14. TERTIARY PILOT UNIT

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1. Introduction

A tertiary unit in the Indonesian irrigation system is a part of farm land (rice field) which receives water from an offtake at main or secondary canals. It is the smallest unit in the irrigation system, and at the same time the largest one in the farm level system with average 100 ha in size.

In technical irrigation such an offtake is equipped with measurnig device (Romyn gate or Cipoletti weir) and it can be considered as the boundary between the main system and the tertiary irrigation system. The policy of management in each irrigation is up to now executed as follows:

—Operation and maintenance of main irrigation system is on the responsibility of the Provincial Government c.q. the Provincial Public Works.

—Operation and maintenance of tertiary irrigation system is on the responsibility of the village c.q. the farmers concerned by carrying out water contribution and mutual help.

Most of the irrigation systems are at present under rehabilitation. Hereto include rehabilitation and improvement of weirs, reservoirs, pumps, major structures, canals, drains and minor structures up to tertiary offtake. There are included tertiary canals of 30 to 50 m in stretch in the unit and measuring devices. While the irrigation facilities in the tertiary unit are still in unsufficient conditions.

In order to maximize agricultural production and gain full achievement of project benefit, attention should also be paid to the tertiary unit by performing:

—improvement of tertiary irrigation networks;

—establishment of organization for operation and maintenance, and

—training of farmers.

For above mentioned purpose, the Department of Public Works, in cooperation with other Departments especially the Departments of Agriculture and Internal Affairs c.q. the related Local Government, establish the Tertiary Pilot Unit as sample and extension to other tertiary units within the irrigation area.

2. Conception

2.1. A Tertiary Pilot Unit is a tertiary unit with a complete irrigation network where there are found a good and effective water management in combination with usable agricultural inputs to be practised by the farmers themselves.

Irrigation facilities to be improved in the tertiary pilot unit cover:

—Tertiary, sub-tertiary, quarternary and drainage canals.

—Division boxes (tertiary and sub-tertiary boxes).

—Other structures (culverts, dropstructures, bridges etc.).

—Farm road.

—Other facilities for irrigation water management in the rice field.

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2.2. The farmers in the tertiary pilot unit are associated in an organization for irrigation water users. This organization has to carry out irrigation water management at the tertiary pilot unit under the guidance of irrigation and agriculture officers. Hence, in this pilot unit a demonstration on agricultural matters is carried out through a demonstration plot for an individual farmer (±0.10 Ha), as well to be developed as a demonstration farm for a group of farmers (±10 Ha).

One demonstration farm is equal to one quarternary unit in extent.

2.3. The Department of Agriculture is developing this Tertiary Pilot Unit to become an Agriculture Extension Center. This Center system will be equipped with facilities for extension and training purposes on modern agriculture techniques.

3. The Aim of Tertiary Pilot Unit.

3.1. The Tertiary Pilot Unit has the intention to visualize to farmers the matters concerning development of tertiary irrigation network and the method for effective water distribution based on the existing cropping pattern or to be developed one.

3.2. It is up to now for the Government c.q. the Department of Public Works its obligation as the policy for the construction of tertiary irrigation net work through concerned projects:

—carry out plan and design of tertiary unit.

—carry out surveying and setting the poles for canal center line.

—carry out the construction of upper part of tertiary canals for about 30 to 50 m in stretch as sample purposes.

—support the construction of heavy canal works and heavy structures.

—guide the farmers on construction of canals and structures by indicating mutual help.

Entering the second period of Five Years Development assistance and interference of the Government will be increased by establishing the Tertiary Pilot Unit. This is expected to spread out over the whole irrigation area.

3.3. After developed all tertiary units in the irrigation area as the tertiary pilot unit, it will mean that modern agriculture techniques can be practised in this available technical rice field.

