

FARM-LEVEL WATER MANAGEMENT
IN
SELECTED ASIAN COUNTRIES

Report of a Multi-Country Study Mission

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FOREWORD

The present volume reports on the outcome of an APO multi-country study mission on farm-level water management. The mission was a follow-up activity of a symposium on the same subject held in Tokyo in 1976. Incorporated in this volume are the highlights of first-hand observations of the participants in the countries visited and their individual reports on the status and problems of irrigation and on-farm water management in their respective countries.

The study mission comprised three phases implemented respectively in Thailand, Japan and the Republic of China. Twelve participants from 11 member countries joined the Thailand and Japan portions, and six of them opted to visit the Republic of China.

The APO believes that the report of the study mission carries with it useful lessons and experiences that need to be disseminated and shared with many other institutions and individuals interested in irrigation and water management, particularly for rice production. To the extent that it becomes useful to others, the APO feels justified in publishing and distributing this report.

The APO is grateful to the Governments of Thailand, Japan and the Republic of China for hosting the mission and to the concerned agencies and individuals in those countries for providing unselfish support and cooperation in making the study mission possible.

HARUMI TAKEUCHI
Secretary-General

March, 1980

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PART I. OBSERVATIONS IN COUNTRIES OF VISIT

1. THAILAND

Introduction

The summary report that follows reflects the general impressions gained by the study mission participants, as a group, during their visit to Thailand. The report draws from the participants' brief written and verbal comments about what they heard and saw at first-hand based on the following sources:

1. Briefing by officials of the country's Royal Irrigation Department (RID);
2. Briefing by officials of the Land Development Department in the regional/field offices and job sites;
3. Presentations by and discussions with Dutch consultants of the Netherland-based ILACO/EMPIRE M&T and Japanese experts of the Tokyo-based Japan International Cooperation Agency (JICA) currently assisting the Thai government in developing irrigation and on-farm improvement projects;
4. Interviews with half a dozen farmers in one village;
5. Brochures distributed in the course of the mission; and
6. Sights of on-the-spot and unrehearsed scenario of various stages of rice farming activities that unfolded one after another by the roadsides en route from project to project and village to village.

It is important to appreciate this summary report in the light of circumstances and ecological conditions peculiar to Thailand and to the Thais, particularly in the Central Plain region as far north as Chainat and as far down to the west to Kanchanaburi, the venues of the visit. Such characteristics of the country as physiography, e.g., geography, climate, rainfall pattern, river networks and a brief historical reference to Thailand's irrigation development efforts, among other considerations, should lend meaning to the report. In this way, the aspirations of the RID and Central Land Consolidation Office (CLCO) can be better understood. More than that, this background setting should enable the participants to rationalize their individual impressions about technology transfer from Thailand of the art, science and practice of farm-level water

management to their respective spheres of official responsibilities in their own countries.

For this reason the report comes in six subtopics as follows: a) The Setting; b) Brief Irrigation History; c) Salient Features of the Irrigation Improvement Efforts; d) Land Consolidation and Its Implications; e) A Case for Stable Human Organization; and f) Some Lessons of a Common Experience.

The Setting

Thailand is one of the monsoonal nations of continental Southeast Asia. It is a country of many navigable rivers, deltaic vast plains, verdant mountain ranges and is often referred to as a rice-growing society. It is bounded by Cambodia in the southeast, Laos in the northeast, Burma in the west and by Malaysia in the south. The country extends in latitude from 6°N to 21°N and, in longitude, from 98°E to 106°E. Of the country's total land area of 51.4 million ha, 25 percent is devoted to rice cultivation; 21 percent to field crops; 6 percent to orchard and 45 percent is forested. The balance, 3 percent, represents all other uses of the land. Close to 80 percent of the population of 45 million depends on agriculture for livelihood.

Rice is the staple crop even as other major export crops like maize, cassava, sugarcane, pineapple, kenaf and rubber play an expanding role in Thailand's agriculture and foreign exchange reserves.

Thailand's climate is predominantly sub-tropical which is primarily dependent on the northeast (dry season) and southwest (wet season) monsoons. The former occurs in late October or early November until mid-March and the latter, in mid-May through September.

In the Central Plain region annual rainfall averages 1,200 mm +/- 50 mm and where between 85 percent and 93 percent of total precipitation falls in the 6 months of the rainy or wet season.

The major river systems in Thailand originate from the mountain ranges in the northwest region and invariably drain to the Gulf of Thailand, mostly via the Central Deltaic Plain aptly called the "rice bowl" of the country. The river flow cycle is influenced by the southwest monsoon (May through October). On the other hand, the early drought period generally

comes in June and July when most rivers are half-empty. But when the rivers swell from August through October due to torrential rains, floods are common which literally "go down the drain" to the Gulf rather than being impounded in reservoirs and catchment areas for ready use when the rivers recede again in April. It is estimated that the annual surface runoff averages some 110,000 million cu.m 20 percent of which passes through Chao Phya river, the country's largest. Thus, it can be easily appreciated that the enormous runoff is reason enough for the government to invest huge budgetary outlays in controlling water, in harnessing the Chao Phya river and in a massive land consolidation scheme in the deltaic region as will be discussed later.

Irrigation Development: A Shot of History

Some evidences seem to indicate that in many ways, commercial rice-growing for export and the bad droughts that often visit the Chao Phya deltaic region connived to provide the impetus for the government to embark on huge irrigation systems and land development in that region. At the turn of the century, even when crude irrigation systems were in use, the Thai farmers already grew more rice than can be absorbed by the domestic markets. Hence, the government experimented exporting rice and discovered soon enough the potential of the venture. By 1903, they started to make large investments in water control and management when the government deputized a Dutch expert (Mr. Homan van der Heide) to survey the Central Plains in terms of recommending measures to effectively utilize the river flow of Chao Phya for rice cultivation. Hence, the first gravity system of irrigation in Thailand was established on the Prasak River and tributary that links the Chao Phya river at the ancient capital city of Ayuthya. Subsequently, more modern irrigation works were to mark the deltas in 1930, 1938 and 1948 largely as a result of the recommendations of van der Heide and another English engineer (Mr. Thomas Ward) who was deputized in 1915 to replace van der Heide when he left 6 years earlier.

By 1950, more than half a million ha became irrigable and 10 years later all of the projects recommended by van der Heide were completed. No sooner than the World Bank took interest in pursuing the irrigation development scheme when it made the initial loan of US\$18 million that made possible the completion of the Chao Phya diversion in 1957 which brought the total command area to 1.15 million ha. By 1975, some 2.2 million ha were under irrigation in the Central Plain region alone and an estimated 106,800 ha were protected from disastrous floods.

Also, by 1975, 13 large storage dams with more than 100 million cu.m capacity each and 183 small storage dams, all with an aggregate capacity of 32.8 billion cu.m of water were completed - still have a long way to go compared with the annual runoff of 110 billion cu.m mentioned earlier.

In addition, the 324 irrigation projects completed during the period 1950 - 1975 have put 1.6 million ha under irrigation. Sixty-five other irrigation projects under construction or planned are expected to irrigated another 1.6 million ha of riceland eventually.

Over the last 10 years, the CLCO has been engaged in impressive land consolidation projects along the Chao Phya and Me Klong rivers in a conspicuous effort to maximize the use of the existing irrigation projects in the region. The participants came away with the common impression: even when land levelling, consolidation into regular rectangular, bunded plots and installing on-farm improvement facilities is costing the national treasury an enormous sum, the payoff in social benefits for the present generation and those to come will more than compensate the cost: given proper management by either the farmers and the RID.

In the light of the foregoing brief review of Thailand's irrigation development history, it is easy to appreciate the present objectives of the current efforts for future accomplishment as follows:

1. The improvement and rehabilitation of existing irrigation projects so as to construct a complete distribution network, including the provision of on-farm facilities. The completion of projects where irrigation water is available for multiple cropping throughout the year will be speeded up. Such works are regarded to have the highest priority for accelerating crop production increase, as projected within the irrigation project.
2. Construction of new irrigation projects utilizing surface water possibly available in the form of different kinds of irrigation, inclusive of gravity and pump irrigation will overtake the demand for water supply in the years to come.
3. A study of the feasibility of underground water use for irrigation will be held as the highest priority and will be started in areas where surface water is scarce.

4. Water management will be expedited together with training of water operation officials and agriculturists in order to make the most efficient use of available water resources.

5. To work in cooperation with other official units concerned in the field of agricultural development within the irrigation projects in order to coordinate complementary services, e.g., extension, credit, marketing, etc., with a view to obtaining greater efficiency.

Salient Features of the Irrigation Improvement Efforts

At the commencement of the Thailand portion of the study mission, the Deputy Director-General of the RID (Mr. Charin Athayodhin) aptly stated that farm-level water management in the country is primarily carried out for the production of both wet and dry season paddy and those of other dry-season upland crops. In his keynote/welcome address, he made no secret of the fact that the fully equipped engineering works in large-scale land development projects notwithstanding, "water management at the farm level has failed to play fully its important role in agricultural productivity because of insufficient on-farm facilities and underdeveloped technology."

In essence, these statements reveal the salient features of the irrigation improvement efforts of the government, both in the recent past and at the present time. However, the participants realized later that the reference to "insufficient on-farm facilities and under-developed technology" pertains to the absence of efficiently working on-farm and inter-farm facilities such as ditches and canals and the lack of stable human organization to maintain the facilities as will be reviewed in some detail later.

Extensive Development

Even to the casual observer, the completed and on-going projects on water control in the study areas are impressively extensive in scope. This strategy of applying surface irrigation water and draining excess water from individual plots through the provision of diversion structures and canals for drainage was apparent, particularly at Singburi where farm plots are large (25 rai* each, 200 m x 250 m) compared with 5 rai each (50 m x 160 m) at the Me Klong job site.

* 1 rai = 0.16 ha

This feature of extensive approach to irrigation improvement in the country may be explained by four major factors, among other considerations: a) land development precedes, or so it seemed, efforts on irrigation development and is made through government decrees that leave the farmers very little say in the consolidation and reshaping of their existing farms - a task made easy, perhaps, on the part of the government considering that about 70 percent of the farmers are owner-operators compared with much higher tenancy rates in other Asian countries; b) the deltaic region is practically an endless sight of almost flat terrain that renders rather easy on the part of the engineers to reshape many farms into one contiguous large plot; c) the apparent adequacy of existing main diversion canals prior to land levelling, including the availability of irrigation water; and d) the economies of scale in the plowing or harrowing operations, particularly if performed by tractors.

The latter factor (item d above) attempts to explain the rationale of extensive development which needs further qualification in that the immediate objective of land consolidation in Thailand is to increase the productive capacity of the land and the improvement of labour efficiency. In contrast, in Japan, the immediate aim of land consolidation is the construction of farm/feeder roads for greater mobility of farm machines and the regrouping of small, scattered plots. Increase in the productive capacity of the land is rather secondary in Japan.

The participants' impression of the extensive feature of water control development is further reinforced by their observations of the existing (2-5 years in operation) irrigation systems in the Chainat area wherein the provision of engineering hardware such as dams, spillways, intakes, turnouts, lateral canals, etc. were evident. In contrast, the lateral canals and field ditches were wanting in upkeep and maintenance. Water course embankments were either eroded due to the lack of appropriate cover grass (e.g. Cynodon Dactylon or Paspalum notatum) or clogged with weeds every here and there. The impression one gets immediately from this kind of field condition is that these on-farm facilities do not receive the attention that they deserve from the water users themselves or irrigation personnel such as ditchtenders.

Furthermore, one is tempted to associate the relatively poor stand of much of the rice crop seen growing in the area, i.e., uneven vegetative growth of paddy on the same plot, absence of straight-row planting and proliferation of weeds.

This is probably so because theoretically, given properly selected seeds and common age of paddy seedlings, a systematic water application on and withdrawal of water from the plots makes for effective weeding (mechanical or manual) only to the extent that paddy hills are regularly spaced and in straight rows.

In summary, intensive development or management of on-farm structures and facilities seemed to be negated in favour of past and current drive to develop the irrigation system rather extensively. (This topic will be pursued further on the sub-topic on human organization.)

Free Irrigation Water

From time immemorial, irrigation water in Thailand has been customarily supplied free to the farmer-users because many generations ago, land and water were plentiful. To this day, free irrigation water is perpetuated a practice that seems impossible to change. However, the government levies taxes on rice exports which somehow indirectly compensates partly for the cost of providing free water. This background notwithstanding, the participants found the Thai experience quite fascinating and wondered whether the policy to provide free or subsidized irrigation water does not, in fact, lead to an I-don't-care attitude that paddy farmers might consequently develop, Thai farmers included.

One participant observed that collection of water charges from the farmers should aid the government in amortizing foreign loans spent for the construction of the irrigation structures and opined that farmers are likely to be more management-conscious of the water they buy rather than squander it as when obtained gratis. Indeed, one rural sociological concept is that the farmer-user of the irrigation system tends to develop a greater stake, concern, interest and responsibility in the operation and maintenance of the system in order to draw adequate amounts of water that he pays for when he needs it. When this is the case, water use should be more efficient and should be able to create the impact that it has in increasing crop yields.

Land Consolidation and Its Implications

In the context of land consolidation as it is applied in Thailand, the effort is not merely an exercise to reform the land surface just because the farms are small and fragmented. Particularly in the Chao Phya Plain, land consolidation is

conceived as " . . . an integrated, technical method of land development at farm and interfarm levels with emphasis on water control. It comprises the construction of minor irrigation and drainage system, network of farm roads, a certain amount of land levelling and a limited amount of repara-celling to reduce fragmentation caused by the system of water courses and farm road construction. Hence, land consolidation in Thailand can be characterized as a technical method aiming at a more efficient use of available land and water resources. . ."

The underlying objective of land consolidation in Thailand is ". . . to improve the physical production conditions with emphasis on water control in order to attain agricultural development objectives of increasing rice production, initiating or expanding dry season cultivation and creating additional rural employment opportunities." The programme is only about 10 years old but by 1978 more than 30,000 ha have already been consolidated, 163,000 ha are in the process of being consolidated and 119,000 ha more are under preparation. Within the next few years, the programme aims to consolidate land at the rate of 30,000 ha annually throughout the country.

Some tangible benefits that have reportedly been derived, for instance, from the first land consolidation made in Chao Phya over the past eight years or so are as follows:

- a. Introduction of and acceptance by farmers of double cropping which has increased cropping intensity from 110 percent prior to the project to 195 percent after the project.
- b. Paddy yields on an annual basis have increased from an average of 2.65 mt/ha to 6.6mt/ha.
- c. Private ownership of farm tractors has increased from 10 percent to 70 percent.
- d. Rural unemployment problems have been eased as labour demand has increased in the operation of paddy farms since the implementation of the programme.

However, there seems to be some implications in the land consolidation scheme that the participants noted during the discussions and interviews with farmers in one village. Some of the important ones are:

a. In lieu of irrigation tax, the farmers are required to share in the cost of land development payable over a 15-year period at 12 percent interest rate. One farmer admitted that he has not been paying his due share for some years now because he "lost" 7 percent of his land in the process of land consolidation. This case is perhaps isolated but the general impression was that the mechanics for payment is not well-defined or was not made clear by the land consolidation officers during the briefing in the field;

b. In the process of land levelling, ditch digging and reparcelizing which lasts for at least one entire dry season, there are no provisions in the project to compensate the farmers for the one-season crop that they lose;

c. Also, in the process of land levelling, the topsoil is inevitably scraped off and lost or mixed with the subsoil. And even under heavy fertilizer use (which the programme does not provide) it will take sometime to restore the soil's properties suited to a particular crop. This means that for the first few cropping seasons, harvests are not expected to be at par, again, at the expense of the farmers;

d. The plots in Chao Phya seem to be too large (200 m x 250 m each) as to enable an even distribution of water at some stages of paddy vegetation. It seems likely that farmers will eventually need to construct small dikes or bunds within the plot to maintain certain water levels; and

e. Because of the relatively large plots, more than one farmer is likely to own one plot. This condition could spawn serious repercussions in irrigating and draining the farmers' share of the plot.

The legal and social implication of the land consolidation programme is perhaps the most important one except that there were no considerable discussions on the issue due to the fact that the time was short and that there were no officials from either the legal office or the bank during the field visits.

To be sure, the land consolidation effort in Thailand actually and physically "reforms" the land for efficient operation.

A Case for Stable Human Organization

A high-ranking official of the RID dramatized the case for a stable human organization in farm-level water management during the briefing session at the RID when he related that sometime ago, the farmers were urged to plant water melon as a second dry-season crop by an agronomist or agricultural extension officer. So the farmers planted water melon but when harvest time came, prices were rock-bottom and no one seemed to buy their products for which they incurred considerable costs and efforts. As the story goes, the next best thing that the farmers did was to load the water melons on trucks and dumped them in front of the office of the Ministry of Agriculture early one morning to "teach the Ministry officials some lesson".

The implication of the story is manifold: 1) To whichever organization the agronomist or extension official belongs, the official himself or the organization fell short of undertaking a market intelligence study of the water melon before recommending its planting; 2) The farmers do not belong to producers' association, or if they did, the association or cooperative was inactive. The existence of an effective association or cooperative among the farmers, albeit a strong extension programme, could have prevented the "disaster"; and 3) Properly motivated, farmers, through a collective effort can become a potential pressure group.

Nowhere in the areas of visit nor in any of the discussions did the participants note the existence of a joint effort of water users, nay, a cooperative, in maintaining field canals for effective water use. On-farm or interfield management of irrigation facilities is the antithesis of extensive development discussed earlier. This means that the intensive water control or intensive irrigation concept is a function of a stable human organization. Where the latter exists, and exists effectively, water use is likely to be efficient and vice-versa. One participant observed that irrigation operation and farm-level management methods should be simultaneously considered during the engineering, planning and design works to ensure that the on-farm facilities will be maintained and utilized to the fullest extent. But as revealed by one of the consultants during a briefing session in Kanchanaburi, the MOAC has plans to undertake the promotion of water users' associations in the completed land consolidation projects, or, as local officials tended to refer to, there are farmer's cooperatives or associations in most villages but rather refrained from associating

the activities of those organizations to the maintenance of on-farm irrigation facilities.

At one completed irrigation project in Chainat, the consultants pointed out the need for farmers to join hands with the ditchtenders in providing an efficient intake of water into the farmers' fields or plots by maintaining their interfield canals. The consultants also confided that none of the farmers in the area were willing to serve as ditchtenders to augment the staff of the water master because of rather low compensation.

Invariably, the participants expressed apprehension that unless a stable human organization could be established a) among the water users; b) reinforced promotional/educational campaign on proper water use by the RID; or c) an effective agricultural extension service could be instituted, the hardware aspects of the irrigation development efforts might suffer from misuse or disuse in no time at all.

Some Lessons of a Common Experience

The desirability of combining a more or less homogeneous (from the standpoint of experience and educational background) group of participants in a study mission such as the present one lies in the fact that by examining/studying/observing together an existing irrigation system, they are able to exchange experiences and notes freely on the subject at hand. And so, when their dialogue is analyzed in the light of the project being observed, some lessons of a common experience invariably emerge. Such lessons could have been a derivative of their observations (in Thailand, in this case) or the what-should-have-beens instead of the what-is. Still, other lessons might take the form of a conceptualization of the ideal - a hybrid of what the participants do and know with those of what they are told and see at first-hand. In any case, it is useful to briefly catalogue these lessons, both for posterity and for others to appreciate, learn from and share.

Harnessing Water Resources

Great rivers such as the Chao Phya offer potentials and alternatives for accelerating agro-industrial development as is being done in Thailand. Involvement is the keyword in the strategy to harness the water resources, particularly for irrigation purposes. By this is meant that not only the national commitment and political will of the government to launch and undertake the project is necessary but also the involvement

and active participation of the farmer-recipient must be mobilized in the operation and maintenance of the on-farm facilities soon after their completion.

In addition, the Chao Phya and Me Klong projects have clearly shown the need for storing adequate quantities of water during the monsoon seasons even as these projects are primarily intended to augment rain water for wet paddy cultivation. The stored water, when properly channelled and equitably distributed should go a long way in increasing the cropping intensity in the recipient areas during the dry season - be it for paddy or other dry-season crops. In that way, the irrigation structures are put into maximum use in generating farming and other economic activities.

When the impounded water is simultaneously tapped as a hydroelectric plant by a government agency not otherwise a part of the agriculture ministry of irrigation authority, involvement becomes important again for that agency to liaise formally and closely with the irrigation authority in matters of making available excess or allocated water for irrigation purposes.

Incidentally, the use of underground water is not popular in Thailand largely because of salinity in the vicinity of the Gulf and partly because lifting water for irrigation is costlier than tapping runoff or surface water. However, the RID intends to pursue feasibility studies on tubewell construction in areas far from the Gulf and where surface water is insufficient.

Consolidating the Peasant Farms

Land consolidation is, without doubt, a very desirable scheme in optimizing land and water use, in providing better mobility for the rural dwellers, in introducing modern agriculture through the use of farm machinery and, otherwise, in constructing permanent improvements on the land. In so doing, however, land consolidation inevitably causes dislocation on the part of the peasants in terms of their social and economic lives even on a temporary basis. Their right to live on and use their land - their most cherished heritage - is altered. They wind up losing some portions of their land and/or being assigned to an entirely different farm after consolidation.

When this is the case, the implementation of landconsolidation must of necessity consider providing the peasants with just compensation. Their period of readjustment during and after

the land consolidation work is their most critical and difficult period. And unless they are properly compensated, supported and guided, the difficulties might persist for longer periods of time - at the expense of land consolidation itself.

Establishing Stable Human Organizations

Peasant farmers are, by nature, gregarious. Properly motivated, they can and are able to perceive the benefits that will accrue to them if they pooled their resources together for a common good. On this basis, it is imperative that efforts be made to establish some formal or informal association among them in order to help the water master and his staff in the proper use of irrigation facilities and the water itself.

But more than the need to establish human organizations to help operate and maintain the on-farm facilities after completion is the need to consider such organizations during the planning stage of the irrigation projects.

The human organization idea goes beyond the formation and functioning of an irrigators' association. For instance, it transcends to the need for liaising their work with various institutions in the rural areas such as the farm extension service, credit agencies and marketing organizations. Only then could the irrigators' associations perform a meaningful function among their members.

2. JAPAN

Introduction

The special features of Water Resources Development (WRD) in Japan in particular relation to on-farm water management as observed during the field visit to some projects are highlighted in this report. The background information and statistical data on various irrigation projects contained in the brochures provided by the host agencies proved very helpful in enabling the participants to appreciate the WRD objectives, programmes and accomplishments.

It is safe to assume that as the participants saw for themselves the various aspects of modern on-farm water management in the places of visit, basic questions such as enumerated below must have crossed their minds:

- a. How much or what level of the observed technology and modernity could be transferred to the setting in their countries?
- b. Can their governments afford the finances involved in the various projects?
- c. Are the farmers in their countries financially able to bear or, at least, share part of the project costs? and
- d. Can the types of cooperative water management observed in Japan succeed in their countries?

The above questions must be typical of those that the participants had as they were making a mental comparison between the prevailing conditions in their countries and those that they were seeing for the first time in Japan.

Special Features of Water Resource Development

For purposes of agriculture, and especially the production of paddy which is Japan's staple, the efforts at developing water resources based on the participants' observations may be identified as i) water conservation and distribution; ii) on-farm development; iii) reclamation and drainage; iv) flood and salinity control; v) financing of capital costs and operation and maintenance of irrigation projects; and vi) water management by cooperative efforts.

