the reservoir should be so operated that i) as much water release as possible can be allotted for power generation, ii) as small amount of water as possible can be wasted through spillage and iii) reservoir level can be finally recovered to the full water level as frequently as possible at the end of December.

The combination of the above two aspects in the wet and dry seasons will define the conception of the operation rule curve. The optimal rule curve was determined based on the reservoir operation study as shown in Figure-5. As is clear in Figure-5, the proposed rule curve was determined at the lower water level as compared with the present rule curve in resulting from the fact that much reservoir water could be used for dual purposes of irrigation and power generation.

In addition, it is recommended for successful reservoir operation that the consecutive cropping areas should be reduced depending on the availability of storage water as an agronomical counter-measure in the critical circumstances.

The energy available at the Magat hydroelectric power plant through the optimal reservoir operation was estimated at 1,076 GWH/year on an average for 30 years, or 1,114 GWH/year in the past two years, 1984 and 1985, which are slightly bigger than the actual result of 1,080 GWH/year. In this connection, the spillage would also be minimized to 880 MCM/year.

FIGURE 5. MAGAT RESERVOIR OPERATION RULE CURVE



Restrictive release line (2) corresponding to 3-year drought with 40% saving of water. Above the line 60% demand is releasable.

Restrictive release line (1) corresponding to 3-year drought with 20% saving. Above the line, 80% demand is releasable.

Furthermore, the Baligatan hydroelectric power plant newly constructed by NIA will produce 17.8 GWH/year, which will be used for operation of the existing pumps No.1 to No.3 in the Service Area.

It should be also emphasized that the operation rule will be updated periodically on the basis of experiences and result of reservoir operation, in order to find the final target for effective control of the limited water resources.

The total amount of outflow through the Magat power plant is determined by the MRIIS O/M Head Office to be given to NPC on the weekly basis, and outflow control is made by NPC in accordance with the peak power requirement of the Luzon Grid, although involving some difficulties in re-regulating the outflow at the Maris diversion dam and, in turn, in making it difficult to control the intake gates against the rapid fluctuation of water level. To cope with this problem, adequate intake structures and operation mechanism of diversion dam are proposed including electrified gate systems and automatic remote gate control systems in expecting successful and accurate operation of the diversion dams.

(b) Improvement of Diversion Dams Operation

Maris Diversion Dam

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

Followings are proposed as improvement for intake structure and operation mechanism of diversion dam in corresponding to the fluctuation of water level.

- To introduce the new motor driven intake gates,
- To introduce the automatic gate control system for the main canals, and
- To introduce the new monitoring system for upper stream of Maris and North Diversion main canal

Baligatan Diversion Dam

In general, the amount of water taken into the main canals from Baligatan diversion dam is almost equivalent to the amount of inflow to the diversion dams. Therefore, the intake gates for both the South High and Oscariz main canals can be operated adequately with information of the rate of inflow into the diversion dam in advance to the gate operation.

The measuring devices for water level and discharge should be newly provided for correct operation of gates.

Siffuris Diversion Dam

It is proposed to improve the existing facilities and establish adequate operation method of the existing intakes so as to meet the fluctuation of water level and discharge of the Siffu river.

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

(3) Improvement of Operation of Canal System

(a) Flow Chart of Irrigation Water Supply

Irrigated agriculture would not be realized without adequate operation of the MRIIS as water supply system.

The water supply system with considerably long canal extending in a vast area should be operated in close coordination with water users and canal structures' operators of the system, and therefore, improvement of distribution control of water should be discussed on the water supply practices in reflecting upon canal networks in the area.

The improvement plan based data collected for water allocation and supply is shown in Figure-6, although the detailed procedures including programing of these works would be formulated in the next stage in cooperation with MRIIS O/M staff concerned.

The improvement plans for allocation and delivery of water are proposed as follows;