4. Location of Tertiary Pilot Unit

Establishment of tertiary pilot unit is limited, for one irrigation section (±25,000 Ha), however, one unit in minimum is most required. Accordingly, it is considered necessary to carry out a careful survey in order to select a suitable area for the tertiary pilot unit. The location of a tertiary pilot unit is selected by taking due consideration the following factors:

4.1. The area should be located at a place on the following conditions:

4.1.1. About in the center of relevant Irrigation Project area so as to bring about greatest effect of demonstration.

4.1.2. Near by a road with traffic convenience or reachable easily by vehicle.

4.1.3. Near an Irrigation Office or an Agriculture Extension Office and near the house of a water master, such for better and easier extension service, guidance, communication etc.

4.2. Location of a tertiary pilot unit should be approved by three Departments: Public Works (Irrigation Section), Agriculture and Local Government.

4.3. The Farmers in the Unit and the Village Officials especially the Chief of Village have to give responsives.

4.4. If possible, it should already have a farmer organization for irrigation water management.

4.5. From the technical point of view, this tertiary pilot unit should have the following:

4.5.1. an area of about 100 Ha.

4.5.2. an offtake equipped with measuring device and check structure.

4.5.3. no serious drainage problems.

4.5.4. an aerial photograph.

5. Administration Approach

Administration approach is considered necessary among certain Departments, i.e. Public Works, Agriculture and Local Government afore mentioned, in order to decide concerning their duties and their coordination on cooperation.

Duties of each Department are:

5.1. The Department of Public Works (Irrigation Section) has the responsibility for:

—making the designs (mapping, surveying, drawing etc.), construction of irrigation and drainage canals, tertiary boxes, sub-tertiary boxes and additional structures.

—guidance on water distribution system and water management in Tertiary Pilot Unit.

5.2. The Department of Agriculture has the responsibility on:

—Extension service to the farmers concerning the application of agricultural inputs through the demonstration plot and the demonstration farm.

5.3. The Local Government has the responsibility on:

—Cooperation and coordination among the Departments concerned.

—Promote the farmers in mutual help for the construction of canals.

—Avoid/reduce land compensation for irrigation network.

5.4. The farmers have the responsibility on:

—Activities of Water Users Organization.

—Regulation for water management at farm level.

—Collection of water contribution for their organization, operation and maintenance of tertitary irrigation network.

6. Design of Tertiary Pilot Unit

6.1. General rules for design are:

—The size of tertiary pilot unit is about 100 Ha.

—A tertiary pilot unit is subdivided into a number of quarternary units, each of 10 to 20 Ha.

—Both continuous and rotational irrigation should be applicable.

—Rice field property for different villages has to be kept separately, i.e. boundaries of villages coincide with boundaries of quarternary units and tertiary units either.

—Irrigation water will flow outof tertiary offtake through tertiary canal to tertiary division box. It continues flowing through subtertiary canals and subtertiary box to quarternary canals.

—Irrigation to the fields takes place only from quarternary canals through bamboo pipes put in the dikes.

6.2. Lay-out of Canals and Drains

Minimum requirements for preparing a lay-out for a tertiary unit are: a 1 : 5,000 scaled map with 0.25 m contour and aerial photographs.
Following rules are applied for the lay-out of canals and drains in the tertiary pilot unit:

—Avoid many new canal alignments, make use of existing canals as much as
—All canals and drains alignments should follow the boundaries between the individual fields.
—The distance between two quarternary canals should not be more than 300 m.
—Establish clear boundaries between quarternary units.

6.3. Design Criteria

For the different projects, water requirements vary from 1 to 2 1/sec/Ha and drainage capacities vary from 5 to 7 1/sec/Ha. The dimension for the canal cross section will be based on the following criteria:

—roughness coefficient of Manningg's Formula : $k = 40$.
—side slope : 1 : 1.
—canal bottom width (b) should be equal to the water depth (h).
—the minimum bottom width is 20 cm.
—flow velocities should be kept above 20 cm/sec and below 60 cm/sec.

6.4. Division Boxes

The major characteristics of the tertiary division box is the proportional sub-division of the water flow. Proportional distribution is achieved by making the width of the openings in proportion to the discharge required, i.e. in proportion to the areas served.
The box is normally made of masonry with reinforced concrete.