Water Conservation and Distribution

Japan has since devoted a major effort in the construction of storage dams or farm ponds most of which are multi-purpose in nature. River runoff from the country's numerous rivers is stored in dams along the river systems. This stored water assures farmers of adequate irrigation supply in the dry season or during lean river discharges. The dams are invariably complemented by diversion structures such as barrages and diversion channels to and from them. The irrigation distribution systems consisting of the driving tunnel or channel, main canal and secondary and tertiary channels are likewise provided. The canal system traverses undulating terrain through tunnels and sharp curves. All channels are fully lined. The discharge in the channels is relatively high. Of special importance are the elaborate systems installed for the maintenance of upstream and downstream water levels in the channels and the high degree of automation utilized in both the Toyogawa and Kagawa canal systems visited. The entire channel systems are operated by remote control from the computerized control stations. The shortage and high cost of manpower plus the advent of technology helped bring about such automation.

The Kagawa irrigation project that involves an inter-basin transfer of irrigation water demonstrates, hence teaches a lesson on inter-provincial government cooperation in the sharing and use of a common water resource which, in this case, is the Yoshino river. The project is also a study in efficient administration, organization and cooperation among all parties concerned: from the construction phase to the utilization of the irrigation facilities. Likewise, the system of financing in which the national and provincial governments and the farmers contribute to meet the cost of the facilities was a special feature.

On-Farm Development

One is impressed that land consolidation in Japan has been adopted for a long time now but the field layouts did not seem adequate to provide for drainage ditches and farm access roads. The more recent Dainaka, Shiranego and Nishikambara land consolidation projects visited by the participants demonstrate the use of rectangular patterns of field layouts with irrigation and drainage ditches running parallel between the alternate set of fields. The plot dimension is usually 100 m or 110 m x 35 m or 40 m, the cross gradient being 1 in 300 or more. The provision of

on-farm facilities enables the system to attain better water control and high irrigation efficiency. All ditches are lined, including the drainage ditches that allow for influent seepage. Farm roads are laid along either the irrigation or drainage ditch that provide easy access to individual plots.

A blind drainage network is also located in many parts of the entire project using perforated pipes of 5 cm diameter buried about 80 cm deep and spaced 5 m to 10 m apart. This network leads to the drainage ditches.

A highly efficient innovation (and probably also expensive) that participants took note of in the project is the use of surface pipes instead of open ditches in conveying water to the individual fields through a control valve from the water source. The system does not only eliminate water loss in the delivery process but also increases the cultivated land area in terms of utilizing that portion which would otherwise be occupied by the conventional, open irrigation ditches.

In view of the easy access of the fields and the availability of irrigation water, including efficient drainage, the production of fruits and vegetables in green houses is popular in the area. Although this highly intensive method of growing fruits and vegetables evidently involves heavy investments on the part of the farmers, it is assumed that the equally high returns (estimated at many times more than the net income from paddy production) attract the farmers to go into green house farming.

Land Reclamation

The reclaimed land areas visited in the Dainakanoko polder off Lake Biwa and the low-lying flood plains of the Shinano River in Shiranego and Nishikambara are very important lessons in land reclamation, particularly for countries like Japan with very limited arable areas. In the places visited, shallow swampy lands that were previously laid to waste have been converted into productive fields through the usual method of constructing dikes and pumping out water from the swamps. The project is equipped with an elaborate drainage system and computerized water control devices that ensure the availability of the right quantity of water desired. To be sure, the polders have been developed along modern methods of agricultural development, including the provision of resettlement programmes. Proof of the success of the development efforts in these areas is the presence of progressive farmers who are determined to adopt new

technologies in farming.

Flood and Salinity Control

An equally valuable effort of both local and national governments to increase land availability and capability, hence agricultural production, are the control measures for flood and salinity visited by the participants in Niigata Prefecture. Floodways channel overspilled waters from the Shinano River directly to the sea through a special system of controlling the water level at the river. In this way, vulnerable areas are saved from destructive floods by diverting excess water before it is able to cause damage. Control structures in the form of barrages and pump stations are constructed near the mouth of the estuaries that prevent the intrusion of salt water. Notable among the features of these flood and salinity control scheme is the sophisticated computerization of its operation.

Financing of the Project

Financing the capital costs of these facilities is a joint undertaking of the national and prefectural governments and the project beneficiaries (farmers). The national and prefectural governments bear the initial investment costs of 75 to 80 percent of the total. The balance, 20 to 25 percent, is borne by the farmers who amortize it over a 15- to 20-year period at 3 - 7 percent interest rate.

An outstanding feature of the financial arrangement is the fact that the farmer-beneficiaries bear the entire cost of operation and maintenance of the system.

Water Management by Cooperative Efforts

Perhaps the most remarkable aspect observed during the field visits is the fact that water management is a joint effort of the land improvement district, the irrigation associations and the farmers' cooperatives. This joint effort might be ascribed to the disciplined nature of the Japanese, in large measure, and partly to the fact that both the government and the farmers are able to provide the financial inputs. When once the farmers have a financial stake in the project, they develop a deep sense of involvement for it. Farmers in neighbouring countries do not seem to have as great a financial stake in the irrigation undertaking, hence are less prone to developing the interest and involvement in the management of farm water as this is provided (in most cases) by the government at no cost on the part of the farmer-

recipients.

Conclusion

High-level technology best describes agriculture in Japan considering that farm operations are almost completely mechanized; computer devices control irrigation water supply, including drainage and control of flood and water salinity; and efficient cooperatives composed of progressive farmer members.

The level of technology that the participants may transfer from the observations made and lessons learned in Japan will vary by country that they represented. This is because in Japan farmers represent only about 10 percent of the population compared with about 70 percent in other countries of Asia. Add to this the fact that land and water availability in Japan are very different from other countries. To be sure, the lessons learned from farmers' cooperation in the management of on-farm water which cost very little and does not involve high technology can be transferred with relative ease by the participants in their countries.

3. THE REPUBLIC OF CHINA*

Introduction

The China Productivity Center, in collaboration with the Council for Agricultural Planning and Development, implemented the field visits to the Tsengwen Reservoir, Chianan Irrigation Association, Yunlin Irrigation Association, Touliu and Linnei Canal Intakes, Taoyuan Irrigation Association and Taoyuan Canal Intakes and the Shimen Dam.

The notes that follow reflect the general impressions of the six participants and have been derived from:

1. Briefing by officials of the China Productivity Center, Council for Agricultural Planning and Development and the various officers of the irrigation associations;
2. Brochures and reports distributed during the field visits; and
3. Actual observations in the areas of visits and along the way.

Irrigation Associations

Much of the impact that the irrigation systems in the Rep. of China have on the increased agricultural productivity may be attributed to the existence of active irrigation associations that methodically operate the on-farm facilities. These associations represent a militant rural institution in the countryside that lends meaning to the infrastructure development on irrigation facilities of both the national and local governments. They are the power structures that assure maximum use of irrigation water through meticulous scheduling, upkeep of the on-farm water facilities and continued support from the government.

* The Republic of China portion of the present study mission was optional on the part of the participants. Half of the original number of 12 participants who joined Phses I and II were able to proceed to Taipei and spent a week making the observations.

Three of the country's 17 irrigation associations were visited by the participants. These are the Chianan Irrigation Association, Yunlin Irrigation Association and the Taoyuan Irrigation Association. Invariably, the associations are guided by clarified goals, enjoy close support from the government, operate on a cooperative spirit and are staffed with qualified personnel.

More specifically, an irrigation association is a self-governing cooperative body that is organized by farmers to administer irrigation facilities, construct irrigation systems and promote agricultural production. Each association is composed of a policy-making body and an executive body. The former is composed of 15 - 55 persons depending on the size of the command area. These persons comprise the members' representative assembly. On the other hand, the executive body operates from a head office through several regional management offices and field offices or working stations. Among the farmer-members themselves, a water group is organized within each irrigation service unit of about 150 ha and function under the working station in that district. Furthermore, a water group may consist of several sub-water groups or small working teams. Essentially, the water group serves as the channel of communication between the farmers and the irrigation association. It is the over-riding function of the irrigation association to charge the beneficiary members with the responsibility of operation and maintenance of the irrigation system, including the prompt and full payment of water fees.

In an effort to put into proper perspective, hence appreciate fully how the irrigation associations perform their functions, two major aspects will be reported in this section: i) finance; and ii) operation and maintenance.

Finance

Unlike the observations made in Thailand (Phase I of the Study Mission) where farmers do not pay irrigation fees for the use of irrigation water, those in the Rep. of China pay ordinary and special membership fees in order to finance the operation and maintenance costs of the irrigation system. This fee payment practice is governed by the country's Water Law wherein the equivalent amount of membership fee collected is limited to an equivalent minimum of 20 kg paddy and a maximum of 300 kg paddy depending on the circumstances and needs of the association.

Ordinary membership fees are used to finance operation and maintenance costs, including amortization and the usual flood damages. They are collected twice a year at varying rates depending on the location and general conditions at a given year. Engineering costs in major improvements or construction cannot usually be covered by membership fees. As such, this is financed partly by a loan and partly by a grant from the central government, the latter ranging from 30 percent to 85 percent of the total cost. The present trend has been to increase the grant and reduce the loan. The term of payment of loans varies from 5 to 15 years at equally varying rates of interest from 5.5 percent to 12 percent.

Fees are usually collected twice a year right after each crop harvest. A one-month grace period is allowed for payment without penalty. But a penalty rate of 1 percent of the value of the fee is charged per three days for the first month of delay in payment and 10 percent is the maximum penalty. The association may sue the member for payments delayed one month after the due date although this is seldom resorted to as almost every farmer pays the fees promptly.

The responsibility for collecting membership fees rests with the leader of the water group or sub-water group who resides in the community. As such, he is usually regarded as a community leader and, therefore, enjoys the respect of his constituency.

Operation and Maintenance

Water delivery system - The association uses a series of forms for recording and reporting the daily irrigation activities. The association delivers water from the source through different levels of canals and conveyance facilities to each field. The successful operation of an irrigation system in the country depends not only on proper management of the conveyance system that brings the irrigation water to the headgate of the distribution system but also on proper management of the irrigation water distribution system.

Irrigation planning and implementation - Typical of the water delivery system adopted by the irrigation associations is what they call "rigid scheduling system" which is suitable for areas with small holdings. Its success hinges largely on the efficiency of the water controllers and their effective interaction among the farmers that they serve.

As a rule, irrigation planning by the associations consists of four basic steps, namely; over-all target plan; on-farm irrigation planning; regional irrigation planning; and final overall irrigation planning. After the association chairman signs/approves the plan, it is presented in a regular meeting of the representatives' assembly and the Provincial Water Conservation Bureau representatives for their consent. Once ratified, the plan is ready for implementation based on the following actions: announcement of the irrigation plan; meeting of water group, preparation in the field; release of required irrigation water; observation and recording; and review of implementation phases.

Maintenance - The maintenance of irrigation on-farm facilities represents the most important routine work of the association. On it depends the effective use of water and cooperation of the farmers. Maintenance work is generally categorized into: routine maintenance, annual repairs and rehabilitation of damages.

Routine maintenance work is usually carried out during the irrigation period in order to keep all facilities working properly. The condition of all the facilities are recorded methodically and necessary adjustments are done on the spot.

Annual repairs, on the other hand, are done soon after the period of irrigation based on the compiled daily reports and inspection by the working station. Major repairs are generally accomplished through open bidding to contractors. Otherwise, minor repairs (usually in ditches) are performed by the water groups.

Rehabilitation of damages caused by force majeure, e.g., floods, unusually heavy rains and damages by water buffaloes and rats are done without delay. When the work is estimated to last more than 10 days, temporary conveyance by-passes are immediately constructed in order to avert interruptions in water delivery or drainage.

Rotational Irrigation Method

The evolution of effective and active irrigation associations in the Rep. of China may be considered to have been influenced by the development of an equally effective method of rotational irrigation which is popular in the country. The associations, however, are not bound by any specific practice of distributing water to the farm plots. Rather, even the rotational

method may be altered at various distribution points of the irrigation system depending upon the available water supply and cropping patterns, among other considerations.

The total discharge of water sources is only 70 percent or less of the irrigation requirements of most of the irrigation systems in the country. It is essentially for this reason that the general design, construction and improvement of the irrigation system is oriented towards the rotational method of water distribution. But regardless the condition of the water supply and modification of the irrigation method employed, efficiency and economy of water use is stressed by the irrigation associations and farmers themselves.

The rotational irrigation method comes in three alternative forms: i) rotation by sections along the main canal; ii) rotation by sections along the lateral or sub-canal; and iii) rotation by farm ditches. In any of these alternative forms, the capacities for both conveyance and distribution networks must be necessarily larger than those normally used for the continuous type of irrigation.

The average command area of a rotational irrigation unit in the country is about 50 ha. Each unit is served by one turnout gate except in areas where land elevations undulate and where two or more turnout gates are provided. The rotational units are further divided into rotational sub-units. In order to measure and regulate the water flow, water measuring devices and steel gates are provided at the diversion points of the main canal, lateral canal and sub-lateral canals. In periods of acute water shortage, most of the rotational sub-units may be enlarged into rotation districts where water is distributed according to some pre-determined priority scheduling either by farm plot or simultaneous distribution.

In times of severe drought during an irrigation period, the irrigation associations switch to two basic procedures in scheduling water delivery, namely; i) rotate water delivery at uniform intervals and reduced water depth at each delivery; and ii) maintain a minimum water depth at the plots and extend rotation intervals of delivering water.

Central to the success of the rotational system of water distribution in the Rep. of China is the discipline imposed by the irrigation association technical staff upon themselves who controls water delivery at main and lateral canals all the way from the turnout gates to the farm ditches and individual farm plots.

PART II. COUNTRY REPORTS ON FARM WATER MANAGEMENT

1. REPUBLIC OF CHINA

Chun-tse Cheng*

Introduction

The Republic of China's total land area is 35,962 sq. km. The climate is subtropical with high temperatures and heavy rain falls. The annual rainfall averages about 2,500 mm with a maximum of 8,408 mm and a minimum of 413 mm. Typhoons, which occur from June through September, bring strong winds and storms, and sometimes cause serious damage.

Rivers in the country are short and steep. They originate from the Central Mountain Range which divides the island into two main parts: east and west. On the east coast, the lands are rolling and soils are gravelly and subject to flooding. The region is sparsely populated and the areas suitable for farming are limited to low elevations. On the west coast, there are more agricultural lands with more economic activities and developed industries.

Rainfall and available water from the sources are not distributed quite in accordance with the growing seasons of crops and the areas of agricultural land. The period from November to the following April is dry when more water is needed by the crops. Irrigation is required and this depends on available amount of water and facilities. Drainage facilities are also needed for reducing flood damage and improving the soils. On the other hand, the warm climate of the country provides a comparatively long growing season in which two or more crops can be planted in a year in areas where water is available and other conditions suitable.

Of the total land area, 25 percent or 890,000 ha is cultivated, including approximately 60 percent as paddy fields and 40 percent as upland farms. Rice is the principal irrigated crop. Irrigation and farm drainage facilities are operated

* Senior Engineer, Council for Agricultural Planning and Development. This report only expresses the personal views of the writer and does not reflect those of the Government of the Rep. of China.

and managed by irrigation associations which are organized by farmers under the supervision of the government.

The irrigated area is about 500,000 ha of which 440,000 ha are under the jurisdiction of irrigation associations and served by irrigation systems, including main and lateral canals totalling 52,560 km in length, 1,543 shallow and deep wells, and 18 reservoirs. In 1975, irrigation accounted for about 87 percent of the total water use or 12.7 billion cu.m, of which 74 percent came from rivers, 9 percent from wells, and 17 percent from drainage channels and other sources.

Irrigation Development and Improvement

Engineering Aspects

Irrigation in the country has been essentially developed for rice cultivation. The work on irrigation rehabilitation started in 1945 and some 260,000 ha of lands which had been out of irrigation service recovered production gradually by 1950.

Also, the irrigation projects left unfinished by the Japanese before World War II were completed. In addition, many single-purpose irrigation projects including reservoirs and canal diversions were implemented and drainage improvement was also planned.

The rapid population growth in the Rep. of China after the war necessitated new irrigation development efforts to increase food production. These efforts covered large-scale irrigation extension, construction of multi-purpose reservoirs, groundwater exploitation, and irrigation of reclaimed tidal and river lands. For economical and efficient use of the available water supply, rotational irrigation and canal lining projects were also carried out. The major accomplishments in this period included: i) lining of 1,024 km of canals; ii) extension of rotational irrigation to more than 120,000 ha; iii) drilling of 726 deep wells; iv) reclamation of some 4,000 ha of tidal lands; and v) construction of several reservoirs.

A land consolidation programme was started in 1959 to facilitate and increase the efficiency of farming by improving the shape and size of farm plots and the layout of farm roads, and irrigation and drainage systems. The irrigation systems have been designed according to the requirements of rotational irrigation. Some 275,000 ha of agricultural lands have been consolidated. The achievements of land consolidation work from 1961 to 1979 are shown in Table 1.

Table 1. Engineering Cost of Land Consolidation, 1961-1979

Year of Completion	Engineering Cost (NT\$)	Consolidated Area (ha)	Cost per Hectare* (NT\$/ha)
1961	14,484,325	3,056	4,739
1962	14,314,225	4,126	3,469
1963	19,971,215	4,864	4,106
1964	44,292,445	6,989	6,337
1965	48,407,863	9,921	4,879
1966	89,460,394	13,147	6,805
1967	90,534,799	14,634	6,187
1968	236,184,349	36,177	6,529
1969	458,157,199	37,523	12,210
1970	306,905,767	29,010	10,579
1971	282,311,813	24,650	11,453
1972*	-	-	-
1973*	-	584	-
1974*	-	1,881	-
1975*	-	496	-
1976*	-	140	-
1977	137,758,098	4,003	34,414
1978	151,949,100	4,289	35,428
1979	155,830,000	4,165	37,414

* From 1972 to 1976, the land consolidation programme was temporarily terminated except in areas where cooperation with the irrigation engineering projects was necessary. The engineering costs were totally provided under the irrigation projects and the land consolidation work was carried out with the irrigation work. Therefore, the cost of land consolidation was difficult to separate from basic engineering costs. US\$1 = NT\$36

Table 2. ARDP* Investments in Irrigation Improvement, 1974-1978

Fiscal Year	Benefitted Irrigated Area (ha)	Increase in Irrigation Area (ha)	ARDP Subsidy (NT\$1,000)	Sponsors and Local Contribution (NT\$1,000)
1974	33,600	-	26,200	13,100
1975	12,560	151	121,000	25,500
1976	36,400	2,000	302,000	41,600
1977	62,760	2,000	334,000	47,520
1978	47,520	2,036	295,000	44,308
Total	192,840	6,187	1,078,200	172,028

* Accelerated Rural Development Programme

Since 1973, under the Accelerated Rural Development Programme (ARDP), attention has been paid to the improvement, strengthening and repair of existing irrigation and drainage facilities to prolong their service life. This measure is as important as the construction of new facilities as the latter is not only costly but takes a long time to yield benefits. The investments in irrigation improvement under the ARDP are shown in Table 2.

As rice is the predominant crop, it usually determines the most common cropping patterns whenever irrigation water is available. The current cropping patterns may be classified into seven groups as shown in Figure 1. Of the total service area of 436,593 ha in the 16 irrigation associations, the double rice-crop area occupies 277,957 ha; the single rice-crop area, 38,717 ha; the rotation cropping area (including two- and three-year rotations), 102,915 ha; and the upland crop area, 14,734 ha. Besides, there are many scattered areas beyond the jurisdiction of irrigation associations totalling about 51,655 ha of which the double rice-crop fields occupy 26,051 ha, the single rice-crop fields, 15,679 ha, and the remainder for upland-crop farms.

Since 1945, both rice crop area and production have increased. In 1945, the rice harvested area was 502,018 ha with an annual brown rice production of 639,000 mt. Even as some of the farm lands in the country have been converted into non-agricultural uses owing mainly to industrialization and urbanization, the paddy fields have increased to 786,343 ha with a maximum production of 2,712,985 mt

in 1976. The planted areas and rice production from 1938 through 1977 are shown in Table 3. Needless to say, such progress can be attributed mostly to technological advancement, including the improvement of irrigation, drainage and flood control and farming.

Financing of Development

Irrigation development is financed by the Government and the Council for Agricultural Planning and Development (CAPD)* for grants and the CAPD and the Joint Irrigation Loan Fund for loans. Loan repayment is determined by the amount of loan, repayment period and the expected benefit from the project.

Prior to 1960, new irrigation projects in the east coast received 70 percent and the west coast, 50 percent of the financing in grants. For the improvement projects such as rotational irrigation, supplementary ground water irrigation and canal lining, the percentages of grants were lower and depended on the available annual budget.

The then JCRR contributions in the early post-war years came from the U.S. Aid Program which was phased out in 1965. Since then, the JCRR has been operating with funds appropriated annually from the Sino-American Fund for Economic and Social Development (SAFED) until the advent of the CAPD. The influence of SAFED has declined as funding from the Government budget has relatively increased. A uniform interest rate of 6 percent per annum was charged against the loans extended by the JCRR for all irrigation projects prior to 1961 after which year the interest rate was raised to 12 percent. As a result, the progress of irrigation development was greatly retarded, even though the interest rate was later reduced. Three rates prevailed after 1965: 6 percent for new water resource development; 8.28 percent for irrigation improvement and ground water development; and 10.08 percent for projects which for three years had carried an interest rate of 8.28 percent. In 1971, in view of the depression of the rural economy, all interest rates on outstanding loans were reduced to 6 percent.

* Until 1979 it was called the Joint Commission on Rural Reconstruction (JCRR).

Figure 1. Various Cropping Patterns

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
(1)	Double rice cropping system											
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx					xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx						
	Sweet potatoes	First rice crop				Melons	Second rice crop				Sweet Potato	
	Wheat					Vegetables					Wheat Tobacco	
	Tobacco					Beans					Rape-seed	
	Rape-seed					Green manure					Vegetables	Beans
(2)	Single rice cropping system											
	Upland crops (Sweet potatoes, peanuts, Vegetables, Jute, Corn, Sorghum, Beans etc.)								Rice crop		Winter crops (as above)	
(3)	One rice crop in two year cropping rotation											
	(1st year)					xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx					xxxxxxxxxxxxxxxx	
	Sugarcane	Upland crop & Green manure			Rice crop			Sugarcane				
	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx (2nd year)											
	Sugarcane											
(4)	One rice crop in three year cropping rotation											
	(1st year)					xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx						
	Sugarcane	Green manure			Rice crop			Upland crop				
	(2nd year) xxxxxxxx											
	Sweet potatoes & others			Upland crops & Green manure					Sugarcane			
	(3rd) xxxxxxxx xxxxxxxx											
	Sugarcane											
(5)	Two rice crops in three year cropping rotation											
	(1st year) xxxxxxx		xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx							xxxxxxxxxxxxxxxx		
	Upland crops & Green manure			Rice crop			Upland crops					
	(2nd year) xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx											
	Upland crops & Green manure			Rice crop			Sugarcane					
	(3rd) xxxxxxxx xxxxxxxx											
	Sugarcane											
(6)	The year-round growing system for perenial crops											
	Irrigation - depends on irrigation facilities and water											
	Citrus, Banana, Pineapple, Sugarcane, Tea, Cassava, etc.											
(7)	Upland crop rotation system											
	Irrigation - depends on irrigation facilities and water											
	Sweet potatoes	Peanuts, Beans, Jute, Corn					Sweet potatoes					
	Vegetables	Beans, Jute, Peanuts					Peanuts, Corn Upland rice					

Legend: xxx indicates irrigation period.
Sources: Djang and Wen, 1978

**Table 3. Distribution of Area and Production of Japonica
and Indica Rice Varieties, 1938-1977**

Year	Total*		Japonica					Indica					Remarks
	Area (000ha)	Pro- duction (000mt)	Area		Production		Yield per ha (mt)	Area		Production		Yield per ha (mt)	
			(000ha)	% of Total	(000mt)	% of Total		(000ha)	% of Total	(000mt)	% of Total		
1938	625.4	1,388	301.4	48.2	755	54.4	2.5	247.5	39.6	502	36.2	2.1	Peak before World War II
1952	785.7	1,570	400.0	50.9	874	55.7	2.2	313.2	39.9	605	38.5	1.9	
1953	778.4	1,642	396.0	50.9	892	54.4	2.3	317.9	40.8	662	40.3	2.1	1st stage Economic Plan
1957	783.3	1,839	459.1	58.6	1,144	62.2	2.5	276.9	35.4	630	34.3	2.3	2nd stage Economic Plan
1961	782.5	2,016	489.4	62.2	1,304	64.7	2.7	259.5	33.2	648	32.1	2.5	3rd stage Economic Plan
1965	772.9	2,348	526.6	68.1	1,633	69.6	3.2	218.0	28.2	656	27.9	3.0	4th stage Economic Plan
1969	786.6	2,322	581.3	73.9	1,744	75.1	3.0	176.8	22.5	515	22.2	2.9	5th stage Economic Plan
1973	724.2	2,255	569.7	78.7	1,791	79.4	3.1	130.7	18.1	403	17.9	3.1	6th stage Economic Plan
1974	777.9	2,452	638.0	82.0	2,027	82.7	3.2	117.6	15.1	369	16.4	3.1	
1975	790.2	2,494	653.6	82.7	2,075	83.2	3.2	113.3	14.3	358	14.4	3.2	
1976	786.3	2,713	665.1	84.6	2,318	85.4	3.5	100.1	12.7	336	12.4	3.4	
1977	777.6	2,649	667.1	85.8	2,287	86.3	3.4	91.2	11.7	307	11.6	3.4	

* Includes area and production of glutinous rice and dryland rice. All production data refer to brown rice equivalent.