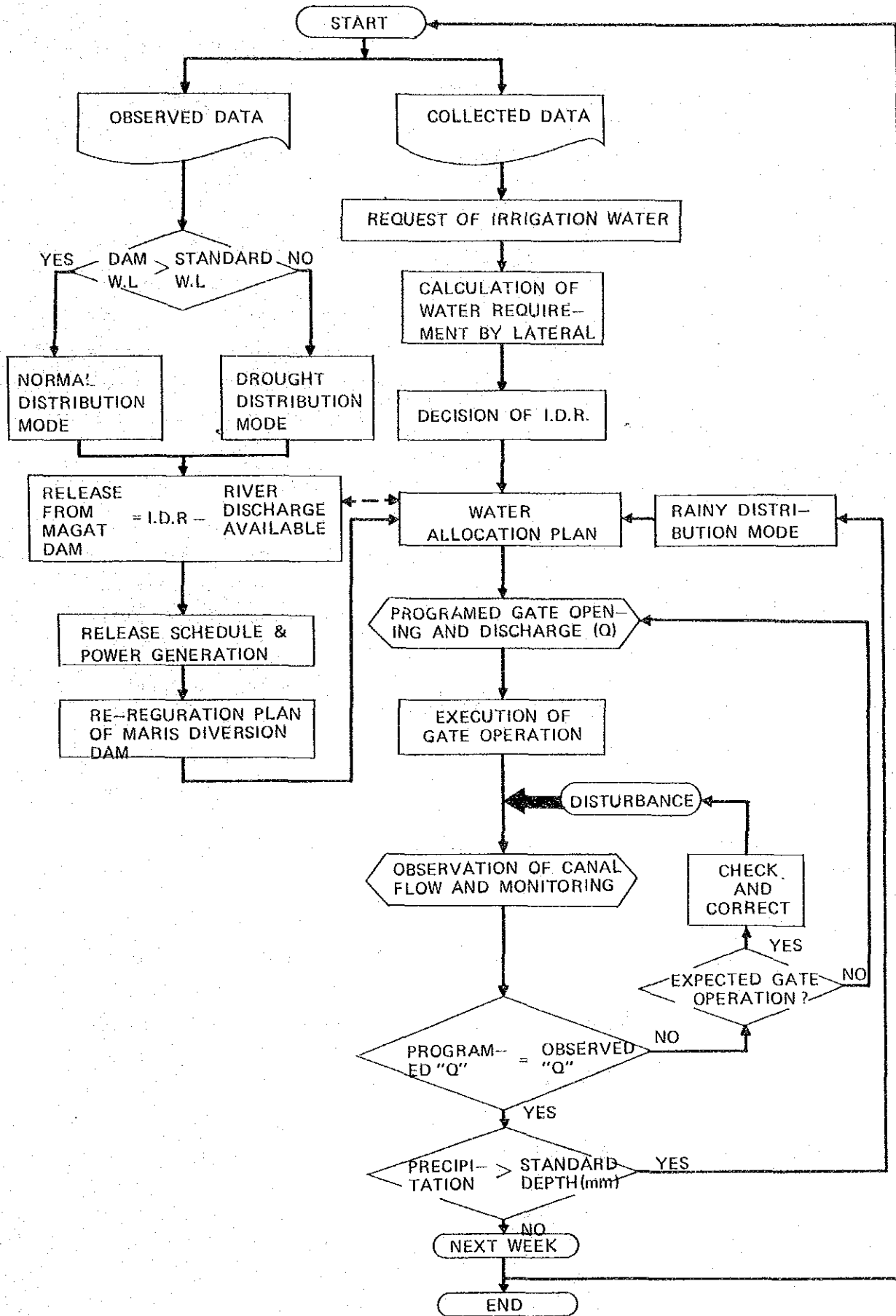
- To practice the correct discharge measurement,
- To set the gate opening rate in corresponding to programmed diversion requirement, and
- To execute monitoring and checking of canal flow.

The improvement of water supply management should be planned including the improvement of canal system facilities and operation program prepared by using data processing system for making the weekly allocation schedule as well as the above items.

(b) Check of Water Flow

Following distribution control of irrigation water in the canals is very important works for the O/M Offices;

FIGURE 6. FLOW CHART OF IRRIGATION WATER SUPPLY FOR THE MARIIS



- To schedule gate operation works,
- To compare discharges between programmed and measured at the specific points in the canals, and
- To adjust the gate opening rate at the problem sites with large difference in flow rate.

The discharges measurement for gate operation will principally be practised by automatic water level recorders or staff gages, and periodical calibrations also are needed to maintain the correct relationship between water level and discharge. For this purpose, the Study Team has proposed about 350 sites of discharge measurement and calibration for the whole canal systems.

(c) Water Distribution Control

As a general rule, the water distribution control by setting the gate opening rate should be done in taking into account its stream characteristics, and weekly irrigation water requirement at the check and head gate points in corresponding to farming activities on lateral basis should be decided and instructed to the operators in advance by the MRIIS O/M Offices. And then, the gate operators can adopt easily correct opening rate for the designated gates.

(4) Improvement of Water Management at On-farm Level

Water management at on-farm level should be practiced under the chief of FIG and IA to conform with the proposed distribution schedule and irrigation rule. The basic rule for water use at the on-farm level is shown as follows;

- Executions of irrigation water supply in accordance with the planting stage of paddy,
- Strict observance of the rotational irrigation schedule,

In connection with the improvement of water management at on-farm level, the existing on-farm facilities such as farm ditches, farm drains and farm roads should be improved under the support by the MRIIS O/M Offices.

3.3. Improvement of System Facilities

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

(1) Centralized Water Control System

The water level of the Maris diversion dam fluctuates on the hourly and daily basis caused by the peak power outflow of the Magat hydroelectric power plant, so that the timely and adequate intake control is required. However, the discharge control in the Maris diversion dam is made manually. In order to practice the steady water management, the automatized intake control system is urgently required.