7. Operation of Tertiary Pilot Unit

7.1. General

Up to now farmers generally use irrigation water without paying any attention to the economical point of view. They usually flow it continuously in abundant amount in the wet season as well as in the dry season. This habitual action results that many farmers make illegal efforts to get water from main and secondary canals, especially during the dry season, sometimes resulting in quarrel among themselves. It is necessary to change such conditions by performing operation rules on Tertiary Pilot Unit. Rules for operation on tertiary pilot unit can be mentioned as the followings:

—Only one man, the water distributor (Ulu-ulu) should be incharge of the operation of the tertiary pilot unit. He should take care of an efficient and equitable distribution. Under no circumstances the farmers are allowed to interfere with the operation.
—Farmers are only allowed to take water from the quarternary canal of their quarternary unit (preparably through bamboo pipes). It is never allowed to take water from main, secondary and tertiary or sub-tertiary canals.
—The farmers in the pilot unit should all start land preparation and transplanting at a certain date decided by an irrigation committee.
—Operation rules for continuous and rotational water distribution should be simple and easy to remember. These rules should always be the same for a

given situation (for example: opening and closing of tertiary boxes during rotation to be at the same time and the same day).

—In order to make these rules obeyed by the farmers, it is necessary to make the sanctions for offenders.

7.2. Determination of Water Requirement

Water requirement is the most important factor for good distribution of irrigation water.

As rice culture in the irrigation area in Indonesia is done by transplanting system, water requirement should be determined for each period of growing stage, i.e. the nursery period, puddling period, transplanting period and after transplanting period. Water requirements vary from project to project, mostly depending on the soil conditions. Other factors are climatic conditions and growth stage of the crop.

7.2.1. Nursery Requirement

Since nursery beds are relatively small in size and operated in the same period as in the area for land preparation, it is assumed that water required for will be supplied from flooded surrounding fields.

7.2.2. Puddling Requirement

In transplanting rice culture, rice fields are ploughed, harrowed and supplied water to soften the soil for transplanting. The quantity of the required puddling water varies from 100 to 250 mm in depth (for Gambarsari and Pesanggrahan area the puddling requirement is estimated at about 135 mm and 120 mm for Wet Monsoon rice and the dry Monsoon rice, respectively). The period of puddling is estimated at about 30 days which is influenced by supplying labour, supplying of irrigation water and period of nursery in connection with the rice variety.

7.2.3. Transplanting Requirement

In case of transplanting, water requirement is estimated at about 50 mm as for land preparation.

7.2.4. Evapotranspiration

Evapotranspiration can be determined from climatic data, using an empirical formula, or from field experimental investigation.

From field experimental investigation in Tajum Pilot Scheme area (Central Java), evapotranspiration ranges from 4 to 6 mm/day. The graphic on the result of observation combined with percolation can be seen at the following pages: (page: 10, 11, 12).

7.2.5. Percolation

Percolation rates are influenced by soil characteristics (soil texture and cracks) and hydraulic conditions (ground water table or water level of nearby canals).

The result of investigation from Tajum Pilot Scheme area (alluvial soil) shows that the average of percolation rate is 2 mm/day.

7.2.6. Effective Rainfall

Different methods are in use for assessing the effective rainfall, which is

defined as the quantity of rainfall which is assumed to use effectively in water requirements calculations during the crop growing period.
As crops are not able to utilize fully the total amount of rainfall available in the growing period, effective ranifall cannot be expressed in terms of total precipitation.
As for Gambarsari Pesanggrahan, the Consultants estimated effective rainfall at 75% for the monthly amount of daily rainfall between 5 mm to 50 mm. Daily rainfall of less than 5 mm and more than 50 mm are considered as non-effective.