Source: Provincial Department of Agriculture and Forestry, 1978

Table 4. Comparative Investments in Agriculture, Irrigation and Gross Domestic Capital Formation, 1961-1977

Year	Gross Domestic Capital Formation (NT\$ million)	Agriculture		Irrigation inclu- ding Drainage	
		NT\$ million	Percent	NT\$ million	Percent
1961	13,931	2,212	19.5	484.0	3.5
1962	14,623	2,128	18.3	790.8	5.4
1963	15,391	2,290	17.2	704.4	4.6
1964	19,642	2,606	17.5	676.3	3.4
1965	26,096	3,306	17.3	605.1	2.3
1966	29,155	3,567	14.9	492.5	1.7
1967	37,014	3,848	12.7	510.9	1.4
1968	45,236	4,532	12.0	795.7	1.8
1969	49,229	4,236	9.7	1,034.1	2.1
1970	58,886	4,108	8.3	1,448.4	2.5
1971	57,565	5,008	8.4	880.2	1.5
1972	72,815	6,737	9.0	1,142.0	1.6
1973	106,552	10,724	10.6	1,260.2	1.2
1974	200,812	12,882	6.4	1,429.3	0.7
1975	185,127	9,153	4.9	360.8	0.2
1976	180,243	10,891	6.0	795.1	0.4
1977	187,596	13,012	6.9	954.8	0.5

Source: Directorate-General of Budget, Accounting and Statistics, Executive Yuan, 1978, Chinese Civil and Hydraulic Engineering, 1975, and Statistics of Construction in Taiwan Province by the Department of Reconstruction, Taiwan Provincial Government, 1978.

The Joint Irrigation Loan Fund was established in 1960 by the irrigation associations to take care of their increased collection of membership fees which were readjusted in that year. The fund was deposited with the Land Bank in order to generate interest. Since 1974, no more loans from JCRR have been extended for irrigation projects, and this fund has become a major source of low-interest loans at 6 percent per annum.

The loan repayment period of the above-mentioned funds varied from seven years to 30 years, depending on the kind and scale of the projects.

Under the ARDP, projects for the improvement and repair of irrigation and drainage facilities have been financed with government subsidies up to 80-95 percent of the total cost. The balance was met by matching funds provided by the associations either with loans from the Joint Irrigation Loan Fund or with allocations from their own annual budgets.

In 1976, the Government also made a special appropriation of NT\$300 million to the irrigation associations to help them pay their outstanding debts which had been a heavy burden to them in the past.

Drainage Improvement

General Description

Surface drainage is poor in the coastal plains of west and north-east areas of the country. Table 5 shows the extent of frequent damage due to poor drainage.

Poor drainage may be caused by any of the following conditions or by their combination: intense rain; topography that favours concentration of surface runoff; inadequate drainage systems; too low drainage capacity which may be due to poor maintenance, sedimentation, or weeds; check gates on drainage channels which cannot be operated in time of flood; and outlet obstructions by high tide or flood, or silting of estuary.

The natural rivers are indispensable for regional drainage. In the Chianan area, artificial drainage systems were built with the irrigation systems in the 1930's. Very few artificial drainage channels were added in other areas. Small drainage ditches extend to farms serving as agricultural drainage which is maintained by the farmers. When the natural stream and main drains in an area are inadequate, crops suffer from inundation,

and villages and townships are sometimes affected.

ARDP Drainage Improvement

Prior to the start of the ARDP in FY 1973, there was little or no emphasis paid to regional drainage improvement each as few drains in Chianan, Kaohsiung, Changhua and Yunlin areas were partially improved. The recent regional drainage improvement has been carried out under the ARDP in Chianan, Yunlin, Changhua and Ilan areas where the damage was more serious and the plans of the major drainage systems are available. These improvements are shown in Table 6.

The main efforts of regional drainage improvement have been to increase the capacities and depths of the drainage channel and to improve the check gates that were built on drainage channels to divert the flow for downstream irrigation. For bank protection, hence reduction of costs in maintaining the systems in good conditions, protective grasses were planted on drainage channels. Automatic electronic control devices were also installed on the gates. Work on drainage improvement proceeds from the main (primary) channels and to large laterals and small laterals. At the present time improvement of the main drains and large laterals is more important for regional drainage. The small drains may have to be built together with the land consolidation programme.

The criterion for optimum drainage capacity of the channels is determined by the required discharge of the overland flow of either the maximum three-day rainfall with a recurrence period of 25 years in a period of three days at uniform flow, or the maximum one-day rainfall with a recurrence of five years in one day at uniform flow. This capacity is approximately equal to the peak discharge caused by the maximum rainfall with a recurrence period of two years. This was selected after detailed analysis to maximize the net benefit that would accrue when the crop damage is decreased through improvement. Recently, rural people requested for more and better drainage systems as a consequence of the expansion of the rural centers and the rising cost of living and the change in land use.

Intense rainfalls are usually brought by typhoons. From the field data, it is often difficult to separate the inundation damage to crops from wind damage. More dependable quantitative information concerning the inundation damage to crops under different conditions of inundation areas, depths and durations are highly desirable for better planning. An experiment on rice

Table 5. Status of Drainage, by Area*

Area (1)	Catchment of major drainage (ha) (2)	Area irri- gated by IAs (ha) (3)	Inundation Duration				Total		Inundation Area/ Irrigated Area(%)		Inundation Area/ Catchment Area(%)		Existing drains (km)	
			Shorter than 1 day (4)	1-2 days (5)	2-3 days (6)	Longer than 3 days (7)	(5)+(6) +(7) (8)	(4)+(8) (9)	(8)/(3) (10)	(9)/(3) (11)	(8)/(2) (12)	(9)/(2) (13)	Main & secondary (14)	Laterals (15)
Ilan	41,941	20,282	926	738	621	2,763	4,122	5,048	20.3	24.9	9.8	12.0	176	77
Taipei and Taoyuan	130,863	57,168	340	0	0	0	0	340	0	0.6	0	0.3	877	76
Hsinchu and Miaoli	61,863	23,208	1,771	566	124	425	1,115	2,886	4.8	12.4	1.8	4.7	629	29
Taichung	86,669	38,462	3,412	2,193	1,614	765	4,576	7,988	11.9	20.8	5.3	9.2	661	34
Nantou	78,616	14,115	0	0	0	0	0	0	0	0	0	0	349	13
Changhua	111,030	50,286	7,305	5,478	4,024	1,457	10,959	18,264	21.8	36.3	9.9	16.4	788	337
Yunlin	115,479	66,956	12,727	5,611	3,417	2,411	11,439	24,166	17.1	36.1	9.9	20.9	947	391
Chianan	131,063	84,415	7,837	8,303	4,587	4,950	17,840	25,677	21.1	30.4	13.6	19.6	1,041	513
Kaoshiung	81,433	21,551	1,540	460	630	0	1,090	2,630	5.1	12.2	1.3	3.2	487	72
Pingtung	101,567	35,005	3,000**	270	398	854	1,522	4,522	4.3	12.9	1.5	4.5	1,027	278
Total	940,524	411,448	38,858	23,619	15,415	13,629	52,663	91,521	12.8	22.2	5.6	9.7	6,979	1,820

* Areas under column (4), (5), (6) and (7) are from "General Investigation Report on the Present Status of the Taiwan Provincial Irrigation Associations", prepared by PWCB, June, 1976, under ARDP Project 76 (ARDP)-3.2-E-77(15).

** Preliminary estimate.

Table 6. Investment in Regional Drainage Improvement, 1973-1978

Fiscal Year	Expenditures (NT\$1,000)			Length of Main and Secondary Drainage Improved (m)
	ARDP	Sponsors and Local Contributions	Sub-total	
1973	36,157	890	37,047	146,073
1974	75,980	13,085	89,065	193,294
1975	17,288	2,355	19,643	30,245
1976	107,503	73,377	180,880	116,479
1977	158,560	34,640	193,200	113,700
1978	140,000	30,335	170,335	101,600
Total	535,488	154,682	690,170	701,361
<u>By Area</u>				
Ilan	79,384	8,765	88,149	23,257
Changhua	148,387	60,678	209,065	97,266
Yunlin	148,747	33,462	182,209	286,096
Chianan	158,970	51,777	210,747	294,742
Total	535,488	154,682	690,170	701,361

Remarks: According to estimates of the Taiwan Provincial Water Conservancy Bureau, about 19,800 ha of frequently inundated area were improved from FY 1973 to FY 1978.

and main upland crops under different inundation conditions was started in FY 1976.

Long-Range Improvement Programme

In order to meet the requirements of regional agricultural development, drainage improvement projects were incorporated in the "National Twelve-Item Construction Program" starting in FY 1979. A total length of about 2,800 km of main and secondary drains will be improved under the programme from FY 1979 to FY 1981. The total budget required for this improvement work is estimated at NT\$1,387 million and a total area of about 23,000

will be benefitted. It is also estimated that a total of NT\$3,400 million is required, after FY 1982, for improving about 1,000 km of main and secondary drains and about 45,000 ha of rice land.

Irrigation Association

General Description

Since 1945, the organization responsible for irrigation management has been the irrigation association, which is organized by farmers receiving irrigation benefits from the facilities controlled by the association.

The major functions of irrigation association are:

- 1) Construction, improvement, operation, management and maintenance of irrigation and drainage facilities;
- 2) Preparation of irrigation plans and regulation of water distribution;
- 3) Settlement of water disputes among farmers;
- 4) Collection of ordinary membership fees for financial operation;
- 5) Collection of engineering costs as loan repayment;
- 6) Studying ways of expanding irrigation and drainage benefits; and
- 7) Coordination with the government in carrying out policies on land and water resources development.

Usually the irrigation associations undertake the construction work of an irrigation project having a service area of less than 500 ha. All larger projects are handled by the government with the facilities constructed to be turned over to the irrigation association for operation and maintenance after completion.

However, the irrigation associations were reorganized in 1975. The two irrigation associations in Taipei have remained as they were before. They are small in terms of the size of irrigation area and still have members' representatives who elect their chairman.

In order to strengthen the 22 irrigation associations, finances and organizations in the country, hence enable them to carry out their functions more effectively, they were merged into only 14 associations in January, 1975. According to the size of their irrigation area, these 14 associations were divided into three classes: Class A, more than 50,000 ha; Class B, 50,000 - 20,000 ha; and Class C, less than 20,000 ha as shown in Figures 2 and 3.

The main considerations taken into account in the reorganization of the irrigation associations were as follows:

1) For efficient operation and management of water resources and irrigation systems, the service areas of the existing 22 irrigation associations were merged into 14 according to water regions.

2) Election of members' representatives and chairmen were abolished and a chairman each for the 14 associations were appointed by the Government.

3) A Provincial Supervisory Committee was established as a temporary setup for decision-making and for supervising the operations of the irrigation associations.

4) The number of staff was set on the basis of one person per 150 ha. About 1,200 persons in the 14 associations either had to be declared surplus or had to apply for retirement.

5) The Government provided a special appropriation of NT\$300 million for reducing the outstanding debts of the associations.

6) The Government also decided to appropriate NT\$200 million annually from 1976 to 1978 for the improvement and repair of existing irrigation and drainage facilities which were in poor working condition owing to deferred maintenance caused by financial difficulties of the associations in the past.

7) An amount of NT\$100 million was to be earmarked annually by the Government for rehabilitation of flood-damaged facilities.

Figure 2. Organization Chart of Irrigation Associations, Class A and Class B

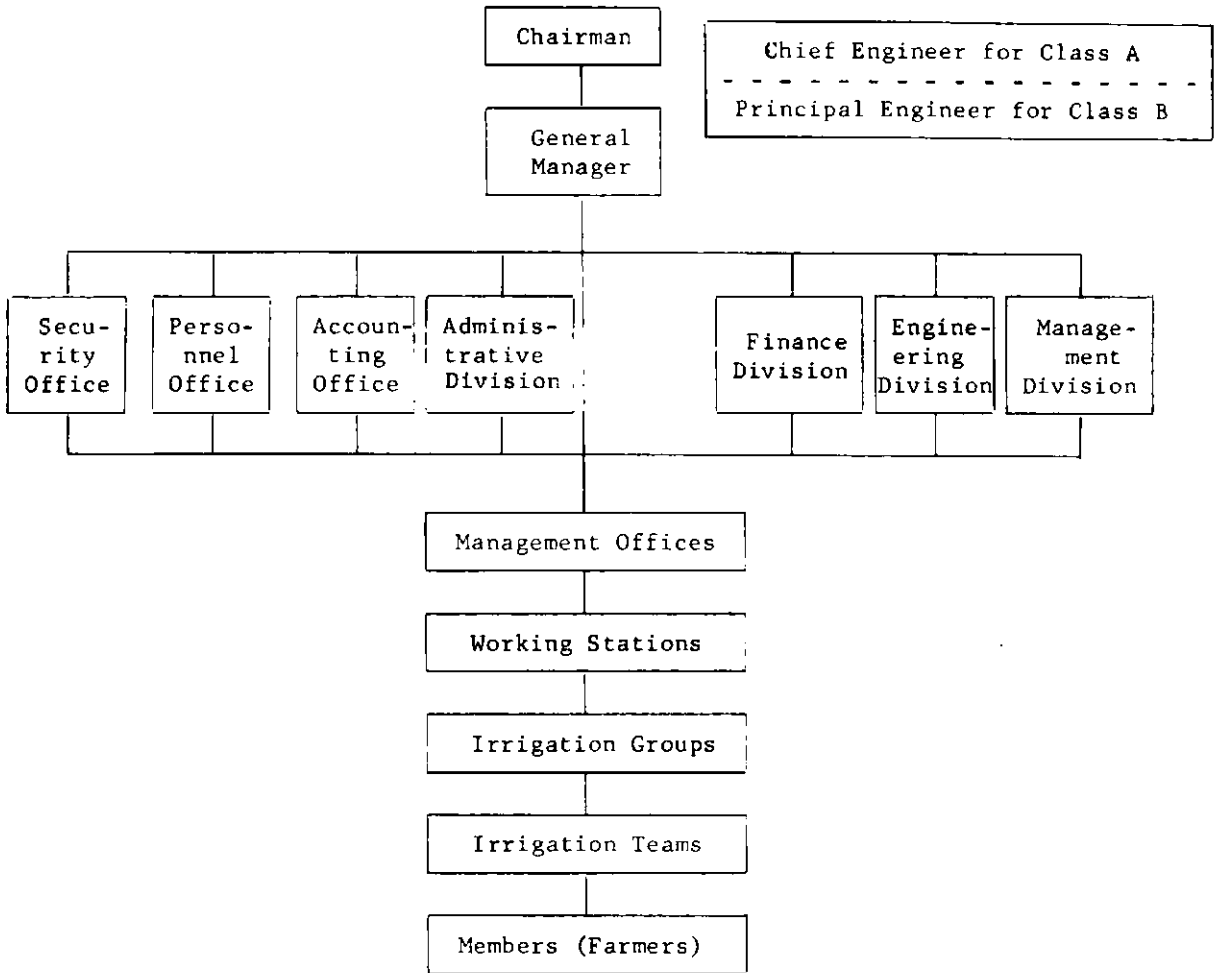
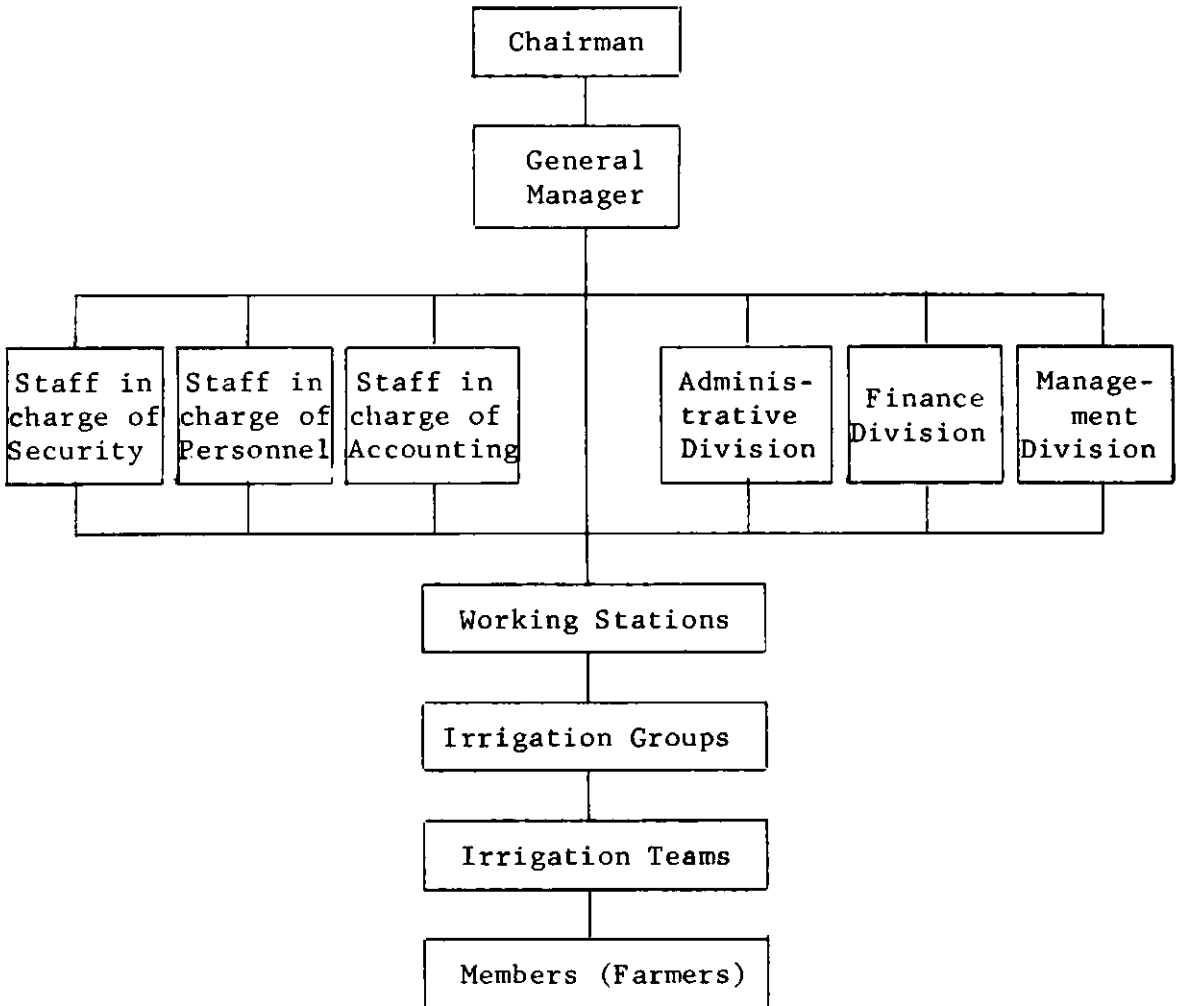


Figure 3. Organization Chart of Irrigation Association, Class C



These measures, together with the ARDP, have assisted the irrigation associations in solving their financial problems, strengthening their operation and management, and improving their irrigation and drainage facilities. A study on how to further improve the organization of irrigation associations is in progress.

Financing the Irrigation Associations

The annual budget of an association comes mostly from the collection of ordinary membership fees for which different rates are set according to water use. In principle, the total amount of membership fees must meet the annual requirements for administrative and personnel expenses as well as operation and maintenance costs. The rates of membership fees formerly ranged between an upper limit of 300 kg of paddy and a lower limit of 20 kg of paddy per ha per year which were collected in cash according to the prevailing price of paddy. Additional irrigation fees for water obtained through pumping were collected according to the actual operation costs expended.

In order to minimize the farmers' burden, the Government reduced the rates of all membership fees by 10 percent in 1971. Since then, the membership fees have been collected at rates between 20 kg and 270 kg of paddy per ha per year. According to an analysis, the membership fee paid by a farmer makes up only 3 to 4 percent of his total farming cost.

Owing to the increase in personnel expenses, labour wages and material prices, the amount of membership fees collected is always insufficient for maintenance and repair of the facilities. Therefore, government subsidies are needed unless the rates of the membership fees can be readjusted so as to enable the associations to promote a self-financing capability.

Irrigation Operation and Management

The technical staff of the irrigation association controls water delivery at main canals and laterals. From turnout gates through farm ditches to individual fields, water is distributed by the irrigation groups under the supervision of the association staff.

Usually, the management division in the head office of the association prepares annually an irrigation guide according to past experiences, government policy, production goals, water sources available, etc. for distribution to the local

irrigation working stations through the management offices. Meetings with the irrigation groups are then called to discuss and work out detailed irrigation plans which are reported to the management offices and head office for approval and compilation. The irrigation plan includes the names of the canal system, number of rotation districts, names of irrigation groups, estimated amounts of effective rainfall and water from different water sources, irrigation methods and intervals, kinds of crops and areas to be planted, conveyance losses, water requirements of seedbeds and main fields, frequency of irrigation, water delivery schedules, etc.

Records of the irrigation work done are prepared by the working stations and reported to the management offices and the management division in the head office for checking and for reference in future irrigation planning.

The water delivery system of a typical irrigation association is shown in Figure 4.