Furthermore, water diversion control at the upstream portion of the Maris main canal is very important for the water management in the Service Area, so that the automatic gate operation systems and the centralized discharge control systems should be provided.

(2) Macanao and Ladeco Weirs

The time-worn facilities of the Macanao and Ladeco weirs have functioned so ineffectively as to cause inundation in the upstream of the weirs. The urgent improvement of these facilities, therefore, will be quite essential for successful operation.

(3) Civil Works in Canal System

Due to shortage of necessary budget for the maintenance and improvement of the facilities, the canal facilities have been deteriorated year by year resulting in the inadequate distribution of irrigation water in the area and reduction of irrigation area.

Heightening of canal banks, widening of canal cross-section, repair of scoured canal and desilting are urgently required and other civil works such as canal lining, drainage excavation, etc. are also required for the execution of proper water management.

(4) Civil Works for Diversion Dam and Others

The rehabilitation of the scoured apron of the Maris diversion dam or revetment at the Magat mini-hydroelectric power plant (A) and (B) should be implemented to maintain the facilities safely and functionally.

(5) Mechanical Works

There are a great number of gates provided as headgates, check gates and turn-out gates, and many of them require repair works or replacement, and furthermore, new gates will have to be constructed at some places in the Service Area. The deteriorated gate mechanisms should be urgently repaired for securing accurate water distribution in the system.

The rehabilitation of intake and sand sluice gates at the Siffuris diversion dam are also important for the water control. Furthermore, the rehabilitation of pump facilities is another subject to achieve the project target.

(6) Systematization of Data Management

The reinforcement of data processing system and communication system is strongly required to improve the data management of the MRIIS.

(7) Improvement of On-Farm Facilities

Without the improvement and construction of on-farm facilities, the system facilities will not function well, so that the MRIIS O/M Offices should support farmers' institution to implement the works.

(8) Procurement of Construction and O/M Equipment

To implement the above mentioned improvement works and to maintain the system facilities, necessary heavy equipment and machinery should be procured.

3.4. Improvement of O/M Activities

(1) O/M Activity

The function of the MRIIS O/M Head Office for data management would be strengthened furthermore in order to appropriately manage the District Offices in their O/M works as well as to plan and program the effective O/M works.

The function of the four Districts on water management at the WM Division level would be strengthened in order to conduct adequate water management by the MRIIS O/M staff.

(2) O/M Organization

The organization of the MRIIS O/M Head Office will not be changed in principle. However, the staff of the MRIIS O/M Head

Office should be strengthened for successful water control and coordination, planing and designing for improvement of facilities and data management, etc.

The Dam and Reservoir District will have a new organization to provide integrated function of water control and hydrological management as well as water management along the Maris main canal in the upper portion, all of which have been conducted by the MRIIS O/M Head Office up to now.

The staffs of WM Division under the four District Offices will be reinforced to meet further require water management practice through cooperation with the newly assigned Gate Keepers to each WM Division.

(3) Irrigation Service Fee Collection

The post harvest facilities belonging to the four District Offices should be improved in the early stage of the project to meet required capacity of the estimated paddy volume by the respective District Offices.

The amount of irrigation service fee collectible after the implementation of the proposed improvement program is 75.4 million pesos, estimated on the basis of the imposed amount of 87.7 million pesos multiplied by the collection rate expected at 86 percent.

(4) Additional Income from Power Generation

The revenue share with NPC for the O/M expenditure of the Magat dam will be increased by a large amount of returns generated by the operation of the Magat dam.

The power generated at the Baligatan power plant will be utilized for the MRIIS pump irrigation system developed in the

Service Area as well as in the Cagayan Valley area. The surplus power will be sold to NPC by the agreement between the two agencies, NIA and NPC.

(5) Proposed Income and Expenditure

The proposed annual income and expenditure for the MRIIS O/M services after the completion of improvement works are estimated at 104 million pesos and 90 million pesos respectively. The operation of the project will promise to have a certain amount of surplus income as well as successful management of the system.

(6) Technical Assistance by Qualified Experts

In order to materialize the proposed O/M improvement works, some well-qualified experts will be needed to technically assist the MRIIS O/M staffs in their planning and practices of the improvement works together with technology transfer.

These experts should cover the field of irrigation and drainage, water management, application programming, design of on-farm facilities, design of improvement facilities, strengthening of irrigators' association, etc.

3.5. Improvement of Agriculture, Agro-Economy and Agricultural Organization

(1) Improvement of Cropping Pattern

Double cropping of paddy will be made exclusively in the paddy land and the most of Dual class land in the Service Area, and the cropping intensity of paddy will be increased to 100 percent in the wet season and 90 percent in the dry season on an average by the improvement of irrigation and drainage conditions.