7.3. Distribution System

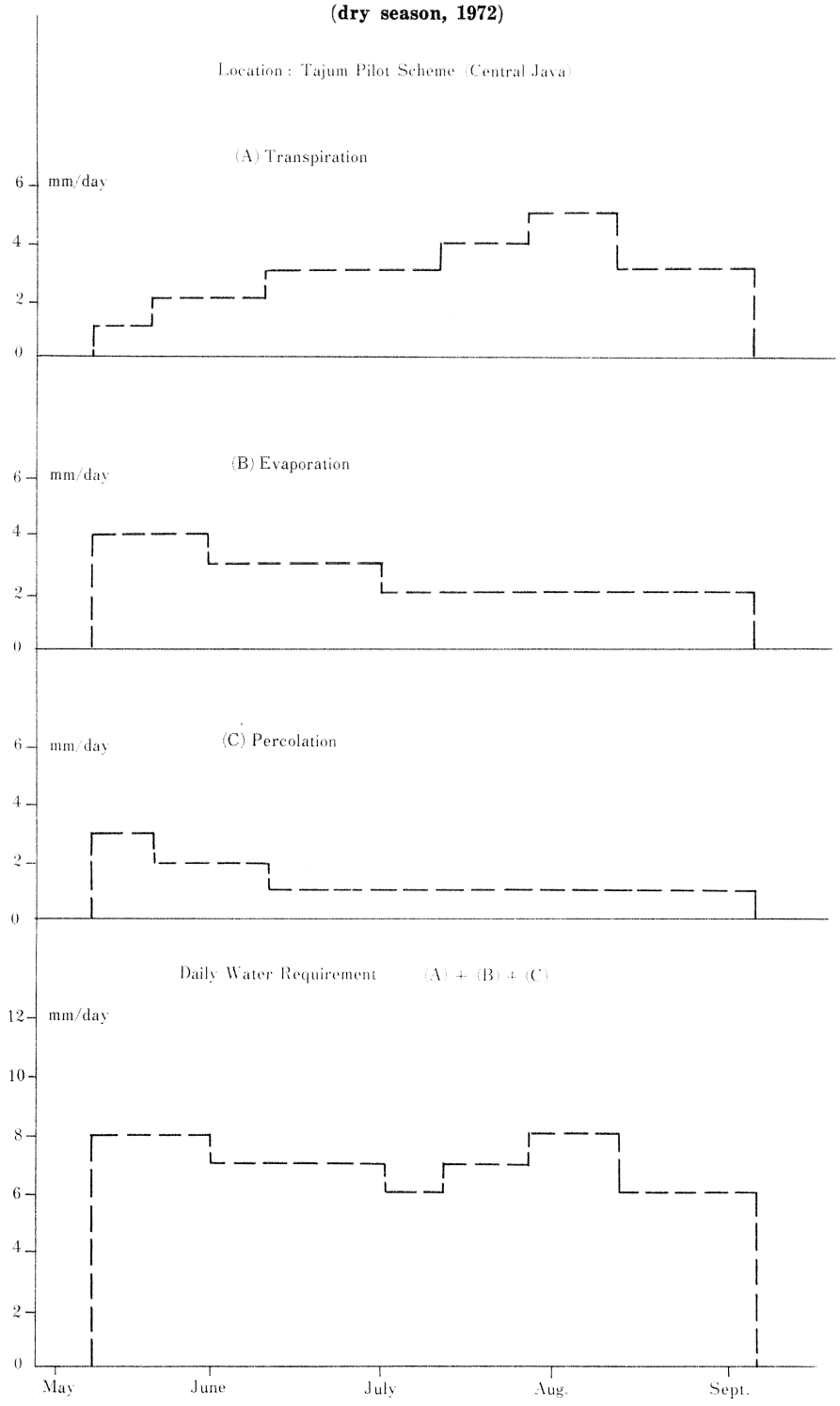
The area of tertiary unit is usually divided into units of rice field with an average size of about 0.10 Ha/unit.
Most of the rice field units are not adjacent to a quarternary canal. Water flows from quarternary canals through bamboo pipes into the first unit, then after filling it the water flows to the adjacent unit below through a kind of spillway which is made only by cuttig levees open (it is recommended using bamboo for spillway), and repeat it to one another in the same way. Finally the exceeding water (especially during rainy days) flows to the quarternary drainage, the tertiary drainage and hence to the natural drainage.
The present system of irrigation in Indonesia is continuous irrigation, i.e. by means of main, secondary and tertiary canals containing water during a crop season, and the water flows continuously from the canals into the rice fields. There is no reason to change this system when supply and demand of irrigation water are high. When, however, supply and/or demand will drop below a certain percentage of the peak demand in a tertiary unit, the flow in the subtertiary and quarternary canals becomes too small for proper distribution. Continuous supply is then discontinued and rotation becomes necessary.