Water Distribution Methods

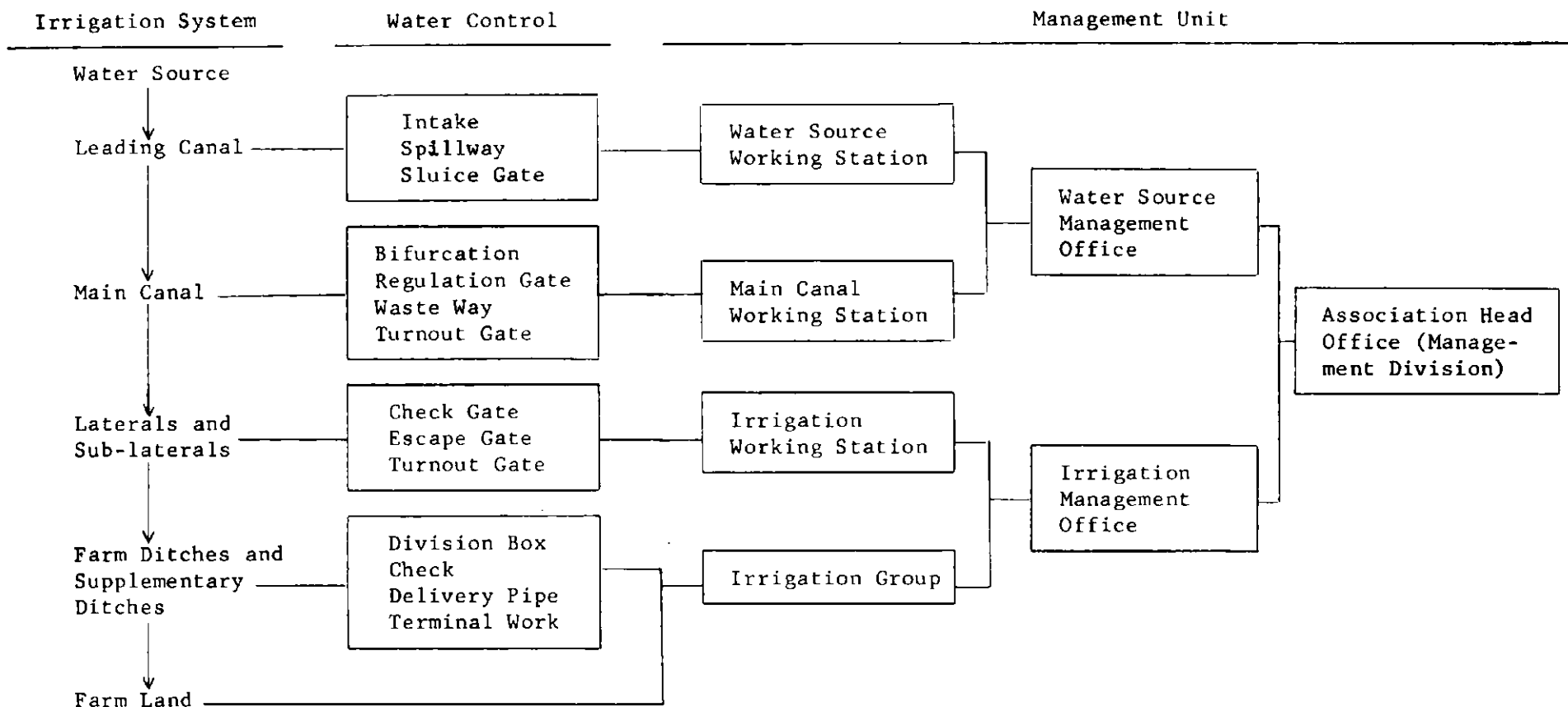
Water distribution methods of the irrigation associations vary somewhat. In general, the association located in the area with limited water sources adhere more to a strict water distribution method. However, as water shortage frequently occurs during the first rice crop growing season, rotational irrigation plays an important role in rice production.

Rotational irrigation, in general, is preferable to continuous irrigation for the simple reason that water can be more evenly distributed in the area and larger areas can be served with the same amount of available water.

Rotational irrigation can be classified into three methods: rotation by sections in main canal or rotation by laterals; rotation by sections in lateral or sub-lateral, or rotation by sub-laterals or farm ditch systems; and rotation by farm ditches.

Rotation method by sections in main canal requires larger capacities for both conveyance and distribution systems. On the other hand, rotation method by sections in lateral or sub-lateral also requires larger capacities in the laterals or sub-laterals and farm ditches than that for continuous irrigation. But the rotation method by farm ditches requires only larger capacities for the farm ditches than that for continuous irrigation.

Figure 4. Water Delivery System of Typical Irrigation Association



Source: Cheng, K.T., T.Y. Tsai and S.T. Hsu, Operation and Maintenance of Irrigation in Taiwan, 1961.

Remarks: 1. The original figure has been modified.

2. For a small irrigation association, water control at the water source, leading canal and main canal is undertaken by the irrigation working stations.

In Taiwan, the construction and improvement of irrigation systems are generally designed according to the method of irrigation for economic reason. About 50 ha served by a turnout is considered as a basic irrigation rotational area. (Sometimes, due to topographical conditions, a rotational area also adapts more than two turnouts.) The rotational area is further divided into several smaller areas called rotation units. Water is distributed among the units according to the order of the provided schedule. Water measuring devices and steel gates are provided at or just near the point of diversion from the main canal, lateral, and sub-lateral to measure and regulate the flow. During water shortage, most of the systems are further divided into several large rotation districts and water is distributed by order among the districts and among farm ditches and/or plots simultaneously. This is also called strict rotational irrigation or emergency irrigation.

When the discharge during an irrigation period is only about 70 percent or less of the irrigation requirement, the emergency irrigation is always adopted by the irrigation associations in order to save water. When drought occurs during irrigation, the following two procedures are open to farmers: maintain the rotation interval and reduce the irrigation depth for each irrigation, or maintain the irrigation depth and prolong the rotation interval.

From the viewpoint of irrigation operation and management, the rotational interval should be maintained like a general rotation and the irrigation depth should be reduced during the period of drought. If the discharge is very small and the rotational interval should be prolonged, the irrigation depth should be minimum. Some irrigation associations resort to the rush method in case of very acute water shortage.

Irrigation Maintenance

The engineering facilities are properly maintained so as to facilitate irrigation operation. Maintenance work is generally divided into three categories: routine maintenance, annual maintenance, and emergency repairs.

In routine maintenance, repairs are done immediately on the spot upon discovery of damage. On the other hand, annual maintenance is performed during the non-irrigation period to insure proper operation of the facilities in the next irrigation season. Emergency repairs are carried out mainly after flood damage and the facilities must be completed in time for

irrigation. When the damage is serious, financial and technical assistance is requested from the Government for emergency repair and subsequent rehabilitation of the facilities. The costs of routine maintenance and annual maintenance are usually borne by the association.

Generally, the annual maintenance work is undertaken at three different places as follows:

- 1) Irrigation working station:
 - a) To determine farmers' needs.
 - b) To investigate all the engineering facilities and identify those requiring maintenance.
 - c) To prepare an annual maintenance plan for submission to the local management office.

- 2) Local management office:
 - a) To assign staff to make field investigations for preliminary screening of the proposed maintenance plan.
 - b) To revise the proposed plan after screening, and transmit it to the management division in the head office of the association.
 - c) To supervise construction after the plan is approved for implementation.

- 3) Management division of the head office:
 - a) To assign staff, if and when necessary, to make field investigations again for finalizing the annual maintenance plan.
 - b) To budget the maintenance requirements for approval by the chairman.
 - c) To notify the local management offices or working stations of the approved plan for implementation.
 - d) To make final inspections for acceptance or rejection of the completed maintenance work.

In some areas, maintenance work on farm ditches are undertaken by the irrigation groups.

Concluding Observations

In order to meet the requirements of a more reasonable and effective development of agriculture in the future, the regional agricultural development planning work was carried out in 1975 by the then JCRR and continued by the CAPD. The arable land resources, available water sources, labour conditions, future demands and other natural and economic conditions were considered in the planning work.

The cultivable lands and water sources in the country are limited. The island is highly populated. In order to meet these situations and to increase crop production, it is absolutely necessary to develop marginal lands such as slopelands, sandy coast-lands, saline lands, riverine lands, and tidal lands. Already, Government has emphasized survey and planning works.

The agricultural areas in the south-west district are comparatively large even as water sources are limited and crop-rotations are largely adopted. The irrigation operation and management should be strengthened. For purposes of supplying more water for agriculture, domestic and industry uses, more reservoirs need to be constructed. Some survey and planning work in this regard have already been intensively carried out in recent years.

Sufficient rice production in the past years was achieved mainly through improvement of agricultural technology and irrigation and drainage facilities. Even so the Government has taken measures to encourage farmers to grow more upland crops in paddy fields. But new irrigation systems must be designed to meet the requirements of both irrigated lowland and upland rice fields.

Previous efforts to develop slopelands, coastal sandy lands and riverine lands included several irrigation pilot projects from which the problems of labour shortage and marketing were observed. Also, the sprinkler irrigation systems with moving lateral pipes were introduced but were not easily accepted by farmers.

Theoretically irrigation water should be applied to the fields according to requirements. But because irrigation fee is based on areas served, some irrigation associations always distribute water according to the farmers' areas regardless of the actual water requirements. In order to solve this problem

and to increase the farmers' income, the associations encourage farmers to adopt the multi-cropping method, i.e., farmers plant rice and upland crops simultaneously on their farms.

Three methods of water distribution at the farm level prevail in the country.

- a) A common irrigator is employed by the association in a rotational area.
- b) The salary of the common irrigator of a rotational area is paid by farmers. The chief of a small irrigation group in a rotational area should be responsible for collecting the required fees from farmers.
- c) Water is distributed by farmers themselves in a rotational area according to the schedule provided by the associations.

In view of the rapid industrialization in the country, farmers find non-farm jobs easier than in the past. When this is the case, methods a) and b) are easily accepted by farmers. Otherwise, method c) seems more reasonable.

Land consolidation projects need to incorporate the development or improvement of irrigation and drainage systems and farm roads (for farm mechanization). However, the layout of irrigation, drainage, farm road systems, and the optimum size of farm plots need further studies from the point of view of irrigation operation, management, and farm mechanization.

Taiwanese farmers do not have as much time as before to participate in the association's activities on irrigation and drainage, hence the need for irrigation associations to contribute more services to farmer members. There also seems a need for adjusting the farmers' membership fees in light of changing economic conditions. There is likewise a need for reducing irrigation operation and maintenance costs, including modernization of irrigation facilities, farm mechanization and maintenance of irrigation and drainage systems. Measures for implementing this should be investigated and implemented.

Due to the rapid industrialization in Taiwan, water pollution problems have become serious in recent years. In some areas, the quality of irrigation water affects the growth of plants. The Government has started the water pollution control work but the implementation needs to be strengthened

and hastened.

For drainage improvement, it is often difficult to analyze the benefits and the rational share of construction cost. Some actual study on inundation damage to major crops should be continued and refined.

The limited function of the present drainage engineering work is not well understood. Storms that visit the country often damage the drainage systems which need very large channels to drain excess water on the flat land. Major modification of drainage planning may be necessary and should involve industrialized and urbanized areas on a regional drainage level.

2. HONG KONG

Lin Yang Chung*

Source and Supply of Irrigation Water

Natural sources of water for irrigation in Hong Kong are streams and underground water. Stream water is usually diverted to cultivated fields by weirs, or, occasionally by pumping. In some areas stream water is impounded in irrigation reservoirs and stored for later use when the natural flow in the stream is not sufficient to meet irrigation needs, particularly in the latter part of the dry season (December to early March). There are nine irrigation reservoirs in Hong Kong at present with a total storage capacity of 325.5 million gallons. The names and the locations of the irrigation reservoirs are Lo Fu Hang at Lam Tei, Hung Shui Hang, Ho Pui, Tsing Tam and Wong Nai Tun at Yuen Long, Kwu Tung, Hok Tau and Lau Shiu Heung at Tai Po and Shap Long on Lantau Island.

Underground water in Hong Kong is very limited in comparison with other countries. However, shallow wells are used successfully in some areas, particularly in areas of intensive market gardening. In many cases water is lifted from these wells by small electrically-driven centrifugal pumps and then applied to the crops by sprinkler irrigation. Deep wells in Hong Kong do not provide a reliable source of irrigation water. The conclusion that the ground water supply in Hong Kong is negligible was reached in 1948 by Dr. F. Dixey, Geological Advisor to the Secretary of State. Dr. E. A. Stephens (Senior Geologist) later reviewed and agreed with this note on groundwater in 1969.

Water is normally distributed from stream diversion weirs or irrigation reservoirs through open channels or pipelines to the cultivated areas. Many of the open channels are unlined earth channels and are prone to problems of high seepage and evaporation rates. They also require regular desilting and weeding which not only clog up the channels but also take up water intended for crops. Although pipelines are occasionally prone to blockage by silt they have an additional advantage in that they carry water under pressure which makes possible the use and operation of sprinkler irrigation by gravity without the need for expensive pumping.

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Application of Irrigation Water

The application of irrigation water on the farm is usually undertaken by one of the following four methods: flood irrigation, flooded furrow irrigation, bucket irrigation or sprinkler irrigation. Conventional furrow irrigation is occasionally used in the main market garden areas. As yet the use of drip or trickle irrigation is still in the trial stage on government farms.

Flood irrigation is extensively used in paddy fields and in low-lying areas with poor drainage, but, in general, it is not suitable for most market garden crops except the aquatic types such as water cress and water spinach. It has the advantage of low-cost labour even as evaporation and percolation result in through high water loss.

On the other hand, flooded-furrow irrigation is extensively used in vegetable fields, usually in low-lying areas with heavy soils that enable the cultivation of land that would otherwise require expensive drainage work. Like flood irrigation its main disadvantage is high water loss through evaporation and percolation. Also, large areas of land is rendered unproductive owing to the presence of the flooded furrows themselves.

Bucket irrigation is used by some farmers in market garden areas with sandy or sandy loam soils. This method has the advantages of low field preparation cost, low water loss, a small area of land left unproductive and the simultaneous application of water and manure. However, it entails a very high cost of labour.

Sprinkler irrigation is increasingly used in market gardening. Its advantages are that it may be used on any type of soil, land preparation is not required, percolation and evaporation losses are minimized, water application is easy to control, water distribution is more uniform, no land is left unproductive and cost of operation is low. However, its principal disadvantage is its high cost of installation. Solid set sprinklers are required to facilitate the necessary high frequency of irrigation of market garden crops, usually once or twice per day for leafy vegetables which are the major crops.

In general, all paddy fields are flood-irrigated, flower fields are mostly sprinkler-irrigated or flooded-furrow irrigated, vegetables are irrigated by any one of the four types of

systems and orchards and field crops are mostly unirrigated.

The trend in agricultural land use in the last 10 years in Hong Kong are briefly summarized in Table 1 to provide some indications on the extent of irrigated area by types of irrigation.

Table 1. Trend in Agricultural Land Use, 1968-1978

Land Use	(Unit: acre)					
	1968	percent	1973	percent	1978	percent
Paddy	14,510	43.3	5,640	17.9	280	1.1
Vege- tables	8,890	26.5	10,100	32.0	8,560	33.1
Flowers	520	1.6	850	2.6	680	2.6
Field crops	2,510	7.5	1,300	4.1	230	0.9
Orchard	1,560	4.7	1,590	5.0	1,260	4.9
Fish ponds	1,980	5.9	3,180	10.1	4,880	18.8
Fallow	3,550	10.6	8,900	28.2	10,010	38.6
Total	33,520	100.0	31,560	100.0	25,900	100.0

The area for crops under flood irrigation (paddy) has been considerably reduced. The total area of land under field crops and orchard have also been reduced largely due to urban encroachment. Despite the continuous loss of agricultural land to urban development, the total areas for vegetables and flowers have remained indiminished. However, considerable land areas which used to be irrigated by flooded-furrow or bucket-irrigation, have been converted to sprinkler irrigation in recent years.

Impact of Irrigation, Drainage and Water Management

In order to obtain consistently high crop growth rates and yields, sufficient water must be constantly available in the soil, i.e., in the root zone of the crops to enable them to transpire water at as near as possible potential transpiration rates. The soil water levels in the root zone must be

fairly close to field capacity all the time throughout the period of crop growth. Although this water requirement varies with weather, location and crop and its growth stage, it is estimated that under Hong Kong conditions about 0.2 inches (5 mm) of water per day are required for normal crop growth which is provided both by rainfall and irrigation.

The uneven distribution of rainfall in Hong Kong does result in seasonal water shortages and this is one of the major constraints in the development of market gardening. Water shortage causes reductions in crop yield and quality, and may cause, during prolonged dry spells, crop failure and even land abandonment. Therefore, for farming, especially vegetable and flower production, to be successful throughout the year, reliable and adequate supply of irrigation is imperative.

Rapid removal of flood water from land under market gardens is the main objective of most of the proposed or requested farm land drainage schemes in Hong Kong. The level of flood water tends to build up during and immediately after heavy rain storms. If the flood water is not removed rapidly, market garden and field crops may be severely damaged or destroyed.

The main problem in the drainage of flood water from agricultural land in Hong Kong stems from the fact that the fields were originally laid out for paddy cultivation, which is tolerant to floods. Many of these fields are used for growing market garden crops which cannot tolerate flooding in most cases. Large drainage channels have not been provided during the change-over from paddy cultivation to market gardening. Consequently, there has been an increase in flooding/drainage problems in recent years.

Since 1976, the Agriculture and Fisheries Department has undertaken farmland drainage schemes in areas where the proposed channels would function as both drainage and irrigation channels. The cost of drainage construction is considerably greater than that of installing irrigation development schemes, on an unit area basis, as the construction cost of a drainage scheme for removing water from some 10 inches (254 mm) of rain in one day is very high.

There is need to construct more farm land drainage channels in order to solve flooding problems. This should bring about a reduction of crop damage and losses, minimize soil erosion and help reduce government relief payments to farmers suffering from such damage or loss after heavy storms.

National-level Problems

The Agriculture and Fisheries Department has placed considerable emphasis on irrigation, drainage and on-farm water management. In monetary terms, the total provision for "Minor Irrigation Works in the New Territories" and "Maintenance of Irrigation Works" for 1979/80 is HK\$845,000, which is three times greater than the provisions allocated for other crop development programmes.

During the planning of irrigation development schemes by the staff of the Agriculture and Fisheries Department, priority for new scheme is now usually given to areas of existing or potential market gardening.

In addition to the design and construction of new irrigation schemes, the Agriculture and Fisheries Department undertakes the maintenance of existing irrigation schemes. Current annual expenditure on this work is about HK\$316,000.

Not all Government irrigation projects were economically justified. Due to the extension of the urban water catchment system, many irrigation water supply improvement schemes have been undertaken to ensure that the fields under the catchment areas are still provided with sufficient water for irrigation. During the period 1972-77, a large amount of such compensating irrigation work was carried out in association with the High Island Water Scheme which aimed at increasing the urban water supply. This irrigation work amounted to a Government expenditure of HK\$7.2 million. However, because of factors such as the inaccessibility of many of the fields in remote areas, the shortage of farm labour, lack of skill or incentive to farm, reluctance to lease the land to tenants, and land speculation, there are cases where these irrigation schemes have not been fully utilized for agricultural production. In these areas a considerable land area has been left fallow or is only producing a meager crop of paddy.

Irrigation Associations and Their Problems

An attempt to improve the day-to-day management of irrigation water supply schemes is being made through the Agriculture and Fisheries Department (AFD) through the organization of rural committees and leading farmers' irrigation committees. These committees, when formed, are responsible for the distribution of water in the irrigation area, the regulation of flow of water in the irrigation system and the sorting of water

disputes and questions of water rights. They also clear the irrigation system of silt and report the occurrence of damage to the AFD for necessary maintenance work. The irrigation committees are able to draw on the AFD for technical advice, but their success depends ultimately on their ability to obtain cooperation from the farmers who use the irrigation water.

Two such irrigation committees at Tuen Mun and Wang Toi Shan have been formed. In areas where irrigation committees have not yet been formed, matters relating to the operation and administration/coordination of irrigation systems are generally handled by elected members of the rural committee in the area or the village representatives concerned.

Problems at the Farm-Level

Water disputes are common in areas where there is insufficient irrigation water, especially in areas where the same sources of water are shared by more than one village. Numerous and lengthy discussions with the villages concerned are often required to settle the water disputes before the details of irrigation projects for the areas concerned can be finalized. Because of the stubbornness or superstition of some villagers, irrigation and drainage schemes cannot be always designed in the most efficient way. At the completion of an irrigation project, villagers are obliged to undertake minor maintenance works such as the clearance of rubbish accumulated at the weirs or channels. Due to negligence of the villagers, some irrigation works have not functioned properly. Unlike farmers in many other countries, those in Hong Kong enjoy using irrigation water without charge. It appears that many of them depend too much on Government and do not wish to assume responsibility in helping keep the irrigation works functioning.

Since 1966, sprinkler irrigation systems have been installed by progressive market gardeners in order to reduce irrigation labour costs, which are high in traditional methods of irrigation e.g., the bucket method. The AFD has encouraged the development of sprinkler irrigation by setting up sprinkler demonstration schemes in selected areas, by providing farmers with technical advice on the design of sprinkler irrigation systems and agricultural credit for the purpose of purchasing the sprinkler equipment specified in the designs. Up to the end of 1978, there were over 1,700 sprinkler irrigation systems operating in Hong Kong. However, there is a need at present for investigation on ways to reduce the very high

installation costs of sprinkler irrigations, i.e., HK\$18,000 per acre. These high installation costs are acting as constraint on the adoption of sprinkler irrigation by market gardeners.

Continuing investigation work is being carried out on new methods of irrigation, in particular, sprinkler and drip irrigation. Two types of drip irrigation equipment are being tried at government farms. Promising and encouraging results have been observed on drip irrigation of fruit trees, e.g., citrus, "longan" and banana during the dry seasons in a mixed orchard at a government farm since the system was installed in 1976. Adoption of modern methods of irrigation water application, such as sprinkler and drip irrigation will greatly reduce water losses and wastage on the farm and this will become steadily more important as urban requirements for water continue to increase.

3. INDIA

Vijendra Singh*

Introduction

Agriculture is the occupation of nearly 70 percent of the Indian population and contributes nearly 50 percent of the gross national income. Therefore, the economic uplift of the country very much depends upon a stable and productive agriculture base. However, so far, agriculture is mostly dependent on rainfall as only 25 percent of the cultivated area is provided with irrigation facilities.

Almost 85 to 90 percent of the rainfall occurs in the monsoon months (June to September). Not only is its areal distribution uneven over the country, but very often fails to meet the needs of crops. The annual rainfall varies from 11,000 mm in the eastern region to less than 100 mm in the western region. The number of rainy days (precipitation exceeding 2.5 mm) varies from 10 to 150. Irrigation is a must for raising crops during the dry season of the year; even in the monsoon season irrigation becomes necessary to tide over long dry spells. The general climate and temperature conditions in the country are such as to permit raising of two or more crops over the entire cultivable area provided water for irrigation becomes available.

India encompasses many regions with widely varying topographical and climatic conditions. The cropping patterns and irrigation practices in the various regions also vary widely. The basic needs all over are, however, the same for increasing agricultural production, namely: i) creation of additional irrigation potential and extension of irrigation facilities; and ii) efficient use of available irrigation facilities by proper water management.

The problems of on-farm water management, though similar throughout the country, are being tackled in varying manner in different regions. This paper discusses these problems for India as a whole with particular reference to the State of Uttar Pradesh (U.P.). This is fourth largest State of the country

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and on the basis of its population of 100 million it is the seventh largest country in the World.

Some of the salient features for India and U.P. are given in Table 1.