As for the calendar of paddy double cropping, delay in paddy planting in the wet season will cause not only the low yield with poor quality but also disturbance of cropping schedule in the dry season. Then, other disturbances like the increasing year-round infestation of pests and the decreasing soil bearing capacity will be induced. So, it is proposed that the same cropping calendar as that of the paddy double cropping mentioned in the existing O/M Manual will be taken as the standard cropping calendar.

(2) Increase in Irrigation Area and Farm Input Use

In case of "with O/M improvement project", the whole service area in each District will be utilized for the paddy cultivation. The annual expansion of irrigation area in both the wet and dry seasons from 1986 to 1992 is scheduled and summarized as follows for without and with the improvement project.

Expansion of Irrigation Area

(unit: '000 ha)

	<u>Year</u>	<u>Dry Season Paddy</u>	<u>Wet Season Paddy</u>	<u>Total</u>
Present	1986	66.9	69.1	136.0
Without Improvement Project	1992	69.2	77.9	147.1
With Improvement Project	1992	87.7	97.4	185.1

(3) Increment of Paddy Production

The present paddy production per hectare would not be increased without the improvement project, because the paddy cultivation applying proper farming practices with optimal cropping calendar could not be introduced even in future, if the farm conditions remain unchanged. On the other hand, the paddy production per hectare with improvement project will reach the average target yield of 4.0 to 4.5 tons/ha for the wet and dry season paddy in the Service Area. The paddy yield per hectare in the both cases of "without and with the improvement project" is estimated in each District as shown follows;

Paddy Production

(unit: '000 ton)

Item	1986	1987	1988	1989	1990	1991	1992
Without Improvement Project	419	439	458	477	496	510	510
With Improvement Project	419	439	478	537	606	686	764

Note: The increase of paddy production with improvement Project will start in 1988.

(4) Retrenchment of Paddy Production Cost

It is proposed to employ the following two ways to minimize the production cost, which would contribute to an increase in farmers' income. One is the application of a package technology for cost reduction, and the other is the strengthening of agricultural supporting services to reduce the production cost by the hired labor and machinery services.

(5) Improvement of Post-Harvesting Facilities and Paddy Prices

The existing post-harvesting facilities have to be improved to minimize quality deterioration and losses of paddy, especially when paddy is harvested later than the middle of October. To compete with other paddy producing areas and also to raise farmers' income, it will be necessary to keep paddy quality excellent at village level. For this purpose, it was proposed to expand drying pavement and to install supplemental mechanical dryers and warehouses in the villages through strengthening IAs/IAF, aside from the improvement of cropping calendar to avoid late planting. It was proposed that paddy drying and storage facilities should be introduced in the selected 24 IA areas for the experimental purposes, and then the proposed would be realized in the remaining areas according to the results of the experimentation.

The losses of paddy after harvesting will be reduced through the improvement of cropping calendar, increase of powered threshers

and introduction of post-harvest technology. It is expected that the selling price of paddy will be increased from the prices prevailing in a range from 2.3 - 2.5 pesos/kg (wet paddy) to 3.3 - 3.5 pesos/kg by means of the above improvement in the post-harvest processes.

(6) Possibility of Crop Diversification

In the flood plain area, where most of the land may be reclassified into the first class land for diversified crops and upland crops will be planted exclusively. The cropping area of diversified upland crops, mainly vegetables and beans will be also expanded with the improvement of on-farm level drainage conditions in some Dual class land.

It is desirable to introduce such water-saving cropping patterns as "the wet season paddy with diversified crops in the dry season", because the net return of dry season paddy is affected significantly and adversely by the expensive pump operation cost.

(7) Improvement of Irrigators' Association

In order to improve the present farm management, especially the agro-service activities carried out by dealers and retrench of the production cost, it is necessary to establish the IA Federation consisting of three to four IAs which manage the agro-services activities.

As for the scale of IA Federation, a slightly larger scale federation consisting of three IAs covering the area of about 1,000 ha, 30 FIG and 700 farm households is ideal from the viewpoint of the present Division organized by the MRIIS O/M and the organization power to fulfill the following functions.

- i) To be responsible for operation and maintenance in the related areas,

- ii) To request NIA to provide training of water management, equipment services for repair and improvement of on-farm facilities, repairing services of farm machinery, and also coordination activities on the improvement of farming technology,
- iii) To negotiate with dealers to procure agricultural equipment and input materials as well as to keep the high selling price of paddy,
- iv) To request the institutions concerned for the procurement of the agro-service equipment/facilities,

For successful farming activities according to the cropping schedule in each season and also improvement of post-harvest activities, it is proposed for IA Federations to introduce following equipment/facilities;

- Drying pavements at Barangay level,
- Mechanical dryer for the supplemental use for sun-drying by drying pavement and warehouse at IA level,
- Power tillers, powered threshers and trucks.