7.4. Water Users Organization

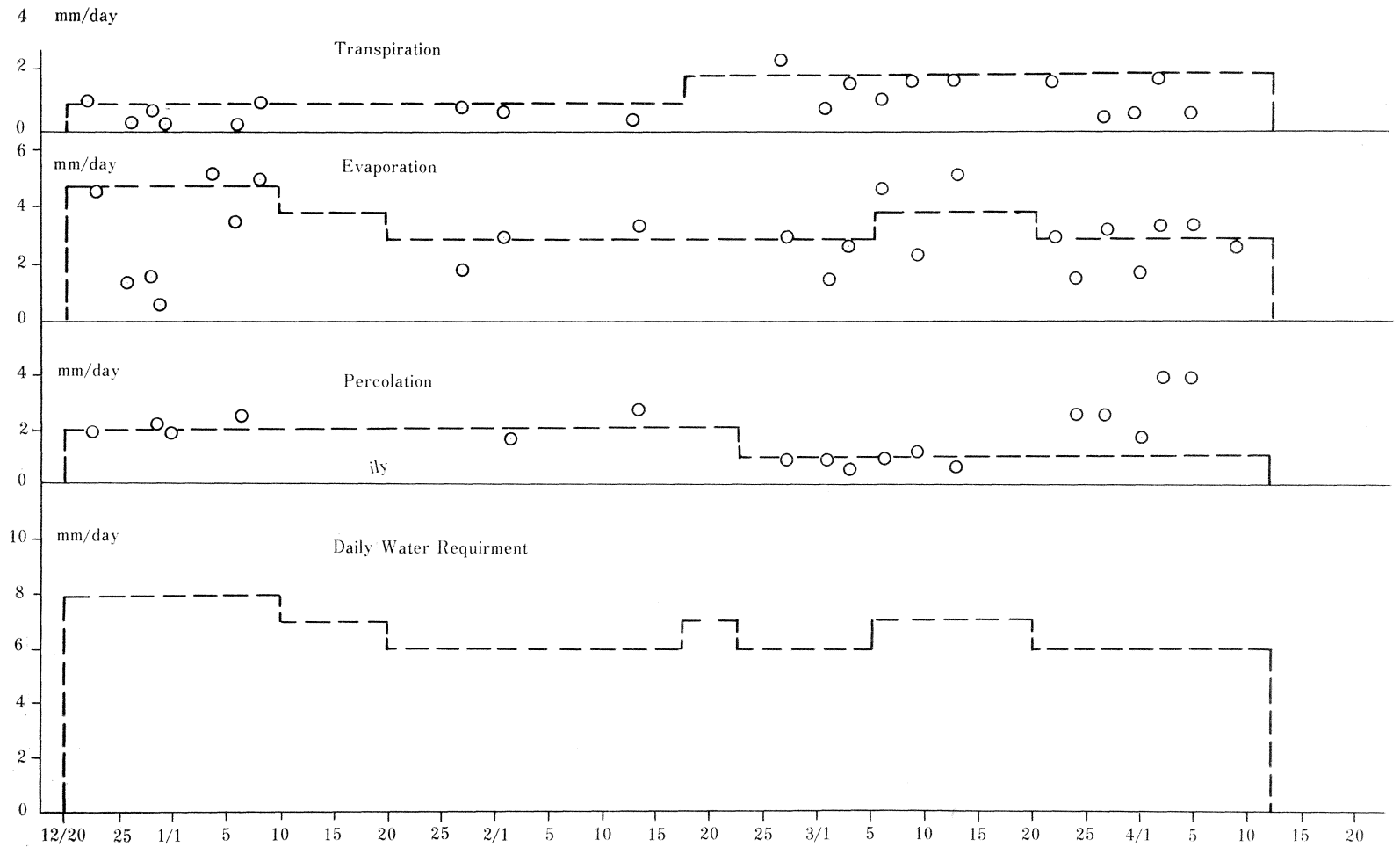
7.4.1. Organization Form

Good operation of tertiary pilot unit resulting in an efficient and equitable water distribution has to be based on cooperation. Farmers have to be organized, so that decisions about any action concerning the tertiary unit can be explained and discussed.
In fact, cooperation among the farmers has existed already and in some regions the organizations of water users also had been established (i.e. Dharma Tirta in Central Java and Subak system in Bali).
As an organization it should be able to catch all interests, the interests of farmers as well as those of the Government. As it has been mentioned already in afore section, the village has the responsibility to manage the tertiary unit.
Unfortunately, the boundary of tertiary unit is not parallel with that of village administration. Sometimes in one tertiary unit contains a rice field belonging to different villages and on the other hand the rice field of one village may have several tertiary units.
Above conditions considered the organization should perform the combination to be the village administration boundary oriented and the tertiary unit boundary oriented views.

GRAPHIC ON WATER REQUIREMENT OBSERVATION FOR PADDY PLANTS
(dry season, 1972)



Location : Tajum Pilot Scheme (Central Java)