Table 1. Irrigated Area and Irrigation Potential in India and Uttar Pradesh

Item	(million hectares)		
	India	U.P.	Percent
Geographical area	328.8	29.8	9.0
Cultivated area	142.2	17.2	12.9
Gross cultivated area	171.0	23.6	13.8
Gross irrigated area (State & private works)	42.6	9.4	22.7
Percent irrigated area to gross cultivated area	25.0	40.0	-
Intensity of cultivation	125.0	137.0	-
Irrigation potential			
Gross potential (State works)	52.3	7.8	15.0
Percent to gross cultivated	30.5	33.0	-
Production (million tonnes)			
Wheat	28.3	8.5	30.0
Rice	49.5	4.3	8.7
Other food grains	29.9	4.0	13.0

U.P. is predominantly an agriculture State with 77 percent of the population engaged in this sector. This State lies in the river Ganga basin and is situated in the northern region of India and comprises of three broad physical divisions: i) Northern hilly region; ii) Central alluvial plains; and iii) Southern plateau (which is a part of the Deccan plateau).

The area and crop statistics of the various divisions are given in Table 2.

Table 2. Irrigated Area in Uttar Pradesh, by Division

(million hectares)

Division	Geog. Area	Cultur-able Area	Cropped Area		Gross Irrigated Area	Percent Irrigated Area to Gross Cropped Area
			net	gross		
Hills	4.4	0.5	0.4	0.8	0.1	11.3
Plains	21.1	15.7	14.2	20.2	8.8	43.4
Plateau	4.3	2.5	2.3	2.6	0.5	21.1
Total	29.8	18.7	17.2	23.6	9.4	40.0

The crop year is divided into two principal seasons, namely:

- Rabi: October to March, principal crop wheat
- Kharif: i) April to June, principal crop fodder and sugarcane
- ii) July to September, principal crop paddy

The paddy crop extends right up to November. Sugarcane extends over both the seasons.

For U.P., the total surface water resources have been assessed as 335,000 million cm* out of which it is estimated that it would be feasible to harness 180,000 million cm which will suffice for irrigation needs of 20.0 million ha. The ground-water reservoir in the alluvial plains, after full development and optimum utilization of the surface waters for irrigation, should be able to cater for the irrigation needs of another 10.0 million ha. With improved water management and increased efficiency of irrigation, it should be possible to increase the irrigated area by another 4.0 million ha. Thus, with the optimum and conjunctive use of surface and ground waters and proper on-farm water management it should be possible to achieve an irrigation intensity of 200 percent of the net cropped area of the State.

* cm signifies cubic metre.

Recent Trends in Irrigated Area and Types of Irrigation

In U.P., about the middle of the last century many large diversion canal systems, based on run-of-the-river supplies, were constructed to provide protective irrigation to save crops from failure due to droughts. These canals were designed to provide one or two waterings to the principal rabi crop, namely: wheat. Many small reservoirs and canals in the southern plateau region were provided in the beginning of this century. Besides these there were many privately owned small reservoirs, tanks, dug and bored wells. From 1930 onward the State undertook extensive development of ground water by deep State-owned tube-wells and at present there are about 15,000 nos. In recent years many large new irrigation schemes of the diversion type have been taken up. In the last ten years there has been a phenomenal increase in privately-owned shallow tube wells (0.5 cmm* discharging capacity) and pumping sets on dug-cum-bored wells and presently their number is about 1.1 million. These wells, a substantial majority of which are situated in areas already commanded by State Irrigation Works, provide conjunctive irrigation. These recent developments have come about to meet the needs of intensive agriculture and adoption of high-yielding varieties of crops with their more exacting water demands.

Irrigation schemes involving inter-basin transfer of river waters have been taken up. Most notable amongst these is the Sarda Sahayak Irrigation scheme which will serve a culturable commanded area of 2.0 million ha and is probably the largest irrigation scheme in Asia.

Conjunctive use of surface and ground waters is being widely practised and integrated development of State irrigation works and private wells and tube wells has been adopted as a general policy. The basic idea is that State works should spread the benefits of irrigation over as extensive an area as possible and intensification should be by conjunctive use through private wells and tube wells.

As part of conjunctive development, the State is constructing augmentation tube wells (with discharges of 3 to 5 cmm) to feed directly into canals. These will help in augmenting canal supplies during the lean months of river flows and will simultaneously help in lowering the water table with benefit to water

* Cmm signifies cubic metre per minute.

logged areas. Similarly in areas where the spring water table was falling rapidly due to excessive withdrawals of ground waters, canals utilizing, by diversion or pumping, the ample monsoon river flows are being constructed to provide irrigation to paddy crop. These will replenish the groundwater reservoir simultaneously.

For areas which cannot be commanded by gravity flow canals and where replenishment of groundwater by natural processes is inadequate, a number of canals pumping water from rivers have been constructed.

Most of the old canals, had good drainage systems to carry away storm water as well as excess irrigation waters. These systems have been extended, improved and modernized. The new canal systems under construction are being provided with extensive drainage networks. These will help in relieving water-logging and in draining out shallow areas in which rain water gets locked.

All the above measures have considerably increased the irrigation potential and the irrigated areas has shown a significant increase. Due to better irrigation facilities double cropped area has also increased. Conjunctive use has led to extensive adoption of high-yielding varieties (HYV), particularly wheat; nearly 90 percent of the irrigated wheat is now HYV.

Impact of Irrigation, Drainage and On-farm Water Management on Cropping and Productivity

In U.P. there has been significant impact due to increase in irrigation potential and improvement in the on-farm water management. The total irrigated area under the non monsoon crops notably wheat has considerably increased changing the annual cropping patterns. The average per hectare yield of irrigated wheat has increased by about 42 percent during the period 1961-1978. Table 3 illustrates the impact.

No significant impact is discernible in the rice crop. The position should improve as the State has recently taken up a large-scale programme for construction of channels for paddy irrigation.

Table 3. Impact of Irrigation on Wheat and Rice Farming

Item	(million hectares)	
	1961	1978
Geographical area	29.80	29.80
Net cultivated area	17.00	17.20
Gross cropped area	21.60	23.60
Percent to net area	126.00	137.00
Net irrigated area	5.08	8.40
Gross irrigated area	5.56	9.40
Percent to gross cultivated area	25.80	40.00
Area as percent of gross cropped area:		
Rice	19.30	20.00
Wheat	18.50	28.00
Percent irrigated wheat to total wheat area	49.00	80.00
Irrigation potential (State works)	3.80	7.80
Average yield in Quintal per hectare:		
Irrigated wheat	10.01	14.29
Rice	7.53	10.65

Relative Priorities of Irrigation, Drainage and On-farm Water Management in the Agriculture Development Programmes

The State is keenly interested in development of agriculture as this sector generates high employment opportunities for its unemployed and partially employed labour force. The State has a target to achieve a growth rate of at least 4 percent per annum in the next five years. The programme envisages the following strategies for increasing agriculture production and productivity: i) To increase irrigation potential and to increase area under irrigation; ii) To increase cropped area; iii) To increase cropping intensity; and iv) To increase use of inputs and to emphasize their judicious application.

The highest priority has been allocated to increasing area under irrigation by rapid full utilization of the created potential. The State plans to add an additional irrigation potential of 2.6 million ha in five year period (1978 to 1983, by State Irrigation works and the programme is progressing well. Drainage of irrigated lands is also receiving priority. On-farm development and water management is also an item of high priority in the State programmes.

Three major irrigation projects, with details as shown in Table 4, have been taken up for on-farm development.

Table 4. Three Irrigation Projects For On-Farm Development
(million hectares)

Item	Name of Irrigation Project			Total
	Ranganga	Sarda Sahayak	Gandak	
Culturable commandad area	0.82	2.00	0.44	3.26
Irrigation potential				
Ultimate	0.58	1.92	0.33	2.83
Created to end of 1978	0.54	0.68	0.26	1.48
Programme to end of 1983	0.58	1.92	0.33	2.83
Number of blocks (nos.)	143.00	160.00	33.00	337.00
Total number of outlets (thousand nos.)				82.00
Area covered under OFD				0.2
Programme for 1978-83				
Area proposed for OFD				1.50
Construction of field channels (thousand kms)				75.00
Construction of field drains (thousand kms)				57.00
Warbandi on outlets (thousand nos.)				32.00

Note: OFD means On-Farm Development

The OFD programme in these three project areas is a very big task and so far only a beginning has been made. An ambitious programme has been drawn up for 1978-83; however much will still remain to be done after 1983.

Organizational Features

Several different organizations are involved in planning and management of irrigated agriculture. Irrigation is a State subject, while the Central Government gives general policy guidelines for irrigation and flood control, examines programmes and coordinates activities. Responsibility for construction, operation and maintenance of irrigation systems at the State level lies with the Irrigation Department, while agricultural extension is the concern of the Agriculture Department. The departments of Rural Development, Cooperatives, Rural Engineering Service, Land Development Banks, etc. are also involved in various ways.

At the Central Government level the agricultural and irrigation functions are combined in the Ministry of Agriculture and Irrigation, which includes a special department for water management, but in most of the States these functions are separate.

To provide for on-farm development in the commands of major irrigation projects, the Government initiated during the period 1974-78, Command Area Development (CAD) programme with view to guiding the farmer in carrying out land development and shaping work, construction of field channels and field drains and water management downstream of the outlet from the Government irrigation channels. 38 nos. CAD Authorities have been set up in 13 States to provide integrated service in command areas of 50 major irrigation projects. However, there are variations from State to State in the allocation of exact functions and organization of the CAD Authorities.

Major Problems in Promoting Irrigation, Drainage and On-farm Water Management

The objective is higher agriculture productivity and the contributive factors of irrigation, drainage and on-farm water management have to provide an integrated and coordinated approach.

One of the major constraints is the compartmentalization of the duties and jurisdiction of the various Departments involved in the above activities. The Irrigation Department is responsible for conveying the water in the Government channels up to and to the downstream of the outlet. (The norm is to provide an

outlet for a culturable commanded area of 40 ha or less.) The Agriculture Department looks after agriculture extension work, but is not concerned with the equitable distribution of the water becoming available from an outlet. The work of land levelling and bunding is the domain of the Soil Conservation Department. The proper layout of the network of field channels and drains and their upkeep and maintenance is the jurisdiction of the CAD Authority. This rather rigid distribution of functions, while purposeful in terms of the activities of each Department as a separate entity, is unsuitable for tackling a problem which requires active inter-departmental coordination and cooperation at the field level.

The supplies in a diversion canal depend upon the water available in a river; during periods of shortage of supplies, the aim is to distribute the available water most equitably over the command area by proper rotation of running/closing of the network of Government channels. A canal system has inherent inflexibility of operation and its roster for running of the channel network cannot be modified to suit the requirements of an outlet, with different types of crops having varying base and critical periods for irrigation in its command. The choice of which crop to grow depends entirely on the farmer. With no control over the cropping pattern in the command, problem of water management at the farm level becomes very difficult.

Irrigation Associations

Irrigation or Water User's Association can be of many types. In U.P. a form of association in vogue is for distribution of water in the command of an outlet; all the cultivators in the command may form themselves in a single group or a number of sub-groups each headed by a sub-group leader. These groups are given a time schedule, called WARBANDI*, for one week; each group becomes entitled to receive water from the outlet for specified time period which can be availed by the constituent individuals forming the association. The WARBANDI system has proved useful for equitable distribution of water.

A factor which makes formation of Irrigation Association most essential is the small size of holdings. Table 5 gives the grouping of various sizes of holdings.

* WARBANDI signifies the system of allocation of total time amongst various groups of farmers entitled to receive water from an outlet. The apportionment is related to percentage of land holding of a group to the total command of the outlet and is based on a weekly rotation.

Table 5. Size Distribution of Operational Holdings, Uttar Pradesh

Size Class-Hectares	Percent no. of Holdings to the Total no. of Holdings	Percent Area to the Total Area
Below 0.5	46.75	8.67
0.5 to 1.0	20.09	12.42
1.0 to 2.0	17.19	20.79
2.0 to 3.0	7.11	14.79
Above 3.0	8.86	43.33

Grouping together of farmers with small holdings would help in water management, as with proper cooperation and staggering the irrigation demands can be met. But this very factor makes the working of Associations difficult, because the number of farmers involved for any reasonable sized viable Association becomes large.

Associations formed for upkeep and maintenance of field channels and drains have not worked well.

Among the more important reasons for lack of success of such Associations are: i) wide differences between the social and economic status of farmers forming it; and ii) different cropping patterns adopted by individual farmers.

Problems at the Farm Level

The water rate charged for irrigation from canals is on the basis of the area irrigated and the crop harvested and does not take into account the number of waterings taken. This gives rise to the tendency to use excessive quantities of water. Furthermore, cultivators situated in head reach of a channel and thus being more fortunate in access to water, tend to take larger number of waterings and thus starve the cultivators at the tail of the channel.

The rates of State tubewells are on volumetric basis and crop. The rates are higher for cash crops, like sugarcane, and lower for cereals and least for fodder. This system is more equitable.

Normally the farmer meets his obligation to pay the irrigation charges willingly. This is recovered along with the land revenue.

Prior to 1950's the holding of a farmer was in the shape of a number of plots dispersed and distributed over an area. In order to bring these fragmented plots together to farm a single unit, a massive operation of 'Consolidation of land holdings' was carried out throughout the country and is still in progress in some regions.

When the plots were dispersed there was considerable cooperation, as each farmer depended on mutual good-will for maintenance of the field channels and irrigation supplies reaching his various plots. Subsequent to consolidation there has been a decrease in this cooperation, because a farmer situated near the outlet does not have to depend on farmers situated downstream. Corrective action is being taken by marking and setting aside land for laying of the trunk and main field channels at the time of consolidation.

The maintenance of field channels and drains is the responsibility of the farmers concerned. The field channels are normally kept in fair order, but drains are mostly neglected. The farmers adjoining the drain have a tendency to gradually encroach on the land of the drain.

Training in On-farm Water Management

For educating the farmer the Agriculture Universities and State Agriculture Farms run a number of field demonstrations. Study tours are also organized for farmers. Information is also disseminated through films and other mass media like radio and T.V.

Each district (administrative unit) is divided into a number of Blocks in each of which the development work is looked after by Block Development Officer. This officer is assisted by Assistant Development Officers drawn from various disciplines like agriculture, irrigation, cooperatives, plant protection etc. There are a number of village-level workers each block. The farmer is periodically contacted by the development staff to assess his problem and help in proper farm management.

Major Obstacles to Better Water Management

For proper development of the irrigated agriculture, it is necessary to define the tasks, analyse the efforts required for each item of work, prescribe precisely the role of each participating group in the exact sequence of operation and ensure cooperation of the participants.

For proper water management it is necessary that each farmer gets his entitled quota of irrigation water at his farm at the allotted time. The necessary infra-system of field channels and drains should be provided so that he is able to apply the required depth over his farm and drain off excess irrigation water with minimum wastage.

Some of the major problems in better water management practices at the farm level are given below:

- a) The size of most of the land holdings is small and the cultivator feels that there is no need for field channels and drains. He is reluctant to part with the land required for them;
- b) The cultivators whose fields are near the outlets and who get water easily do not feel the need to construct field channels;
- c) The losses in the field channels are high. The farmers at the tail of field channels feel that there is no proper method for equitable distribution of water. Even if the field channels are constructed their fields may not get water because a major portion of the same is likely to be consumed in the fields nearer to the outlets;
- d) The farmer is averse to night irrigation;
- e) The farmer is still to be motivated to the effectiveness and utility of soil conservation and drainage works;
- f) Ways and means have to be found for proper maintenance of field channels and field drains; and
- g) Creation of organizational capability for farm-level problem solving.

Conclusions

For increasing agriculture production, irrigation is the most important input because the success of other inputs depends on the availability of irrigation water at the proper time in adequate quantity. Irrigation water is a costly and scarce input, hence it has to be used economically. The whole irrigating system must be so devised that there is minimum loss and high water use efficiency is ensured. Since the maximum portion of losses occurs in the field distribution system, it is essential that field channels and drains are carefully and properly laid out and maintained. The farmer must be educated to realize the importance of this and there must be properly trained and dedicated workers to educate him. Proper on-farm water management is the most important factor for increasing agriculture productivity and production.

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4. INDONESIA

Otje S. R. Bratamidjaja*

Introduction

The operation, maintenance, and water management activities at the tertiary unit of Government irrigation and at village-level irrigation are the responsibilities of the village communities or beneficiaries.

Over the last ten years irrigation development in Indonesia has progressed considerably. More than one million ha of main system of government irrigation have been rehabilitated. These are the irrigation systems in Jatiluhur, 260,000 ha; Pekalen-Sampean, 238,000 ha; Pemali-Comal, 127,000 ha; Jratun-Seluna, 86,000 ha; Cisadane, 40,600 ha; Rentang, 96,500 ha; Cirebon, 82,000 ha; Sadang, 56,000 ha; Madiun, 140,000 ha.

The Government started with the rehabilitation of on-farm system in 1974. As the first stage of this programme, efforts were made to develop 550,000 ha of small-scale irrigation and to rehabilitate 360,000 ha of tertiary system during the five years. Efforts on irrigation development have increased wet paddy field areas by approximately 9.8 percent and harvested paddy area of about 2 percent over the last five years (Table 1). Annual rice production also increased about 3.8 percent annually during the same period.

Parallel with the development of the irrigation system, have been the increasing activities on the strengthening of water users' association ("Perkumpulan Petani Pemakai Air" = P.3.A.) which carries out the management of on-farm systems, including on-farm water management. Sense of ownership and responsibility and the participation of village communities are developed together with the development of their ability and capacity on matters of operation, maintenance and water management.

The "Subak" is reputed to be the oldest of these village communities in Indonesia. It is peculiar to Bali and its organization and system do not seem to operate throughout the country.

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The "Subak" concept seems to fit rather well the Bali conditions and customs which is why other provinces in the country whose setting are different from Bali have not been able to adopt the concept. The institutional-social aspect is, therefore, very important in considering the improvement of farm water management.

Food Crop Development Strategy

It is the policy of the Government to intensify crop production and expand farm areas at the same time. Improved irrigation facilities enable the farmers to utilize fully the recommended farm inputs such as high-yielding varieties, fertilizer, plant protection and better water application in order to raise yields and incomes.

The need for Indonesia to push workable strategies in food crop development is borne by the meager increases in rice production (average of about four percent annually over the last decade) and the consequent rice importation to augment local supply. Much of the success of the strategy to increase food crop production will lean heavily; on increased efficiency in water use and cropping intensity.

It is estimated that by 1983 - end of the third Five-year Development Plan - the average annual consumption of the Indonesian people will be about 1,970 kg of rice equivalent consisting of 125 kg rice, and 45 kg of corn, cassava and sweet potatoes. Therefore, the target of rice production in 1983 is about 20,685 million mt (including 10 percent for seed and losses) - still on average annual increase of about four percent (Table 2).

In order to realize this target, the total harvested paddy field should increase from 8.7 million ha in 1978 to 9.9 million ha in 1983 and the average yield of 1.98 mt of milled rice should increase to 2.07 mt per ha. Another 1.2 million ha of harvested area could be realized through efficient farm water management.

Irrigation Development

It is clear that the main objective of irrigation development is to support food crop development. According to the country's water law (Undang-undang No. 11 tahun 1974), water resources development, including irrigation, the responsibility is of the Directorate General of Water Resources Development (DGWRD), Ministry of Public Works. To carry out the task the DGWRD has six Directorates, namely; one each for Planning and

Table 1. Trends in Irrigated Lowland and, Rainfed Riceland, and Harvested Area and Production, 1974-1978

Year	Irrigated Lowland		Rainfed	Tidal & Swampy Area	Total Riceland	Area	Rice Production (1000 mt milled rice)
	Govt.	Village					
1974	2,628	1,028	1,990	587	6,233	8,509	15,275
1975	2,721	1,036	1,561	658	5,976	8,495	15,185
1976	2,811	1,033	1,414	651	5,871	8,369	15,845
1977	2,832	1,110	1,528	808	6,278	8,388	15,941
1978	2,904	1,114	1,421	875	6,314	8,701*	17,213*

* Estimated

programming, rivers, irrigation, swampy area, hydrolic engineering, and logistics.

The operation and maintenance of irrigation networks of the main system of government irrigation and water management are undertaken by Provincial Public Work services on behalf of the Provincial Government. On the other hand, the on-farm system routine work is the responsibility of village communities or beneficiaries.

The Presidential Decree No.1, 1969 requires that at the district/regency ("Kabupaten") level an irrigation coordination committee consisting heads of local government agencies should be constituted as follows: Regency head ("Bupati"), Chairman, head of Public Works, secretary and members - heads of Agricultural services, Agrarian office, Rural Development Office; and the Chief of Police. The objectives of the irrigation committee are to solve problems concerning irrigation and water distribution, and to encouraging water distribution schedule and planting calendar, in general, twice a year (rainy and dry seasons). The committee, therefore, is the coordinating body for water management. The government has since increased the activities for irrigation development by improving the skills of irrigation officials and beneficiaries in water management.

Table 2. Targets of Harvested Areas and Rice Production, 1983

Type of Land	Harvested Area (000 ha)			Yield (mt milled rice)			Production (000 mt)		
	Inten-sified	Non-in-tensi-fied	Total	Inten-sified	Non-in-tensi-fied	Average	Inten-sified	Non-in-tensi-fied	Total
<u>Existing</u>									
Govt. irrigated	3,400	600	4,000	2.74	2.09	2.64	9,320	1,255	10,575
Village irrigated	1,600	500	2,100	2.49	1.90	2.35	3,985	950	4,935
Rainfed	500	500	1,000	2.00	1.60	1.80	1,000	800	1,800
Other wet paddy	300	100	400	1.82	1.32	1.69	545	130	675
Dry field	400	800	1,200	1.22	0.77	0.92	488	617	1,105
Sub-total	6,200	2,500	8,700	2.47	1.50	2.19	15,340	3,750	19,090
<u>New Areas</u>									
Irrigated	-	-	350	-	-	1.75	-	-	612
Dry field	-	-	600	-	-	0.90	-	-	540
Tidal	-	-	175	-	-	1.25	-	-	218
Rice estate	-	-	150	-	-	1.50	-	-	225
Sub-total	-	-	1,275	-	-	1.25	-	-	1,595
Total	6,200	2,500	9,975	-	-	2.07	15,340	3,750	20,685

Source: Directorate General of Food Crop Agriculture, 1978.

Water Users' Associations

Village Setting

In discussing water users' association, it is important to note the general characteristics of the village and the role of village officials. There is a considerable variation among the village irrigation systems but there are some generalizations that can be made. A major distinguishing characteristic is their small size and their tendency to be located in hilly or mountainous terrains. The command area of tertiary units of government irrigation systems vary from 80 ha to 300 ha although the standard size is 100 ha which are located in lowland and flat terrain, mostly along coastal areas. The on-farm irrigation facilities in one village can cover other villages. Conversely, one village could be served by one or more irrigation systems.

For the most part, the kind of technologies present in village irrigation systems consists of simple structures made of locally available materials such as stone, bamboos and coconut tree trunks. Canal density is mostly less than 30 m with very limited drainage provisions. Field-to-field irrigation is a common method of irrigation. Villages ("desa") in Indonesia are divided into "kampung" or "dukuh" (hamlets or sub-village) each headed by a "kepala kampung/dukuh" (hamlet headman). Some "kampungs" have had close ties with neighbouring villages. It is important to note that the highest authority in the village rests with the "Kepala Desa" (village-headman) and his assistants (village officials). Hence, village officials with administrative responsibility, play a major role in any activities in the Desa, including irrigation matters. Hence, in making development designs and/or initiating the construction of irrigation network, it is imperative that the village officials be consulted or involved.