Since two Models consisting of three IAs or six IAs are proposed to render aforesaid agro-services in each District, the total budget of the Models for the four Districts is estimated at about 44 million pesos. In addition, the particular production loan of about 22 million pesos will be needed to establish effective farming practices.

The IA Federation should collect the repayment of the fund for agro-service activities at the end of cropping season and be responsible to pay it back to bank.

It is natural that the fund of IA Federation should be carefully spent depending on the farmers economic situation in the Model area. In the case that some farmers have enough fund to carry out the farming operation, their production loans are also to be reduced.

(8) Improvement of Farmer's Income

The farm households in the MRIIS area are mainly dependent on paddy monoculture with an average farm size of 1.8 ha. The agricultural income of the owner farmers is assumed to be 16,100 pesos without the improvement project. With implementation of the improvement project, the owner farmers' agricultural income will become 21,500 pesos and 30,500 pesos for the outside and inside the IA Federation by the increase of paddy yield and quality.

The farmers having the farm land less than the average farm size of 1.8 ha, which occupy about 47 percent of the total farmers, will not always enjoy the present benefit and not be fully independent by the farm income only to engage inevitably in the non-agricultural sectors.

Under the circumstances, an intensive guidance and education on the farming techniques and cropping pattern should be given to these farmers.

(9) Improvement of Agricultural Credit

The estimated amount of loan interest for institutional and informal sources are about seven million pesos and 48 million pesos respectively, totalling to 55 million pesos (400 ₱/ha/crop) in the MRIIS area. Assuming that the total amount of loans is provided by the government, the total amount of interest is estimated at 24 million pesos (180 ₱/ha/crop), which corresponds to 44 percent of the above 55 million pesos.

4. PROJECT COST AND IMPLEMENTATION

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4.1. Project Cost

The total project cost excluding price escalation is estimated at 1,060 million pesos with the exchange rate of 20.5 pesos/US\$, of which 778 million pesos is in foreign currency (FC) and 282 million pesos is in local currency (LC).

Engineering and administration cost is considered as 20 percent of the total construction cost and physical contingency by about 15 percent is also included in the project cost.

The summary of the project cost is shown in the following table.

<u>Project Cost</u>			
	(unit: ₱'000)		
<u>Description</u>	<u>F.C.</u>	<u>I.C.</u>	<u>Total</u>
Improvement of Water Control/Data Management System	137,860	10,470	148,330
Improvement of Mechanical Facilities	28,540	8,070	36,610
Procurement of Equipments	134,550	-	134,550
Rehabilitation Works of Canal System	225,280	124,540	349,820
Rehabilitation of Major Structures	43,320	19,870	63,190
Agricultural Development	4,500	43,200	47,700
<u>Total</u>	<u>574,050</u>	<u>206,150</u>	<u>780,200</u>
Engineering and Administration (20%)	50,000	106,050	156,050
Physical Contingencies (15%)	81,100	42,650	123,750
<u>Grand Total</u>	<u>705,150</u>	<u>354,850</u>	<u>1,060,000</u>
	(66.5%)	(33.5%)	(100%)

Note: Details are given in Table-1.

4.2. Operation and Maintenance Cost

The annual operation and maintenance cost is composed of salary and wage for O/M organization staff, equipment depreciation and repair, maintenance fuel and oil, office maintenance cost, power cost of pumping facilities and administration and general expenditures.

The annual operation and maintenance cost of the MRIIS is amounted at 14.7 million pesos of the Magat dam and reservoir, at 75.3 million pesos of the MRIIS head office and four district offices and at 90 million pesos of the total expenditure (920 pesos per hectare), respectively.

4.3. Implementation Program

The rehabilitation and improvement works of the project will be implemented for five years, 1988 to 1992, by NIA with the following priority given by three groups. Figure-7 indicates the implementation schedule of the project.

i) First Priority Group:

- Centralized automatic and remote control system in Maris diversion dam and canal,
- Intake and scouring sluiceway gates at Siffuris diversion dam,
- Macanao and Ladeco weirs,
- Pump No. 1, No. 2 and No. 3,
- Procurement of construction and O/M equipments,
- Reinforcement of computer system at MRIIS O/M Head Office,

ii) Second Priority Group:

- Civil works in canal system,
- Mechanical works in canal system,

iii) Third Priority Group:

- Rehabilitation of scoured portion of Maris diversion dam,
- Construction of Gaddanan spillway,
- Revetment of Maris mini-hydroelectric power plant,

The MRIIS O/M Office should implement the project under the assistance of consultants and well-experienced contractors on the contract basis. Civil works in the canal system are to be carried out by local contractors on the contract basis except some works executed on force account basis.