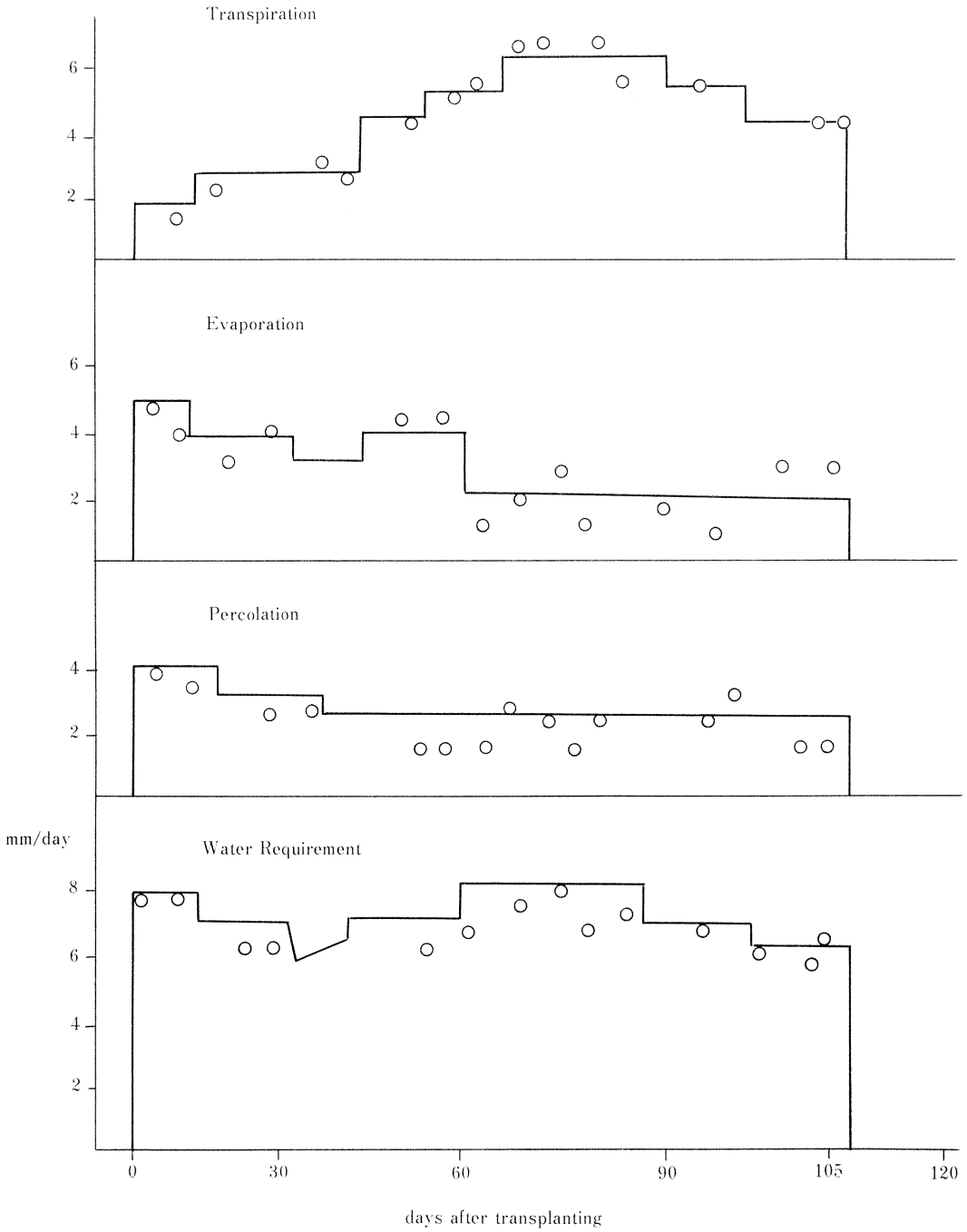
GRAPHIC ON WATER REQUIREMENT OBSERVATION FOR PADDY PLANT

(Rainy season, 1972/1973)

GRAPHIC ON WATER REQUIREMENT FOR PADDY PLANTS

(dry season, 1973)

Location : Tajum Pilot Scheme (Central Java).



7.4.2. Structure of Organization

The body of Water Users Organization consists of:

a. Board of Management

The organization is managed by a body called: Board of Management consisting of the following members:

—one Chief
—one Secretary
—one Treasurer
—several members, as much as the number of quarternary unit concerned.

The main duties of the Board of Management are: management and control the organization to run smoothly. The members of the Board of Management receive salary, the amount of which to be decided by the organization.

b. Coordinator Ulu-ulu (Water Distributor)

Coordinator Ulu-ulu is the chief for technical execution and is responsible to the Board of Management. The Coordinator Ulu-ulu is by approval of the members of the organization, fuctionable for:

1. The Ulu-ulu of tertiary unit or several Ulu-ulus of Village alternatively, when the area of tertiary unit consists of more than one village's field.
2. The Ulu-ulu of Village, when the area of the tertiary unit or of several tertiary units are located at one village.

The Coordinator Ulu-ulu has the following duties:

1. coordinate, manage and control the execution of water management in the tertiary unit concerned.
2. make reports on water management and cropping pattern for the Board of Management, Sub-District Irrigatoin Committee and the Water Master.
3. coordinate the execution of canals and structures repairs in the tertiary unit concerned.