Formation of Water Users Association

Prior to the Government's effort to formalize the water users' associations in Indonesia there were already existent village communities such as the "Subak" mentioned earlier and the "Dharma Tirta". In both types of informal village communities, a ditch tender ("ulu-ulu") is elected by the villages whose job encompasses such activities as scheduling water distribution. These power structure at the village is being utilized instead of being disregarded in the current efforts of the government to organize formal associations. As a matter of fact,

in 1967 the Central Java Agricultural Services initiated a programme on rural irrigation development involving much of this power structure. Also, during the first session of the national field meeting on rural irrigation held by Ministry of Agriculture at Desa Celep in Central Java in 1969, that evaluated the policy and programme on rural irrigation development, the "Dharma Tirta" set up was formally recognized. These two occasions initiated the movement to organize more water users' associations in the country.

In 1971 the "Dharma Tirta" was formally declared by Provincial Governments the service area of which relates with the administrative boundaries of villages. Hence, the role of village headman is important in encouraging water management as shown in Figure 1. Since 1974 the government has taken an increasingly active role in promoting the development of water user association (P.3.A.) which is part of a larger effort to improve the ability of village communities to take on the responsibility of implementing irrigation projects.

The kinds and level of government intervention and control vary widely within specific systems. Similarly, the capacity of the "ulu-ulu" and P.3.A.s to undertake irrigation management varies among communities and systems. The appropriate policies and roles of Government in improving P.3.A. capacities is very important.

It is interesting to note that the tertiary level of irrigation which derives water from large government irrigation systems are often those which are poorly organized and managed compared with small village irrigations where the level of government involvement is less. The tertiary level of large government irrigation systems often depend on management and involvement of government, or on conditions in the wider irrigation environment. This means that when irrigation water is carried out in an orderly fashion, it is easier to promote effective irrigation at the farm level through the water users' association.

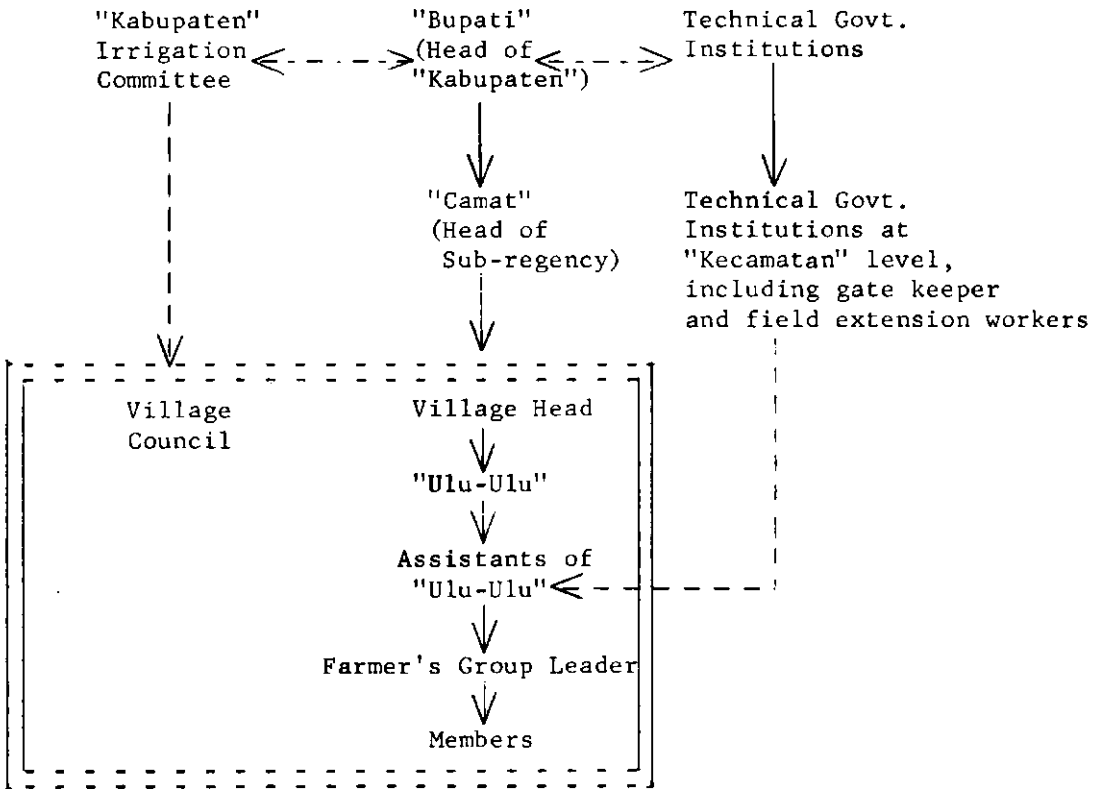
Up to the present time, only the P.3.A.s of four provinces have formal status from their Provincial Governments. Twenty-three others have yet to gain formal status. These four provinces are Bali, Central Java, West Java and West Sumatora where 4,944 P.3.A.s cover an area of 398,348 ha (Table 3). The average service area of a P.3.A. is approximately 100 ha.

Table 3. Distribution of P.3.A.s and Areas Served, 1978

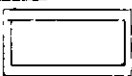
	P.3.A.	No.P.3.A.s	Area Served (ha)
Bali	Subak	1,262	98,673
West Java	Mitra Cai	2,568	171,460
Central Java	Dharma Tirta	1,114	128,215
Total		4,944	398,348

Source: Seminar on Institution of Water Users Association Semarang, Central Java, April, 1978

Figure 1. Organization Chart of a "Dharma Tirta", Central Java



Legend



= DHARMA TIRTA

————— = Command line

- - - - - = Coordination

- - - - - = Supervision & assistance

The major problems facing most village P.3.A.'s in carrying out construction and maintenance work on irrigation systems are: inadequate finances; lack of experienced technicians; lack of hand tolls; and social problems.

Problems at the Farm Level

The authority of a village headman is influenced by leadership qualities, custom, size and complexity of the irrigation system, nature of problem to be solved, level of interdependency with other neighbouring farmers among other considerations. The headman's irrigation role centres around his responsibility to help build a consensus in irrigation and cultivation activities that require coordination and frequently the mobilization of labour ("gotong royong"). The village headman is responsible for calling and presiding over meetings attended by other village officials (Hamlet heads, ulu-ulu desa), key farmers and cultivators themselves; and agricultural extension worker or irrigation officials usually meet twice a year prior to each cultivation season. On the ability of the village headman depends the result of such meetings and the ensuing activities in the village.

In recent years the government has intensified the training for water management skills for both farmers and irrigation officials. Farmer training is implemented in two ways: ad hoc training by projects and training as part of extension activities by the extension field worker.

The major problem in carrying out irrigation development activities is that there is sometimes a tendency among agencies to push crash programme without taking account of existing manpower constraints. This is the proverbial problem of moving from successful pilot units carried out under special efforts to extensive operations under different sets of efforts and conditions. The factors to be considered in constructing on farm system are quite complex and often different from those involved in designing and constructing the main system. The P.3.A.s are the major vehicles for improving the capacity of cultivators to assume subsequent responsibility for operation and maintenance of on-farm system.

5. JAPAN

Satoru Takeuchi*

Introduction

Trends in Irrigated Area

It is said that rice farming was introduced in Japan in the third century B.C. In the centuries that followed more and more land was gradually converted into paddy fields. Irrigation water was secured through building intakes or canals wherever a river or stream was available and through building small reservoirs. By about 1750 most of the existing irrigation systems in the plains along the lower parts of rivers were already developed. Further efforts have since been made to develop and improve irrigation and drainage systems in the country.

Table 1 shows the present status of irrigation system by source of water in Japan.

Table 1. Status of Irrigation System, by Source of Water

Item	Unit	Rivers & Streams	Reser- voirs	Others	Total
No. of projects	'000	303	113	82	498
"	(%)	(61)	(23)	(16)	(100)
Area of irrigated land	'000 ha	2,682	478	109	3,269
"	(%)	(82)	(15)	(3)	(100)

* Section Chief, Disaster Prevention Division, Structural Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries, Tokyo

Today as much as 95 percent of all paddy fields are irrigated which account for 57 percent of the total arable land.

Two major types of irrigation systems for paddy cultivation are observed. One type enables each field plot to be irrigated or drained independently of adjacent plots. The other is plot-to-plot irrigation. Previously, the plot-to-plot irrigation was rather popular but with the rapid progress made in land consolidation, the former type of paddy irrigation has since 1960 been preferred, presently accounting for 42 percent of all paddy fields.

Quite recently, pipe lines have been used in lieu of irrigation ditches at the farm level in some areas. This is a new system under which each plot can obtain a required amount of water when necessary through a valve from the pipe line. This system is generally costlier but has the following merits: i) saving of labour required for water management; ii) more efficient use of water; iii) saving of land for ditches; and iv) prevention of water pollution.

The area of arable land equipped with this type of irrigation facilities totalled some 83,000 ha in 1977 or 3 percent of all paddy fields. It is likely to increase in the future.

Irrigation in upland fields is mostly by means of sprinklers, mainly in orchards and for vegetables, tea and other horticultural crops.

Impact of Irrigation and On-farm Water Management on Productivity

Climate - Japan consists of a chain of islands extending from 27° to 45°50' north latitude. Japan belongs to the temperate zone but has a wide seasonal variation in climatic conditions as exemplified by very hot and humid summer under a high atmospheric pressure over the Pacific Ocean and cold and dry winter affected by strong seasonal wind from Siberia. The rains in June and July, typhoons in August and September and snows in winter, especially along the Japan Sea coast, are characteristic of the climatic conditions in the country.

The annual rainfall averages about 1,600 mm 30 to 50 percent of which falls in the rainy season in June to July. The rainfall during the rice growing season (May to August) is some 660 mm which is short of the water requirements for rice of 1,200 to 1,800 mm, hence the need for supplementary irrigation.

Rice can be grown only once a year owing to low temperature in winter.

Topography - Japan has a total land area of some 370 thousand sq. km, abounding with mountains and hills with steep slopes. Forest land occupies 67 percent of the total area, agricultural land 15 percent (paddy fields 9 percent), and others 18 percent, respectively.

Rivers descend steeply with rapid stream, with the result that the amount of water available for irrigation is small considering the amount of rainfall. In many areas, on the other hand, there are no rivers with adequate water, hence irrigation relies on reservoirs.

Much of the paddy fields are located in the low-lying plains and are from time to time visited by floods caused by typhoons or sudden copious rainfalls concentrated on a limited area.

There are many poorly-drained paddy fields in the lower parts of rivers and in surroundings of lakes and marshes. Improvement of drainage has been carried out in those field in order to reduce flood damage and to make possible farming operation using large-type machinery.

Table 2. Paddy Fields, by Gradient

Gradient	Area (1,000 ha)	Distribution Percent
Below 1/300	1,438	48
1/300 - 1/100	780	26
1/100 - 1/20	514	17
1/20 and over	289	9
Total	3,021	100

Productivity - The increase in rice yields in Japan was most notable during the past 100 years. With a shift from the traditional to the modern method of farming, rice yield per hectare increased from 2.4 mt in 1867 to 4.3 mt in 1950 and further to 5.8 mt in 1978 in terms of brown rice equivalent. The yield increase is mainly attributable to progress in farming technology, including the introduction of high-yield varieties, fertilizer, farm machinery, etc. as well as to irrigation and drainage facilities and on-farm water management which made possible the adoption of such advanced technology. Another important contributory factor has been the farmers willingness and efforts to adopt new farming practices and to cooperate in irrigation and drainage projects.

On the other hand, the average annual labour input in rice fields was reduced almost into one-half from 2,000 man-hours/ha in 1945 to 1,100 man-hours/ha in 1971 due largely to extensive and more efficient use of farm machinery which was, in turn, preconditioned by re-forming paddy fields into well-drained, large and consolidated plots.

A recent survey shows that 43 percent of all paddy fields consists of regular-shape plots of 10 ares * and over each, and that 53 percent has groundwater level of 70 cm or more or 90 percent with groundwater level of 40 cm or more.

In the northern part of Japan the rice crop is susceptible to cold-weather damage, hence on-farm water management is important as a means of preventing cold-weather damage to the crop.

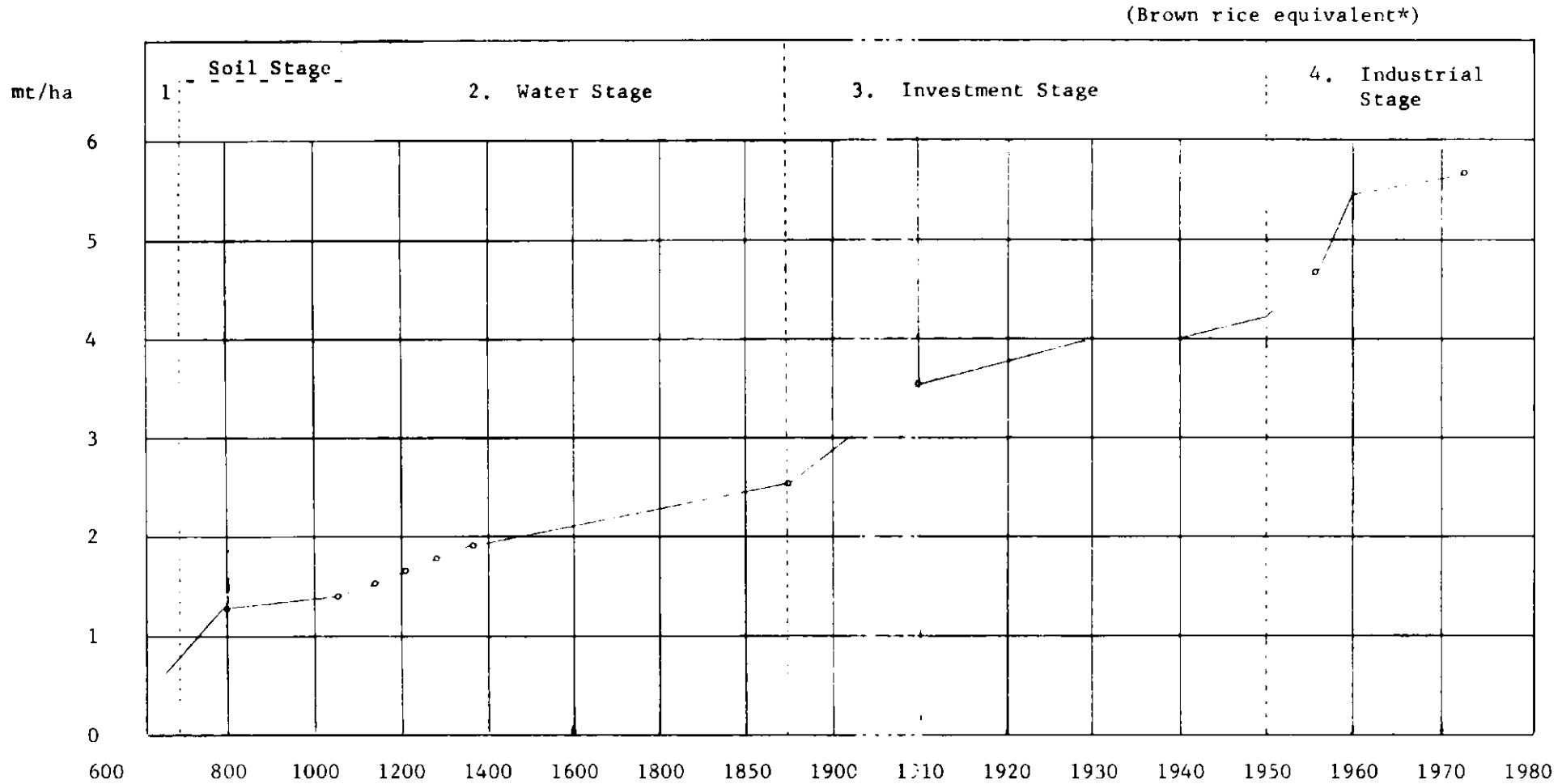
National-Level Problems

Diverted Use of Paddy Fields

At present the country's rice supply far exceeds domestic demand resulting in burdensome carryover stocks. For wheat, barley, soybeans and feed grains, on the other hand, indigenous production is so small that most of their supplies depend on imports. Therefore, steps have been taken to reduce rice acreage, hence production, and to increase the production of wheat, barley and soybeans instead by encouraging farmers to plant these crops in paddy fields.

* 100 ares equal 1 hectare.

Figure 1. Histocial Trends in Rice Yield per Hectare



* Brown rice is meant the husked, unpolished rice that is traditionally stored in Japan compared with unheeled rice (paddy) common in other countries, particularly in Asia.

To this end, emphasis in irrigation and drainage projects has been placed on the following:

i) Improvement of drainage in paddy fields through early elimination of rainwater and by lowering groundwater level;

ii) Improvement of irrigation and drainage systems through land consolidation which permits efficient water management in each plot independently of neighbouring plots; and

iii) Securing sources of water to satisfy increased duty of water resulting from land consolidation and land re-formation into well-drained paddy fields.

Proper Water Management

In recent years the water demand and supply situation in the country has become tight. Thus, proper water management the farm level is required in order to ensure efficient use of irrigation water which accounts for well more than half of the total use of water.

Organizational Features

Construction - Irrigation and drainage projects are divided into three levels depending on the scale of the project. Large-scale projects are planned and constructed by the state; medium-scale projects by the prefectures; and small-scale projects by the organizations of farmers. These projects are normally implemented together under a coordinated plan. In the case of state-operated projects, for instance, the state is responsible for the construction of head works, main canals, etc., while the prefecture constructs branch canals and the organization of farmers are responsible for the construction and maintenance of farm ditches.

Table 3. Distribution of Irrigation and Drainage Projects Currently Implemented

Implementing Agency	Number of Projects	Benefitted Area* (1,000 ha)
State	212	857
Prefectures	434	640
Organizations	1,049	188
Public corporations	6	44
Total	1,701	1,729

* Includes double counting to a certain extent.

Also, the method of cost sharing varies according to the executing body as shown in Table 4.

Table 4. Project Classification and Cost Sharing*

Executing Body	Land Area as Criteria (ha)	Cost Sharing			Repayment by Farmers		
		State	Prefecture (percent)	Farmers	Repayment period**	Interest** (percent)	
State	3,000 <	60	20	20	17	(2)	5.0
Prefecture	200 <	50	25	25	25	(10)	6.5 [6.05]
Organization	20 <	45	5-10	45-50	25	(10)	5.5 [5.05]

* For representative types of projects.

** Figures in parentheses refer to grace periods in loan repayment while those in brackets refer to interest for 1978 onward.

Operation and Management - Principal irrigation and drainage facilities are operated and managed mostly by land improvement districts organized by farmers. Terminal facilities have traditionally been operated and managed by such bodies as village communities, hamlets, or spontaneous associations. This is because the autonomous control among the farmers concerned was thought to be most appropriate since the control

of irrigation facilities means the distribution of water and, therefore, directly affects the interest of individual farmers.

Historically, most of the present irrigation and drainage systems were initiated during the Edo era (1603-1868) and have been well managed by farmers' autonomous efforts based on the order of village communities. The modern legal system has taken over this precedence, which is indeed well suited to the actual farming conditions.

Except for periodic maintenance, the operation and management of irrigation systems do not receive aid from the government.

Table 5. Managing Bodies for Irrigation Systems

Item	Number of Systems		Irrigated Area	
	Number	Percent share	Area (1,000 ha)	Percent share
State	59	0.1	142	5.1
Prefectures	244	0.2	82	3.0
Cities, towns & villages	12,034	10.0	183	6.6
Land improvement districts	27,830	23.1	1,433	51.5
Irrigation associations	47,292	39.1	529	19.0
Other bodies	5,015	4.2	120	4.3
Individuals	27,766	23.0	283	10.2
Unidentified	362	0.3	11	0.3
Total	120,602	100.0	2,783	100.0

Public Administration - At the national level both the Planning Department and the Construction Department of the Structural Improvement Bureau, Ministry of Agriculture, Forestry and Fisheries are primarily responsible for public administration with respect to irrigation and drainage since these aspects are component part of land improvement projects.

Likewise, at the prefectural level a division in charge of land improvement within the department of agriculture is responsible for irrigation and drainage.

The planning, design, implementation and operation of irrigation and drainage projects regardless of scale have been closely coordinated by the Ministry of Agriculture, Forestry and Fisheries since the immediate post-World War II years.

On the other hand, the Ministry of Welfare is responsible for the supply of drinking water and the Ministry of Construction for flood control, while the supply of industrial water and hydro-electric power generation are under the jurisdiction of the Ministry of International Trade and Industry.

Major Problems

Irrigation - The demand for water for various uses is likely to increase in the future. The demand for irrigation water is projected to increase from 57 billion cu.m to 65.5 billion cu.m in 1985 and further to 70 billion cu.m by 1990. The demand for water for all uses in 1975 amounted to 87.6 billion cu.m. The expected increase in demand will be 24.7 billion cu.m by 1985 and 32.6 billion cu.m by 1990.

If the construction of water resource development facilities like dams makes progress as planned and if groundwater is adequately developed, the total supply will more or less meet the total demand even as there may be some gaps in some areas.

When a dam is built, however, difficulties are often encountered in negotiating with the residents for compensatory payments in the area to be submerged. When water is newly channeled out of a river, adjustment has to be made with existing users downstream. More often than not such adjustment faces difficulty. For these reasons, it is somewhat questionable whether the water resource development facilities could be constructed as smoothly as planned. Another question is the pollution of, and increased rubbish in, irrigation water that has been caused by waste water from homes and factories as a result of rapid urbanization and slow provision of sewerage systems in recent years.

Drainage - There has been much progress in the primary improvement of drainage in paddy fields. Today, few paddy fields suffer from poor drainage to the extent that the use of farm machinery is inhibited. Only about 10 percent of all paddy

fields have groundwater level of 40 cm or less from the surface.

In order to facilitate the use of paddy fields for other crops and the introduction of large machinery, further improvement should be made to reduce the groundwater level and to enable each plot to be drained independently of neighbouring plots.

Operation and Management - In recent years difficulties were encountered in operating and managing the land improvement district (which controls principal irrigation and drainage facilities) owing to sophisticated and larger-scale installations, increasing number of part-time farmers' and rising wages.

As the number of part-time farmers continue to increase, they have generally become less active in agricultural production. As their farms are already provided with improved facilities for irrigation and drainage, many of these part-time farmers now show less interest in irrigation and drainage activities. As a result, not a few terminal facilities have suffered from poor management and the efficient use of on-farm water management is being adversely affected.

Problems at Project-level Operations

Organization and Coverage of Land Improvement Districts

Land Improvement Law - Land improvement projects in Japan are implemented under the Land Improvement Law of 1949, as amended. The Law provides for necessary procedures and regulations in order to carry out land improvement projects properly and smoothly. Its main components are land improvement district and the execution of projects.

The land improvement district is organized primarily by farmers who are owner operators. (For tenanted land, the tenant is normally a member of the district, and the land owner may become a member subject to approval of the local agricultural committee.)

The district is the sole executor of all kinds of land improvement work and is responsible for the construction, operation and maintenance and collection of charges. The projects may cover the construction, operation or alteration of land improvement facilities (such as irrigation, drainage, farm roads, etc.); land readjustment; land development; land reclamation; land exchange; and land consolidation.

When once the project area is determined, it is implemented with the consent of more than two-thirds of the concerned farmers except for land development where the consent of all farmers is necessary. The district is empowered to enforce the collection of charges from the concerned farmers.

For large-scale construction work requiring high-level technology, the state or the prefecture may undertake the actual work on behalf of the land improvement district when requested by the latter. In such cases the district handles the coordination of conflicting interests among farmers which may arise from the implementation of the project concerned.

Other provisions include the operation and management of land improvement districts, government's grants-in-aid and the consolidation of farmlands.