TABLE 1. PROJECT COST FOR THE MRIIS IMPROVEMENT PROJECT

(unit: '000 P)

Description	Project Cost		Remarks	
	F.C.	L.C.		
I. Improvement of Water Control/Data Management System		Total		
1. Marris Gate Centralized Control System	119,620	9,710	129,330	Item 1
2. Reinforcement of Computer System	9,740	260	10,000	" 2
3. Reinforcement of Communication System	8,500	500	9,000	" 3
Sub-Total	137,860	10,470	148,330	
II. Improvement of Mechanical Facilities				
1. Rehabilitation of Siffu Diversion Gate	14,850	1,400	16,250	Item 4
2. Improvement of Weirs	11,100	6,560	17,660	" 5
3. Improvement of Pump Facilities	2,590	110	2,700	" 6
Sub-Total	28,540	8,070	36,610	
III. Procurement of Equipments				
1. Procurement of Construction Equipments	102,930	-	102,930	Item 7
2. Procurement of O/M Equipments	32,220	-	32,220	" 8
Sub-Total	134,950	-	134,950	
IV. Rehabilitation Works of Canal System				
1. Civil Works	225,280	101,680	326,960	Item 9
2. Repair C/H Gates	-	18,620	18,620	" 10
3. Repair of Turn-Out Gates	-	4,240	4,240	" 11
Sub-Total	225,280	124,540	349,820	
V. Rehabilitation of Major Structures				
1. Rehabilitation of Marris Diversion Dam	39,840	17,550	57,390	Item 12
2. Construction of Gaddana Spillway	290	710	1,000	" 13
3. Revetment of Marris Mini-Hydro Plant	3,190	1,610	4,800	" 14
Sub-Total	43,320	19,870	63,190	
VI. Agricultural Development				
1. Agricultural Service Facilities	-	43,200	43,200	Item 14
2. Institutional Facilities	4,500	-	4,500	" 15
Sub-Total	4,500	43,200	47,700	
TOTAL	574,050	206,150	780,200	
VII. Engineering and Administration	50,000	106,050	156,050	
VIII. Physical Contingencies	81,100	42,650	123,750	
GRAND TOTAL	705,150	354,850	1,060,000	
	(66.5%)	(33.5%)	(100%)	

FIGURE 7. IMPLEMENTATION SCHEDULE OF MRIIS O/M IMPROVEMENT PROJECT

DESCRIPTION	Y E A R				
	1988	1989	1990	1991	1992
Preparation Work					
Detail Design					
Recruitment of Consultant	—				
Procedures' of Tender	—				
Tender and Contract	—				
Procurement and Delivery of Const. and O/M Equipments					
Improvement of Water Control/Data Management System					
Maris Gate Centralized Control System					
Reinforcement of Computer System					
Reinforcement of Communication System					
Improvement of Mechanical Facilities					
Rehabilitation of Siffu Diversion Dam Gate					
Improvement of Weirs					
Improvement of Pump Facilities					
Rehabilitation Works of Canal System					
Civil Works					
Enheightening	—	—	—	—	—
Canal Widening	—	—	—	—	—
Repair of Scoured Canal	—	—	—	—	—
Desilting	—	—	—	—	—
Canal Lining	—	—	—	—	—
New Canal	—	—	—	—	—
Structure Repair	—	—	—	—	—
Drainage/Reservoir Excavation	—	—	—	—	—
Road Maintenance	—	—	—	—	—
Repair of C/H Gates	—	—	—	—	—
Repair of Turn-Out Gates	—	—	—	—	—
Rehabilitation of Major Structures					
Rehabili. of Maris Diversion Dam			—	—	—
Const. of Gaddanan Spill Way			—	—	—
Revetment of Maris M.H.E.P.			—	—	—
Agricultural Development					
Agricultural Service Facilities	—	—	—	—	—
Institutional Facilities	—	—	—	—	—
Consulting Service					
Project Administration					

5. PROJECT EVALUATION

5. PROJECT EVALUATION

5.1. Evaluation of Present MRIIS Project

The paddy production in the MRIIS area has been increased steadily, whereas stagnated in the other areas. Thus, it is considered that the MRIIS area plays an important role as the rice granary not only in the Cagayan Valley (Region II) but also throughout the country. The marketable rice surplus in the MRIIS area in 1985 amounts 184,000 tons (milled rice), equivalent to 58 percent of the total rice demand in the Region II (315,000 tons) or 23 percent of the deficit in Region IV which includes Metro Manila area (809,000 tons).

The MRIIS Service Area has reached about 71,100 ha in 1986, and the new rehabilitation/improvement projects for the facilities are required inevitably to accomplish the development of the proposed target area of 97,400 ha. And also, the paddy production remains at 3.2 tons/ha on an average which is lower than the target of 4.1 tons/ha.