c. Assistant of Coordinator Ulu-ulu

Assistant of Coordinator Ulu-ulu is a technical executor and is responsible to the Coordinator Ulu-ulu. The function of the Assistant of Coordinator Ulu-ulu can be occupied by:

1. Ulu-ulu of tertiary unit, when several tertiary units are located in one village.
2. Ulu-ulu of village, when the area of tertiary unit consists of more than one village.

Assistant of Coordinator Ulu-ulu has the following duties:

1. manage and control the execution of water management in his commanded area corresponding to the guidance got from Coordinator Ulu-ulu.
2. control structures and canals located in his commanded area.
3. mobilize the farmers by mutual help on rehabilitation and maintenance of canals and structures in his commanded area and control its execution.

4. contact the Chief of Village concerned for solving non technical problems.

d. Chief of Farmers Group

Chief of farmers group is technical executor who is in direct contact with the farmers in his commanded area and is responsible for to the Assistance of Coordinator Ulu-ulu. For one sub-tertiary box there appointed one Chief of Farmers Group.

A Chief of Farmers Group has to do the following duties:

1. manage and control the execution of water management in his commanded area.
2. control the conditions of canals and structures in his commanded area.
3. mobilize the farmers by mutual help for rehabilitation and maintenance purposes of canals and structures in his commanded area and control its execution.
4. prevent eventually taking water from sub-tertiary, tertiary, secondary and main canal for rice field units directly in his commanded area.