Status of Land Improvement Districts - The actual nature and functions of the land improvement districts vary widely according to the historical background and geographical location of the irrigation system concerned as well as the type and scale of facilities concerned. They are roughly classified as follows:

- a) Land improvement districts which own the principal irrigation/drainage facilities and which usually cover the area of a single city, town or village. The districts are distinguished between those engaged primarily in the operation and management of principal facilities, and in the execution of construction work of terminal facilities.
- b) Terminal land improvement districts which usually cover all or part of the area of a single city, town or village and are distinguished between those of permanent nature, engaged mainly in the operation and management of irrigation facilities, and temporary nature, engaged solely in the execution of construction work.

Alternatively, they can also be subdivided into i) irrigation system as such and ii) city, town or village level, according to the area covered.

The number of land improvement districts by size is shown in Tables 6 and 7.

Table 6. Distribution of Land Improvement Districts by Size of Area Served

Size Group of Area Served (ha)	Number of Land Improvement Districts	Percent Distribution
Under 50	3,246	34.0
50 - 300	3,852	40.3
300 - 1,000	1,773	18.5
1,000 - 3,000	501	5.2
3,000 - 10,000	168	1.8
10,000 & over	17	0.2
Total	9,557	100.0

Table 7. Distribution of Land Improvement Districts by Membership

Size of Membership (Persons)	Number of Land Improvement Districts	Percent Distribution
Under 300	5,877	61.5
300 - 1,000	2,617	27.4
1,000 - 5,000	955	10.0
5,000 - 10,000	77	0.8
10,000 & over	31	0.3
Total	9,557	100.0

Land improvement districts altogether cover some 3,500 thousand ha or 63 percent of all farm lands, with a combined membership of about 5 million persons.

At present the land improvement district is empowered to act in matters of land improvement and ancillary projects only. Other farm services and economic activities are entrusted to other agencies and farmers' organizations.

In view of the present need for locally organized farming, however, the land improvement district should play a more active role in this respect in close cooperation with the city, town or village authorities.

Major Problems and Constraints Facing Land Improvement Districts

As referred to earlier, with changing agriculture and rural communities in recent years, a variety of problems have been encountered by the land improvement districts. These are:

a. More Sophisticated, Larger-Scale Facilities - In the past the operation and management of irrigation and drainage facilities have been left to the farmers' autonomous control. In recent years, however, advanced technology has led to the construction of more sophisticated, larger-scale facilities. As a result, the land improvement districts find the proper operation and upkeep of such facilities difficult, both technically and financially. In addition, the feelings of solidarity among member-farmers has somewhat weakened and has added to management difficulties.

b. Increased Number of Part-Time Farmers - Japanese rural communities are no longer composed of a multitude of more or less homogenous small farmers with stable land tenure owing to the rapid increase in the number of part-time farmers in recent years. The differentiation into a majority of part-time farmers and a minority of full-time farmers has weakened the structure of a once solid a community. Many part-time farmers have tended to cooperate less and less actively in the land improvement district activities. The collapse of the old order of the community has led to less effective operation of the terminal irrigation system.

c. Rising Wage levels - Wage levels in Japan have increased tremendously in recent years against a limited rise in the rate of irrigation water charges. This inequity has contributed to a worsening of the financial position of many land improvement districts.

d. Urbanization of Rural Communities - As the progress in urbanization proceeds and the increase in the number of non-farm families in rural communities, continues problems on pollution are experienced even in rural communities. These include the inflow of waste water, dumping of rubbish, or the falling of children in irrigation canals.

Problems At The Farm-Level

Farmers' Obligations

The existing paddy fields in Japan were mainly developed during the Edo era (1603-1868), with irrigation projects mostly undertaken then by feudal landlords. The village or hamlet community was then the smallest unit of rural organization and the arable land more or less centered around such units. Therefore, the distribution of water at the terminal irrigation facilities and the maintenance of canals and ditches were left to the village or hamlet community. Water management within a village or hamlet was coordinated by the concerned community, while the inter-village/hamlet coordination was conducted by the assembly of representatives of all the villages/hamlets concerned. It may be safely said that the present system has for the most part inherited that pattern of water management.

The following illustrates an example of water management in a certain land improvement district of the recently completed state-executed large-scale project, which irrigates some 10,000 ha of land held by about 23,000 farmers. There are 60 km of main canals, 90 km of branch canals and 160 km of ditches. The organizational setup for operating this irrigation system is briefly described below from the lowest level upwards:

Unit irrigation committees - A unit irrigation committee is set up in each hamlet. It controls the terminal ditches and coordinates distribution of water within the hamlet. While the total number of hamlets is 600, there are 800 such committees because some hamlets have more than one line of canals. On the average, 30 farmers constitute a unit irrigation committee.

Branch canal irrigation committee - A branch canal irrigation committee is set up for each branch canal. It controls the branch canal and coordinates the distribution of water among the hamlets along the branch canal. There are 18 of these committees.

Irrigation coordination committee - The land improvement district directly controls the main canals, while the irrigation coordination committee is responsible for coordinating the distribution of water among the branch canals.

Before undertaking an irrigation project, the farmers at various levels, e.g. hamlet or along the planned branch canal, are given the opportunity to discuss and examine how to operate and manage the facilities when completed, rate of water fee, etc.

A prior agreement among the farmers to undertake the project is necessary.

After the facilities are completed, their operation and management and the collection of water fee are done according to the agreement. The water fee is collected by the land improvement district which is generally based on the area of land served though in some cases on the amount of water delivered.

Training of Farmers in On-Farm Water Management

There is no felt need to train the farmers in water distribution at the terminal facilities because traditionally, they have had good skills in this respect, especially in water-deficient areas, e.g., areas dependent on reservoirs where various age-old methods and practices for ensuring the efficient use of water are observed.

As far as water management in individual paddy fields from the agronomic point of view is concerned, technical advice is provided to farmers as a part of the agricultural extension service. At present there are approximately 600 local agricultural extension offices with some 10,000 extension agents all over the country.

Major Problems and Constraints

The main problems that render better water management practices difficult at the farm level are the increased number of part-time farmers who are generally less active in agricultural production and the existence of many paddy fields yet to be improved in respect of farm ditches.

In fully improved paddy fields under the land improvement or consolidation projects water management in each plot of paddy field can be entirely at the discretion of the cultivator independently of the adjacent fields. For progressive farmers this implies that they can make the most of water use in further developing their farming operations. In contrast, it is also noted that less active farmers tend to become equally less active in water management partly because they are short of labour and partly because they need not fear that improper management of water in their plot may disturb the neighbouring fields.

6. THE REPUBLIC OF KOREA

Dong-Man Kim*

Introduction

The Rep. of Korea is located in the temperate zone. Because of her moderate temperature, humid weather and fertile soil condition, agriculture has since ancient times been a preoccupation of the Koreans. However, since the land is limited (98,858 sq. km) and the density of population is high (369 men per sq. km) and a population of 36.5 million, food crops have in short supply until very recently (1976).

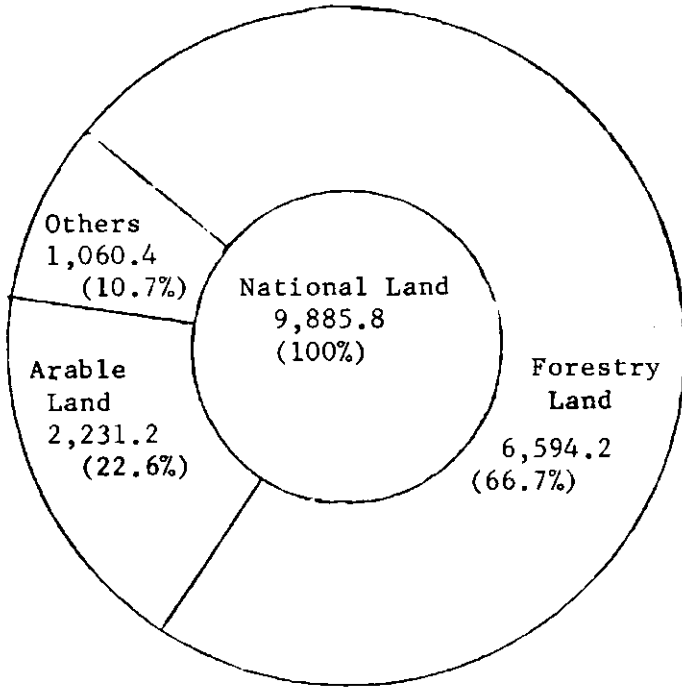
The terrain is rugged, hence only 22.6 percent of the land is arable and 66.7 percent is either wooded or denuded forest lands. The total arable land in Korea is only 22,312 sq. km consisting of 13,032 sq. km wet paddy fields and 9,280 sq. km of dry farm. The arable land is possessed by 2.3 million farming households (farm population of 12.3 million or 33.8 percent of the total). The average farm size is less than a ha (0.97) (Figure 1).

It is against this backdrop that the government has long been making efforts to improve farming methods, agricultural production and the farmer's living standard. The efforts have recently been rewarded as the average rice production has reached 5 mt/ha and that self-sufficiency in rice has been achieved since 1977.

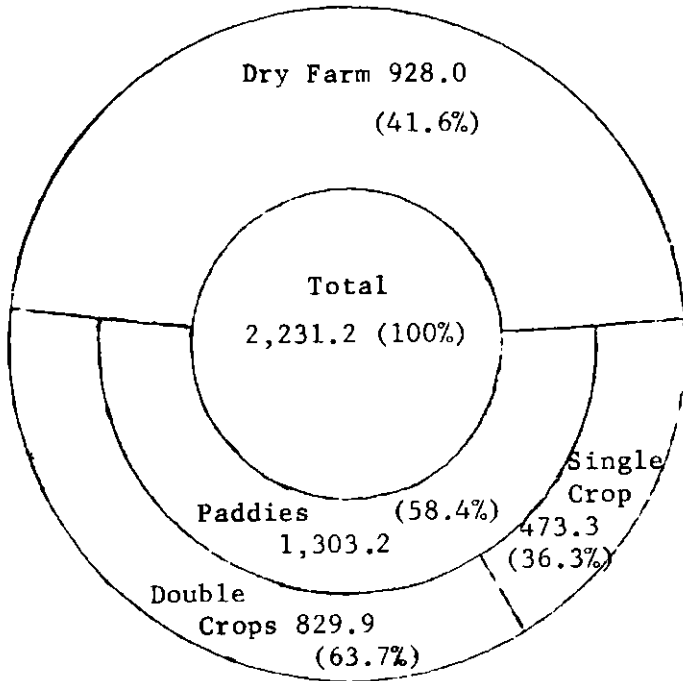
The farmer's living standard has likewise improved and become slightly better than that of urban labour's since 1978 because the farmers are not only engaged in farming work but also in local industrial activities since the SEMAUL Movement started in 1971.

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Figure 1. Land Use, 1977 (Unit: 000 ha)



Distribution of Total Land Area



Distribution of Arable Land

Irrigation Activities

Need for Irrigation

Rice is both the main food of Korean people and the major component of agriculture in the country. For rice cultivation, water is one of the most important inputs. Since time immemorial, the Korean farmers have been trying to obtain sufficient irrigation water for their paddy fields.

According to Korean history, ancient Korean farmers started their irrigation activities since 144 A.D. even as it is believed that actual irrigation activities must have started before that period.

Annual precipitation in Korea is approximately 1,200 mm, and it is usually sufficient for rice cultivation. However, since it is concentrated in July and August, farmers often encounter water shortage during transplanting and rice growing seasons (Table 1).

Approximately 114 billion cu.m of precipitation falls annually of which approximately 51 billion cu.m, equivalent to 45 percent of total precipitation is lost through evaporation, 50.5 billion cu.m (equivalent to 44 percent of total precipitation) is lost through runoff, the balance (12.5 billion cu.m equivalent to 11 percent of total precipitation) is utilized for agricultural, industrial and domestic water supplies (Figure 2).

Irrigation Facilities

The irrigation facilities in the country include 17,610 reservoirs, 2,729 pumping stations, 17,036 diversion weirs and 1,218 feed canals that utilize surface water. Some 672,582 ha of paddy fields (equivalent to 51.6 percent of total) are irrigated by surface water. There are 5,292 filtration galleries and 25,686 tube wells that utilize groundwater which irrigate 33,534 ha (equivalent to 2.6 percent of the total). In addition, mobile pumps and minor irrigation facilities irrigate some another 398,067 ha or 30 percent of the total (Table 2). This means that a total of 1,104,183 ha of paddy lands or 85 percent of the total are irrigated. The remaining 198,977 ha are rainfed.

Table 1. Annual Precipitation, 1977

(Unit: mm)

Province	Observation Station	Monthly Precipitation												
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Gyong-Gi	Su-Won	22	23	56	88	86	144	355	255	163	55	44	27	1,318
Gang-Weon	Chun-Chon	21	23	48	95	78	141	431	268	163	55	44	19	1,386
Gyong-Buk	Dae-Gu	20	26	43	72	74	128	221	166	141	43	32	21	987
Gyong-Nam	Bu-San	33	42	81	129	140	199	268	181	186	68	51	32	1,410
Chung-Buk	Chong-Ju	25	26	54	87	84	164	281	213	155	48	40	28	1,205
Chung-Nam	Dae-Jon	28	35	60	94	87	173	291	241	150	55	47	28	1,289
Jeon-Buk	Jeon-Ju	29	34	61	85	92	145	283	240	158	56	49	31	1,263
Jeon-Nam	Cwang-Ju	34	38	68	97	101	160	251	205	178	56	49	34	1,271
Je-Ju	Chae-Ju	64	70	67	89	91	157	219	233	226	76	70	62	1,424
Total	9	276	317	538	836	833	1,411	2,600	2,002	1,520	512	426	282	11,553
Average		31	35	60	93	93	157	289	222	169	57	47	31	1,284

Figure 2. Water Resources and Utilization
(Annual)

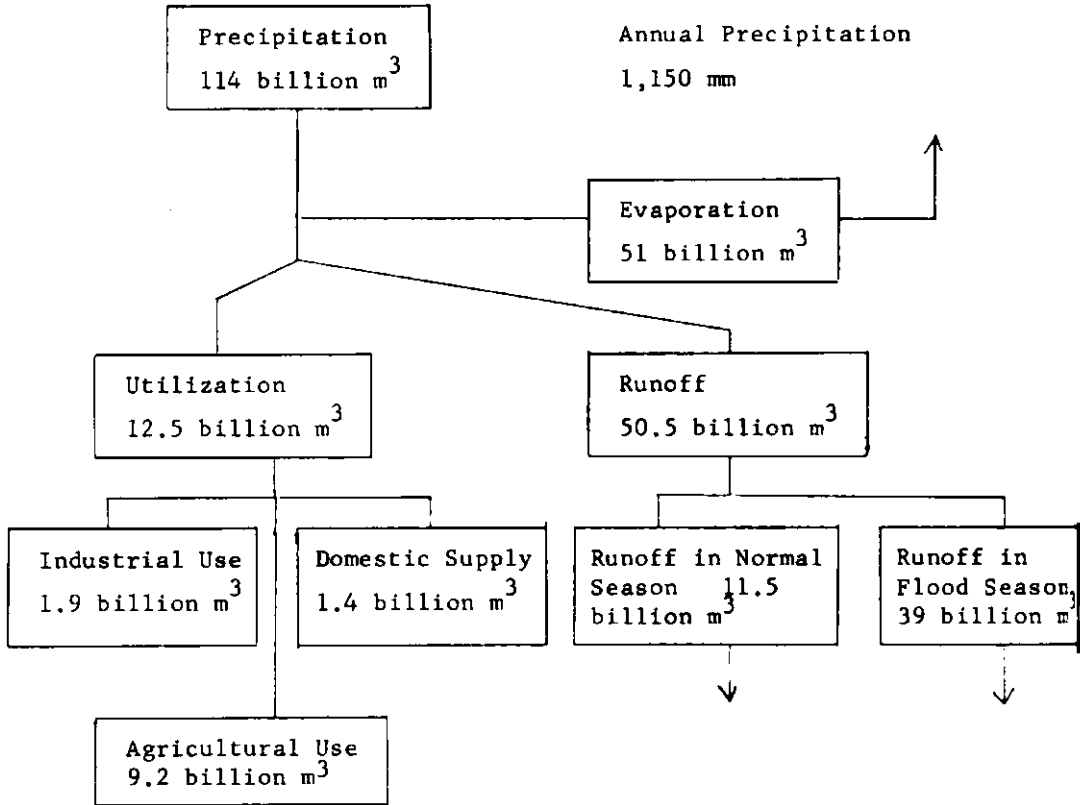


Table 2. Source of Irrigation Water and Irrigated Area, by Facilities

Item	Facility	Number	Benefitted Area (ha)
<u>Irrigated fields</u>			
	Reservoir	17,610	440,748
Surface water (52 percent)	Pumping station	2,729	102,839
	Diversion weir	17,036	120,127
	Feed canal	1,218	8,868
Ground water (3 percent)	Filtration gallery	5,292	19,994
	Tube well	25,686	13,540
Others (31 percent)	Mobile pumps*		78,446
	Other minor facilities		197,557
	Replacement of facilities required		122,064
Sub-total		69,571	1,104,183
<u>Partially irrigated</u> (15 percent)			198,977
Grand total			1,303,160

* 116,590 pumps are possessed by farmers

Future Development Plan

As shown in Table 3, the Korean Government plans to develop 198,977 ha of partially irrigated or rainfed paddy lands. The plan contemplates on establishing more than 27 thousand large- and small-scale surface water and groundwater facilities to irrigate 196,828 ha. The remaining area would be left unirrigated and the farmers who own these rainfed areas will be encouraged to convert the paddy fields into dry farms.

Until recently the irrigation activities were confined to rice cultivation. However, in the current drive to increase the production of other agricultural commodities, irrigation for dry farms and orchards is being contemplated. Already demonstration work on this aspect is being conducted nation-wide. Also, plans are about to undertake reclamation of tidelands and mountain slopes to expand farm lands.

Table 3. Future Irrigation Development Plan*

Item	Facility Planned	Number	Area to be Irrigated (ha)
Non-drought area	Reservoir	4,531	105,374
	Pumping station	485	24,231
	Diversion weir	1,750	23,095
	Sub-total	6,766	152,700
Drought area	Tube well	17,299	14,018
	Filtration Gallery	1,266	10,798
	Pumping station	1,268	15,593
	Diversion weir	513	3,719
	Sub-total	20,346	44,128
Rain-fed (development impossible)			2,149
Total			198,977

* For partially irrigated paddy fields, 198,977 ha.

Irrigation Association

Status of Irrigation Associations

In the Rep. of Korea, all farmland improvement activities, including irrigation projects are planned by the Government (Ministry of Agriculture and Fishery). On the other hand, the survey, design and supervision of irrigation projects are carried out by the Agricultural Development Corporation. However, after completion of the project, the facilities are handed over to the Irrigation Associations for their operation and maintenance. These associations are otherwise known as Farmland Improvement Associations.

As shown in Table 4, there are 123 irrigation associations in the country with a total membership of 733,488. Some 391,675 ha equivalent to approximately 30 percent of all paddy field are benefitted by water supply from 1,314 pumping stations, 2,082 reservoirs, 2,846 diversion weirs, 77 feed canals, 492 filtration galleries and 3,065 tube wells.

Rice Production and Water Charge

Table 5 shows that the average rice production in the area of irrigation associations was 4.95 mt/ha polished rice and the maximum average production was 5.36 mt/ha.

Water charges assessed by the irrigation associations were 60,440 Won/ha (485 Won = US\$1). The maximum water charge was 245,270 Won/ha and the minimum charge was only 1,170 Won/ha.

Water charges collected by the associations are spent for the operation and maintenance of the irrigation facilities and for the repayment of long-term loans. In the Rep. of Korea, 70 percent of the installation cost of the irrigation facilities is covered by the government subsidy and the balance met by long-term loans which bear an annual interest of 3.5 percent and payable in 30 years.

Table 4. Status of Irrigation Associations

Location	Number	No. of Members	Benefitted Area (ha)	Distribution of Facilities					
				Pumping Station	Reservoir	Weir	Feed Canal	Infiltration Gallery	Tube well
Gyong-Buk	21	123,655	49,126.8	292	419	330	16	97	823
Gyong-Nam	18	111,064	47,263.3	263	278	514	17	59	263
Jeon-Nam	18	140,652	62,188.5	170	743	597	26	208	1,119
Chung-Nam	15	88,893	56,057.3	164	141	264	1	16	188
Gyong-Gi	15	83,024	59,288.7	138	116	134	3	23	231
Jeon-Buk	12	121,968	88,057.6	190	195	445	10	21	131
Gang-Won	11	17,359	10,176.4	19	54	121	1	21	138
Chung-Buk	9	41,015	18,270.9	69	130	437	3	46	164
Seoul	2	4,021	981.4	6	-	2	-	1	-
Busan	1	-	-	1	-	-	-	-	-
Je-Ju	1	1,837	263.9	2	6	2	-	-	8
Total	123	733,488	391,674.8	1,314	2,082	2,846	77	492	3,065

Table 5. Rice Production and Water Charge of Irrigation Associations

Location	No. of Association	Irrigated Area (ha)	Production (mt polished rice)		Water Charge/ha (Won)			Assessment (1,000 Won)*
			Per ha	Total	Average	Maximum	Minimum	
Seoul	2	1,151	3.86	4,480	79,880	94,870	43,570	92,590
Busan	1	-	-	-	-	-	-	-
Gyeong-Gi	15	56,477	4.76	268,831	82,460	154,610	9,370	4,660,781
Gwang-Won	11	10,169	4.55	46,269	63,480	165,860	15,700	646,039
Chung-Buk	9	18,272	5.33	97,389	63,720	160,230	14,060	1,163,190
Chung-Nam	15	54,579	5.36	292,543	65,120	131,190	1,170	3,552,581
Jeon-Buk	12	83,841	4.98	417,528	50,830	99,790	4,690	4,256,356
Jeon-Nam	18	60,534	5.13	310,538	52,240	115,260	3,050	3,162,561
Gyeong-Buk	21	47,765	4.74	226,406	55,520	173,590	1,410	2,647,562
Gyeong-Nam	18	46,254	4.61	213,229	59,270	245,270	3,200	2,745,312
Je-Ju	1	196	3.68	722	53,650	65,590	37,480	10,522
Total	123	379,247	4.95	1,877,933	60,440	245,270	1,170	22,937,494

* 485 Won = US\$1

7. NEPAL

P. P. Gorkhaly*

Introduction

Water is a basic natural resource available easily in Nepal. It comes mainly from the south-east monsoon rainfall which averages 1,250 mm a year and is received during the months of June through September.

Thousands of stream that flow from north to south across the country are filled with water during the monsoon season carrying with it fertile soil and causing erosion. Most of them dry up just after the monsoon season and some do not get water until March or April. All but three rivers are large: "Kosi" in east; "Narayani" in west and "Karnali" in the far west. These rivers have their head water in the main Himalayan range and are perennial due to glacial origin. As innumerable streams having variable discharges are available in Nepal, the main aim of the Government is to utilize the stream water for irrigation, hence increase production and the productivity of the land.

At the Narayani Irrigation Development Project, an irrigation and drainage system network is being constructed to service 31,400 ha of land in Bara and Persa districts.

The smallest irrigation unit services about 7.5 to 10 ha. Water users' group have been organized in areas where the irrigation canal and drainage construction works are completed. The project has a rigid schedule method of water delivery. The operation and maintenance of the irrigation system up to the turnout of the tertiary canal is performed by the project, and thereafter, the division boxes and field channels are operated by the farmers.

The Kankai Irrigation Project aims to provide water to 8,000 ha. Farmers' organization will be set up in the entire project area which will organize farm practice groups and village cooperatives. At present three farmers' committees and two village cooperatives work in the project area.