There are many subjects to be improved in the Area, such as system facilities, water management, farmers' organization and farm management for achieving the target production. Therefore, in the case that the MRIIS Project does not take any improvement works in future, although the Project includes some rehabilitation works for the facilities, the estimated financial IRR (FIRR) and economic IRR (EIRR) are comparatively low by five and nine percent, respectively.

The MRIIS Project Cost

<u>Actual Expenses^{1/}</u>				<u>Present Value^{2/}</u>		
<u>Canal & Others</u>		<u>Dam^{3/}</u>		<u>Canal & Others</u>	<u>Dam</u>	<u>Total</u>
<u>LC</u>	<u>FC</u>	<u>LC</u>	<u>FC</u>			
<u>662.4</u>	<u>86.3</u>	<u>912.8</u>	<u>74.2</u>	<u>3,433</u>	<u>3,371</u>	<u>6,804</u>

Note: ^{1/} ... LC: million pesos FC: million US\$
^{2/} ... million pesos
^{3/} ... allocated cost

5.2. Evaluation of MRIIS Improvement Project

(1) Role of the MRIIS Improvement Project for Rice Supply

The paddy production was increased by 30 percent between 1970 and 1980, but the said increase rate is sharply reduced by seven percent in a period between 1980 and 1985. On the other hand, the population growth rate can be foreseen by 25 percent on the national average in a period between 1980 and 1990, while 31 percent in Region IV, and also the rate between 1990 and 2000 is forecasted to be 16 percent on the national average and 21 percent in Region IV, respectively. The population growth rate will not decrease so much as compared with the paddy production. Therefore, the paddy self-sufficiency will become difficult if the paddy production remains at the present level.

According to the next National Development Plan (1987 - 1992), the Philippine Government aims to produce 11.3 million tons of paddy (=7.4 million tons of milled rice) in the whole country in the target year of 1992. The target paddy production is at 38 percent increase of present production level by 8.2 million tons in 1985.

The MRIIS area has also potential to increase the surplus paddy when the MRIIS area reaches the target irrigation area of 97,400 ha which can produce the paddy of 764,000 tons (=500,000 of milled rice) per annum after completion of the MRIIS O/M improvement project. The surplus amount of paddy to supply Region IV will be increased to 380,000 tons per annum. This surplus rice amount is really attractive and important to meet the future increasing demand of about 900,000 tons of deficit rice in Region IV in 1992, especially to the demand of rice in Manila.

Forecast of Rice Surplus and Deficit

(unit: '000 tons)

<u>Area</u>	<u>Year</u>	<u>Demand</u>	<u>Production</u>	<u>Surplus and Deficit</u>
1. Whole Country	1985	5,740 ^{1/} _{2/}	5,360 ^{1/} _{2/}	- 380
	1992	6,900 ^{2/}	7,400 ^{2/}	+ 500
2. Region IV (Southern Tagalog)	1985	1,410 ^{1/} _{3/}	600 ^{1/} _{3/}	- 810
	1992	1,680 ^{3/}	780 ^{3/}	- 900
3. Region II (Cagayan Valley)	1985	315 ^{1/} _{2/}	680 ^{1/} _{2/}	+ 365
	1992	430 ^{2/}	1,230 ^{2/}	+ 800
4. MRIIS Service Area				
- Present	1985	89	273	+ 184
- Without Improvement Project	1992	120	330	+ 210
- With Improvement Project	1992	120	500	+ 380

Source: ^{1/} ... Bureau of Agricultural Economics, MAF
^{2/} ... Based on "National Development Plan, 1987-1992"
 NEDA
^{3/} ... estimated

(2) Comparison of Benefit and Cost

The internal rate of return (IRR) in the above case was estimated at 10 percent of FIRR and 14 percent of EIRR, of which EIRR is deemed to reach the target rate provided for the Feasibility Study (12 percent) and can be considered to give the high priority for implementation as a national project.

(3) Increase of Farm Income

In the case that the improvement of the project was implemented, the farm income is expected to be largely increased to 24,800 pesos/household on an average even in the lowest class of tenant farmer in the District IV. Therefore, the improvement project is considered to give a remarkable and favorable effect to the farmers in the area.

Farm Income

(unit: ₱/farm)

Items	District			
	I	II	III	IV
- Without Improvement Project				
Owner Farmer	16.1	19.1	15.4	15.4
Tenant Farmer	11.1	14.1	10.4	10.4
- With Improvement Project				
Owner Farmer	29.8	32.5	30.4	29.8
Tenant Farmer	24.8	27.5	25.4	24.8

(4) *Upgrading of Water Use and Hydroelectric Power Generation*

The improvement of water management will enable to reasonably control the water in the Magat reservoir, and the present annual release of water of about 3,700 MCM from the reservoir, which is planned in the existing O/M Manual can be increased to 5,600 MCM. Consequently, the improvement of the project will result in the increases of water availability for more effective use.