Question and Answer

J. Kitamura, Japan: "Requesting comments on this introducing opinion". Although I suggested the necessity of land consolidation works in Indonesia, I was inversely asked by one of the officials in Indonesian Government. "The idea is theoretically agreed but, the time to apply it has not yet been matured. Because the country wanted to raise up the land productivity only, not labor productivity. For this purpose, they will choose rather more effective, economical ways, that is, rehabilitation, and intensification—to construct water source facilities for two crop cultivation. Even the cheaper way is applied than that in Japan, people in Indonesia will not be able to stand the burden at present".

Answer: Yes, for the time being land consolidation works do not apply yet. We consider first the increase of agricultural production especially rice by improvement and construction of irrigation and drainage facilities for two crops cultivation and successful of BIMAS/INMAS Program. Beside that, especially in Java island where the land ownership is very low (about 0.35 ha/household) the land consolidation works are very difficult to apply.

M. Goto, Japan: 1. How many "Tertiary Pilot Units" have now established in your country and also how many hectares are covered by them?

2. How the head of "Tertiary Pilot Unit" to be selected and also the top members of "Ulu-ulu"?

Answer: 1. There are about 34 tertiary pilot units now are established in Indonesia, cover about 3,400 ha.

2. They are elected by the members of tertiary unit concerned.

S. Okabe, Japan: (1) a) Does this program include realignment and full consolidation of the land? b) I understand the land tenure situation is very complicated and delicate in Indonesia. How does the Government manage this problem in the pilot unit?

(2) Who has a real responsibility in implementing the pilot unit program at the district and local levels?

(3) How do the local farmers participate in the program? and

(4) To what extent are the farmers financially assisted by the governments

(central and local) in constructing the tertiary and quaternary canals, and farm roads?

Answer: (1) a) No. b) For constructing the tertiary and quaternary canals and farm road etc. there is no land compensation used for those construction. The farmers through the head of village should arrange the land to be used for canals.

(2) Bupati (Chief of Regency) has the responsibility.

(3) Farmers participate in the program by:

—dig the canals

—set up the water users organization and its activity.

(4) The farmers financially assisted by Government only for the construction of heavy canals works and heavy structures. In some region, all tertiary and quarterly *structures* (*except earth works*) also are constructed by local Government (Regency).

P. Kung, FAO: I wish to know that who is responsible to dig the tertiary and and quaternary canals in Indonesia? Government or growers?

Answer: Base on our Government Policy, principly the tertiary and quaternary canals should be dug by the farmers themselves and the Government has to carry out plan and design of canals etc. (see page 3, para. 2 of the paper).

K. Takase, Japan: What is the criteria you defined the size of the tertiary pilot unit 100 ha.? Are there big deviation from 100 ha. depend on topography and other reasons in various tertiary pilot units? If so, please give us a range of size of the tertiary pilot unit in Indonesia.

What is the definition of

(1) Tertiary canal

(2) Sub-tertiary canal

(3) Quaternary canal

Answer: Criteria for the size of tertiary pilot unit 100 ha. — optimum size for good water management in one teritary unit. Based on topography the range of size of tertiary pilot unit is from 80 to 120 ha.

(1) Tertiary canal is the canal which can irrigate the area of one tertiary unit and it take the water from main or secondary canal.

(2) Sub-tertiary canal is the branch of tertiary canal which is necessary depend on topography.

(3) Quaternary canal is the canal which seeve (irrigate) one quaternary unit area (10 to 20 ha.), and farmers can only take the water from this quaternary canal.

K. Takase, Japan: What is the average rice yield (paddy stalk) in

(1) The Tajum Pilot Unit (220 ha.)

(2) Entire Tajum Irrigation Project (3,000 ha.)

(3) Gambarsain Pilot Unit

(4) Gambarsain Irrigation Project (20,000 ha.)

Answer: The average rice yield in

(1) The Tajum Pilot Unit (220 ha.): 5 ton/ha./season

(2) Entire Tajum Irrigation Project (3,200 ha.): 4 ton/ha./season

(3) Gambarsain Pilot Unit: 4.5 ton/ha./season

(4) Gambarsain Irrigation Project: 4 ton/ha./season