In the other respect, there will not be so large difference between the presently generated power of 1,183 GWH presented in the O/M Manual and that of the improvement by 1,075 GWH on an average. The power generation in the dry season (Jan. - Jun.), however, will be increased to 365 GWH from 249 GWH, and the increased value of the power generated by the Project will largely contribute to the national economy.

(5) *Impacts by the MRIIS Improvement Project*

In addition to the above tangible benefits, the MRIIS improvement project is envisioned to give the following socio-economic impacts.

- To improve the villagers' living standards in terms of quantity and quality.
- To give influence on the technical uplevelling of crop cultivation and farm management of the farmers.
- To contribute to improvement of self-sufficiency and to increase the export.
- To balance disparity in living standard between the regions.

6. RECOMMENDATION

6. RECOMMENDATION

The MRIIS has many subjects to be improved and is placed under the conditions that the system cannot accomplish the target of the project. It is recommended, therefore, to make improvement urgently for the MRIIS O/M works in order to i) achieve the largest paddy production by using the system effectively which is the huge national property by investment of about 10,000 million pesos, ii) utilize the system as long as possible by proper maintenance and iii) increase the farmer's income and stabilize the regional economy and people's livelihood by increasing agricultural production with productivity rise.

6.1. Recommendations for Improvement of the MRIIS O/M

The recommendations related to the MRIIS O/M works are itemized as follows:

- Expansion of irrigation area; The achievement of target area of 97,400 ha from the existing irrigation area of about 71,100 ha.
- Improvement of water management; The equal allocation of irrigation water to the upstream and downstream areas on demand and on schedule.
- Revision of Magat reservoir operation rule curve; Reservoir outflow control based on the revised operation rule curve prepared by the Study Team.
- Improvement of system facilities; The rehabilitation and new construction for the improper facilities for successful water management.
- Improvement of on-farm facilities; The improvement and development of on-farm facilities even in the irrigated fields as well as areas newly developed with the assistance by the MRIIS O/M Offices and other Governmental agencies concerned.
- Strengthening of O/M organization and repletion of its function; The establishment of effective countermeasures and proper management to carry out the water management and maintenance of facilities in the O/M organization.

- Provision of operation and maintenance cost for the MRIIS; The increase of irrigation fee to be collected and allocation of maintenance cost of the Magat dam by NPC based on generated power benefit of the Magat hydroelectric power plant.

6.2. Recommendations for Agricultural Sector

The agricultural sectors are recommended on the following subject;

- Assessment of the accurate irrigation area; Assessment of accurate irrigation area by the introduction of updating system of data on the irrigation area.
- Improvement of paddy cultivation and post-harvest practices; The measures to increase the paddy production from the present yield of 3.2 tons/ha to the target yield of 4.1 tons/ha as well as to increase the farmer's income by retrenching the paddy production cost and by introducing post-harvest facilities.
- Strengthening of farmer's institution; The strength of farmer's organization for carrying out the proper water management, economical farm management and on-farm development to realize the target of O/M improvement. For this purpose, it is proposed that further survey should be carried out for the full participation of water users to IA.
- Improvement of Governmental supporting services; The establishment of technical and financial aid to farmers by NIA, MAF and other governmental agencies concerned, especially by agricultural bank to provide production loan.

6.3. Recommendations for Project Implementation

The Implementation of the MRIIS O/M improvement works consisting of two categories of i) the improvement of system facilities and water management in the Service Area and ii) strengthening of farmers' institution, are planned in a five-year program from 1988 to 1992, and these works should be implemented in accordance with the proposed priority under the close cooperation among the MRIIS O/M Offices and other such Governmental agencies concerned such as MAF, MAR, NPC, NEA, etc.

6.4. Recommendations for O/M Activities

After completion of the improvement of the MRIIS O/M, the operation and maintenance activities, consisting mainly of water management, maintenance of system facilities, irrigation fee collection, assistance to farmers' organization for on-farm development, establishment of IA, etc. should be properly conducted by the MRIIS O/M Offices under the direction of the MRIIS O/M Head Office.

In the works mentioned above, MRIIS O/M Head Office should carry out the following data management for administrative works and daily data processings by using a computer.

i) Data Filing

- Hydrology and meteorology
- Water management
- Equipment and materials
- Staff and employees
- Agricultural land and cadaster

ii) Processing and Analysis

- Irrigation fee collection
- Statistical processing
- Cost price analysis and budget control
- Diversion water requirement computation
- Water allocation among sources and demands
- Simulation for periodic updating of optimal reservoir operation rule
- Simulation for optimal cropping schedule

In addition to such data management, the MRIIS O/M Head Office should monitor annual flow and check progress of O/M activities which will be illustrated in the O/M Drawings in order to grasp the prevailing O/M conditions in the Service Area.

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