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The total land area brought under irrigation by the end of the Fourth Plan (1974/75) was 176,218 ha.* For the Fifth Plan (1975/76 to 1979/80) the target of irrigation projects, minor irrigation projects, tubewell irrigation projects run by His Majesty's Government Department of Irrigation, Hydrology and Meteorology and farmers' small irrigation projects is to develop 146,000 ha more for irrigated lands. The area planted to foodgrains in 1976/77 was 2,202,000 ha.**

The main object of conventional irrigation projects is to divert water from rivers using structural works such as diversion dam, main and branch canals, including their facilities. The projects are operated and maintained by the Department of Irrigation, Hydrology and Meteorology. At the planning stage, field channels and structures required for water distribution and utilization at the farm level are not included, hence on-farm water management. In view of the importance of on-farm water management the Farm Irrigation and Water Utilization Division under the Department of Agriculture has been established for that purpose.

Forth-six tubewells drilled by the Department of Irrigation, Hydrology and Meteorology have already been handed over to the Department of Agriculture for management, control and distribution of water at the farm level. On behalf of Department of Agriculture, the Farm Irrigation and Water Utilization Division lays out the irrigation and drainage networks at the farm level. With the cooperation of concerned divisions of the Agricultural Department and related agencies, a programme to increase cropping intensity and crop diversification is maintained through the provision of training and demonstration project for farmers on such topics as water utilization, improved seeds, fertilizers, pesticides and agricultural implements.

* Fifth Five Year Plan, H.M.G.

** Agricultural Statistics of Nepal 1977, Department of Food and Agricultural Marketing Service.

The Farm Irrigation and Water Utilization Division

This Division under the Department of Agriculture was established for irrigation water management projects in 1973. The main development phases for on-farm water management of irrigation projects are four:

- First phase - Design and construction of field channel layouts.
- Second phase - Increasing cropping intensity of commanded area of the project.
- Third phase - Land development for efficient water management.
- Fourth phase - Implementation of efficient water use.

After the engineering survey of irrigation projects, field channels are constructed at His Majesty's Government cost, but on the basis of voluntary procurement of land. After completing the first phase, the cropping programme is launched to provide facilities of improved water control at the farm level and to increase agricultural production with a minimum annual cropping intensity of 250 for tube well projects and 200 for surface irrigation projects.

On the other hand, the land development programme consists of i) providing irrigation facility directly to each farmer's field; ii) regular land shaping of individual farms; iii) land levelling for each farm; iv) providing drainage facilities; v) land consolidation within the area; vi) digging a compost pit at each field; and vii) application of fertilizers.

Implementation of On-Farm Water Management Projects

After completing the technical and administration procedures brick-lined field channels for tubewells and earthen channels for surface irrigation are constructed along with turnouts, division boxes, cross-drainage structures and others. A small pump house and water measuring tank with a V-notch are constructed in each tube well. A small house is provided to each field assistant for tubewell projects and each fieldman for surface irrigation projects. Field assistants and fieldmen look after the management, control, and distribution system along with the agricultural development programme within the irrigation areas.

Water Utilization Programme

The Farm Irrigation and Water Utilization Division has also started a programme on efficient water use in 46 tube well projects and three surface irrigation projects. The progress of development of one of the tube well projects (No. 5, Bara Parsa, Fig. 1) and a surface irrigation (Patharia, Fig.2) will be cited for this purpose. In tube well No. 5, two phases of implementation have already been completed and land development programme at the third phase has just started in four ha of land (Figure 1). In these areas, there are 13 farmers each of which has a turnout for each individual farm. The irregular shape of the field has been turned into a regular one and each individual plot has been levelled. Drainage facilities are provided to all plots. Compost pits are dug on each field plot. Chemical fertilizers are applied after land levelling to maintain fertility. This programme receives technical and financial help from the Farm Irrigation and Water Utilization Division.

After launching the water utilization and distribution programme, the following activities were undertaken by the Division in tubewell No. 5:

- 1) Construction of main and lateral channels (which were brick-lined) and a number of control structures.
- 2) Identification of the command area for the tube wells based on peak water use demand of crops.
- 3) Stationing of a junior technician with irrigation background in the command area to do extension, supervision and other related work.
- 4) Initial steps taken in collaboration with Parwanipur Agricultural Research Station for field demonstrations of improved seeds of paddy, wheat, mung bean and maize, including a suitable crop rotation.
- 5) Conducted farmers' training on irrigation for optimum utilization of water.
- 6) Initiated a nominal water charge to cover fuel consumption of the pump in order to pre-condition the water users to paying water charges.

Figure 1. Tube well Water Use and Distribution Project
Tilawe, Bara Parsa, Nepal

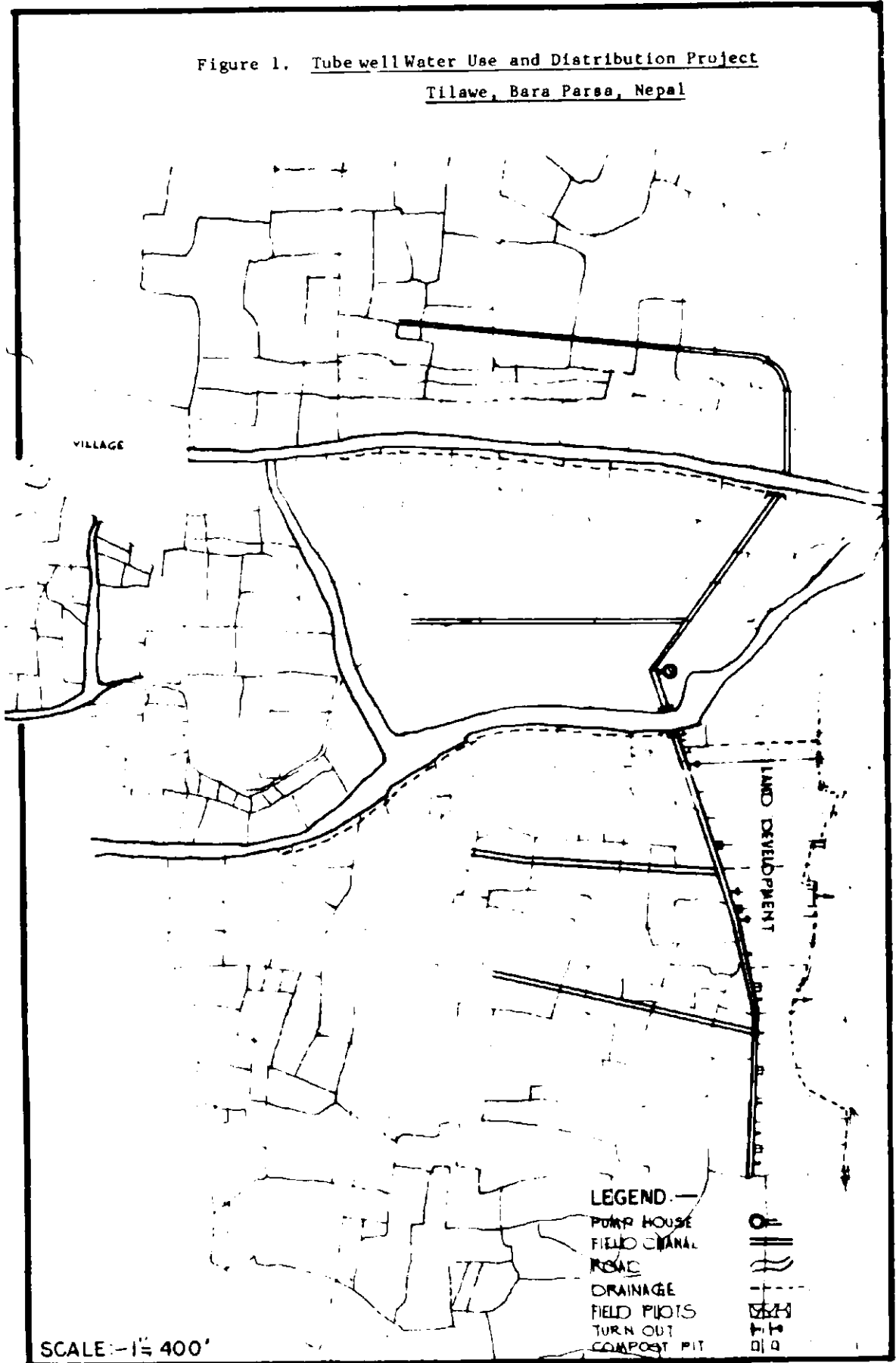
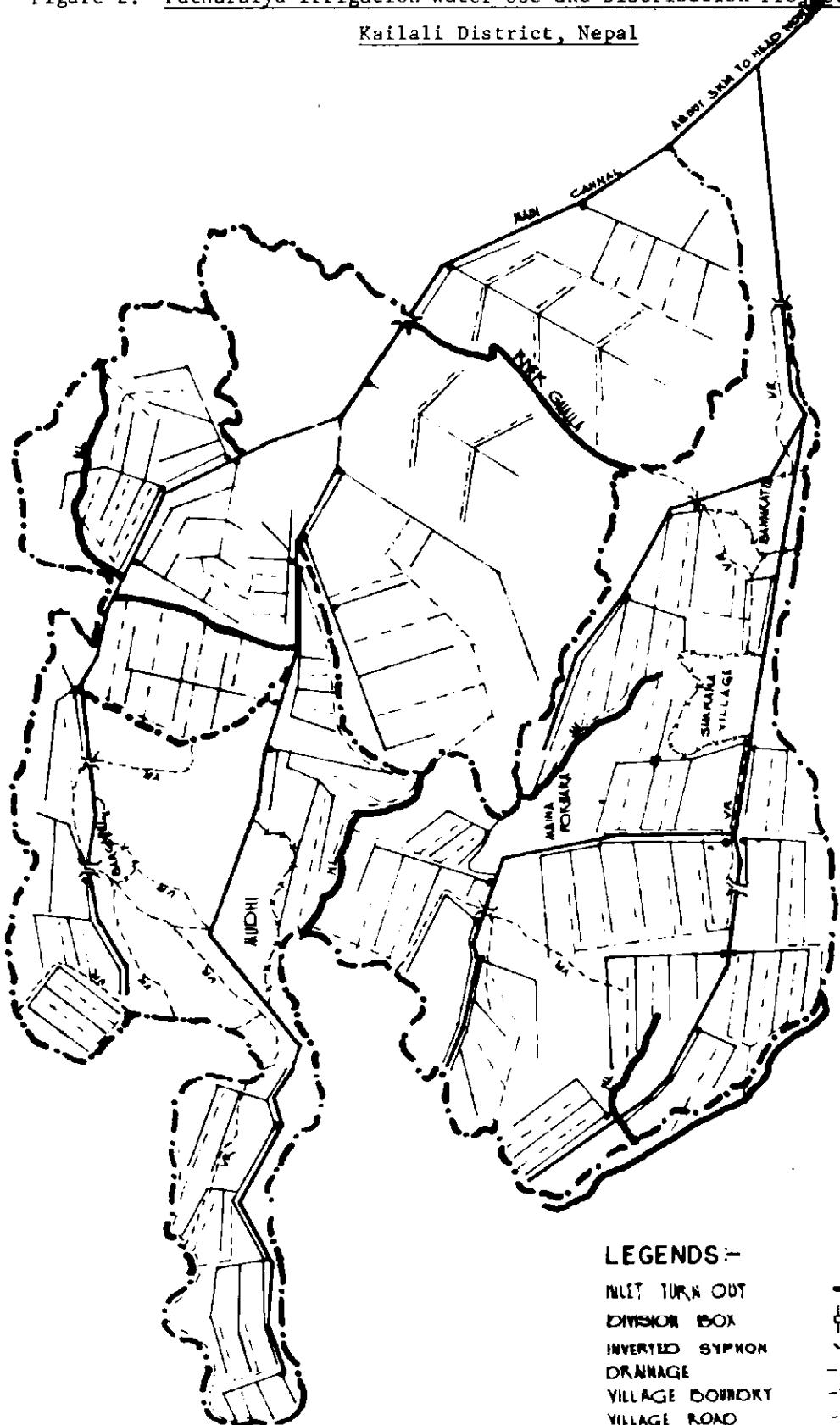


Figure 2. Patharaiya Irrigation Water Use and Distribution Project
Kailali District, Nepal



LEGENDS -

- INLET TURN OUT
- DIVISION BOX
- INVERTED SYPHON DRAINAGE
- VILLAGE BOUNDARY
- VILLAGE ROAD
- MAIN BOUNDARY LINE
- FIELD CHANNEL
- MAIN CANAL

SCALE - 1:38400

Table 1. Incomes and Expenditures of Tube well
Nos. 4 & 5, Parsa District, 1974-1977*

(Unit: Rs.)

Year	Revenue	Expenditures**
74/75	3,112	20,693
75/76	8,353	9,002
76/77	5,191	7,166

* P. P. Gorkhaly, Management Control and Distribution System of Irrigation Water of Tube well Project in Nepal.

** Essentially for feed.

The impact of the introduction of tube well water utilization and distribution programme are as follows:

- 1) Irrigation time for one "bigha" (0.625 ha of land) has been reduced from 8 to 5 hours in medium soil.
- 2) Due to introduction of water charges, farmers have become more conscious and judicious in using tube well water.
- 3) Seepage loss was reduced considerably and water has become easily accessible through turnouts. Water thus saved is utilized to irrigate other areas.
- 4) Farmers have started to adopt improved varieties of seed, fertilizer use and crop rotation.
- 5) Water for irrigation has become easily available for farmers on demand at first-come-first-served basis.
- 6) The Agricultural Development Bank has made loans available for farmers for use in paying water charges.
- 7) Four groups of water users have been organized to look after the water distribution programme.
- 8) Records of water delivery are being maintained for periodic evaluation.

- 9) Farmers have signified intentions to cooperate in land development projects.
- 10) Area planted to crops have increased through the years as shown in Table 2.

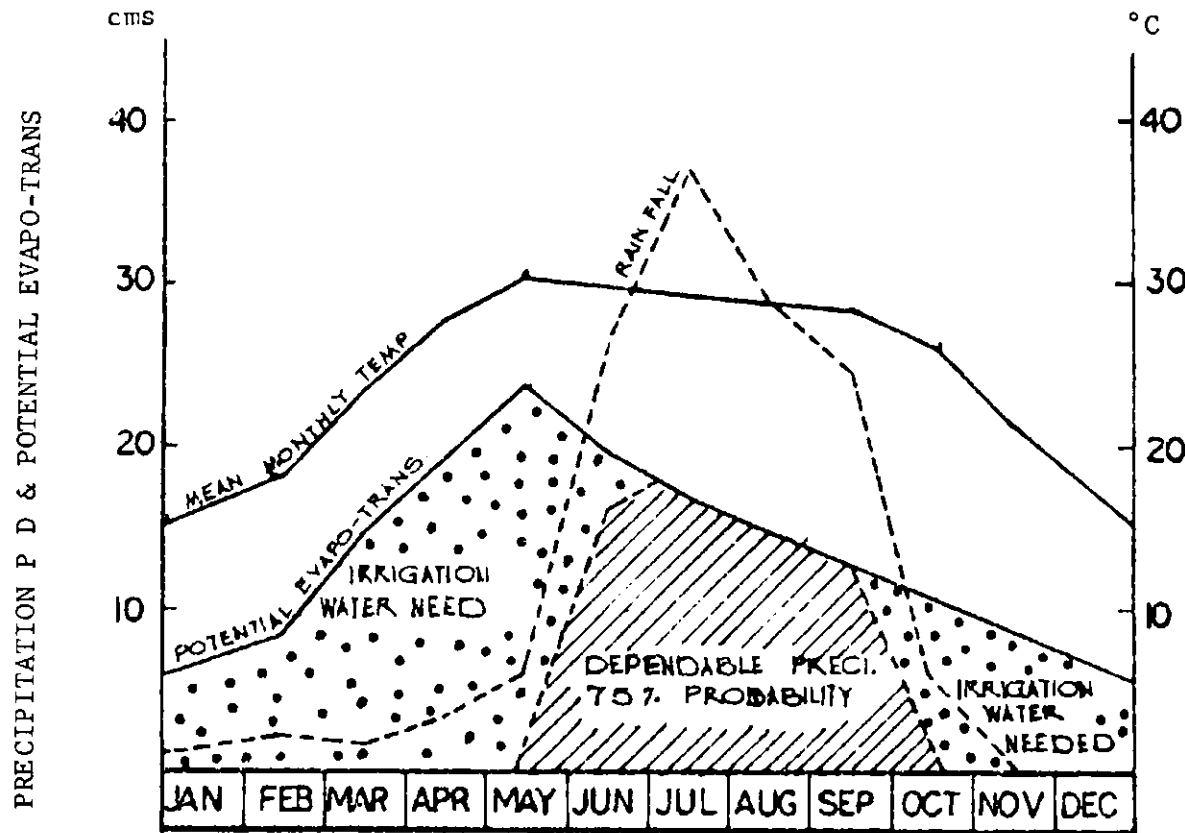
Table 2. Command Area, Tube well No. 5, Parsa*

Crop	(Unit: ha)				
	1973/74	1974/75	1975/76	1976/77	1977/78
Paddy (early)	-	-	18.75	18.75	25.00
Paddy (main)	10.00	15.62	25.00	37.50	46.88
Wheat (local)	6.25	9.37	-	0.65	-
Wheat (RR - 21)	-	-	12.50	35.00	40.63
Maize (improved)	-	-	-	1.25	1.25
Sugarcane	-	-	-	0.63	1.88
Mung bean	-	0.31	-	0.94	0.63
"Masuri"	-	-	-	0.19	0.63
Vegetable	-	-	-	-	0.31
Total	16.25	25.30	56.25	94.90	117.20

* Gorkhaly, P.P., op, cit

Figure 3 shows the monthly temperature, precipitation and evapo-transpiration at the Purwanipur Agricultural Research Station (About 20 km from the tubewell area). It will show that there is no need of irrigation during the month of June, July, August and September, because of the available precipitation which exceeds the potential evapo-transpiration.

Figure 3. Hydro-meteorological Data, Parwanipur Agricultural Station, Bara, Nepal



The Division is working to effect land development successfully with the aid of extension method. It also aims to formulate an improved cropping system based on available water, crop and soil characteristics in cooperation with other agricultural related organizations of the Department of Agriculture.

The Patharaiya irrigation water use and distribution project started in 1976 has a command area of 2,000 ha. The head work, main and branch canals were constructed by the Department of Irrigation, Hydrology and Meteorology. The total length of main and branch canal is about 30 km and their designed capacities were 100 cfs and 60 cfs, respectively.

Due to lack of field channels, proper utilization and distribution of water was ineffective. This project started out with a survey of 500 ha out of 2,000 ha of the command area. The survey and planning were designed to include inlet structures to tap the irrigation water from main/branch tertiary canal, division box, side and end turnouts, inverted syphon, cross drains, foot bridge, drop structure (Figure 2). The survey for the remaining 1,500 ha already been completed and its construction was started in the fiscal year 1978/79.

Coordination of Agencies in Farm Water Management

The main object of providing facilities for improved on-farm water control is to increase agricultural production. To accomplish this object, farm-tested cropping systems and improved cultural practices along with seeds and fertilizers and credit will be provided to the farmers with the help of field assistants, junior technical assistants and junior technicians. The success of this programme will depend largely on the project in-charge. The project will be further strengthened by the Division through the provision of technical, financial and administrative help as well as a coordinated effort among various agencies concerned.

Problems of On-Farm Water Management

The major problems of on-farm water management in Nepal may be summarized as follows:

- 1) Small, irregular and fragmented land holdings.
- 2) Lack of farmers' technical knowledge on proper water application.

- 3) Lack of empirical information on irrigation timing, quantity of water and methods of growing different crops on varying conditions.
- 4) Lack of regular climatological data on the project site.
- 5) Transportation and communication difficulties.
- 6) Land acquisition for drainage purposes.
- 7) Water users' groups still ineffective.
- 8) Coordinated programmes have yet to be organized.

Effective on-farm water management is the focal point of all irrigation projects. Its success depends to a large extent on the proper utilization of water. The modern concept of irrigation, therefore, does not stop with the supply of water alone but involves the application of knowledge of management, control and the distribution of irrigation water to derive the maximum benefit from irrigation.

8. PAKISTAN

M. Ashraf Akhtar*

Introduction

Pakistan is arid to semi-arid with an average annual rainfall ranging from only 50 mm to 800 mm. The total land area is 79.61 million ha. The population is about 75 million and of which nearly 75 percent lives in rural areas.

Agriculture is the mainstay of Pakistan's economy, contributing nearly 35 percent of gross domestic product and providing employment to about 57 percent of the labour force. Moreover, nearly 59 percent of the total export of the country originates from agriculture.

The total land area suitable for agriculture is estimated to be 33 million ha. At present, only 19.5 million ha are annually cultivated of which 13.6 million ha (70 percent) are irrigated. The main source of irrigation is canals which irrigate about 10.5 million ha (77 percent). Tube wells serve a total command area of 2.4 million ha. The remaining area is irrigated by tanks and other sources. The major crops grown in the country are wheat (34 percent), rice (10 percent), cotton (10 percent), and sugarcane (4 percent). About 90 percent of wheat and virtually all rice, cotton and sugarcane are grown in irrigated areas.

Irrigation System

The canal irrigation system in Pakistan is reputed to be largest, contiguous irrigation system in the world. It consists of 48 principal irrigation canals, 12 link canals, 20 river diversion structures and three large dams with a capacity of 18.9 billion cu.m. The cumulative operating capacity of the canals is about 6,990 cu.m per second. The total area served by canals is 17.04 million ha of which 82 percent is cultivable. The present annual diversion of the canals are about 126 billion cu.m or 74 percent of the mean annual river inflow.

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It is estimated that canals and distributaries traverse about 6,300 km and feed nearly 87,500 water courses. About 149,000 private and 12,000 public tube wells are supplementing the canal water by pumping nearly 41 billion cu.m of water annually. Each water course commands 60 to 240 ha of land with a discharge of 28 to 112 li. per second. The average length of a water course is about 5 km. While the main canals are sufficiently controlled by structures to enable them to carry flow from 10 percent more to 60 percent less than the designed full capacity, water course outlets were designed to receive constant discharge until the distributary flow level drops to about three-fourths of full capacity. When this flow cannot be maintained due to shortage of water supply in the main canal, a system of closure of distributaries is put into effect by rotation so that available supplies are equitably shared in the canal command. Under this system water courses can receive full supply or be closed without any intermediate stage of regulation.

Each cultivator has fixed time proportional to his land within the water course command in which he is entitled to take the whole flow of the water course. The turn begins at the field closest to the water course outlet and on to the next farmer until the last gets his turn. Allotment schedule of turns is decided by farmers or sometimes by the irrigation department if requested.

The institutional structure in Pakistan treats irrigation and agriculture as separate input enterprises. The Irrigation Department is responsible for irrigation water supply and the Agriculture Department attends to other inputs, including extension services. There is no clear-cut coordination of activities in these line departments at farm level. There is third agency, called WAPDA, which is responsible for the operation and maintenance of river reservoirs, including the development planning, construction of irrigation system, drainage and reclamation projects. After the completion of a project, the WAPDA relinquishes the responsibility to the Irrigation Department for its operation. But the Irrigation Department is responsible for operating and maintaining the system only up to the water course outlet. Beyond this the farmers are considered responsible for the efficient utilization of irrigation water provided to them.

Canal water delivered to each water course depends upon its command area. As the original canal system was designed for extensive irrigation at low cropping intensity (75 percent), water supply is not only fixed throughout the year but also limits the increase in cropping intensity.

Need for Better On-Farm Water Management

Until recently, the government strategy was to increase the water supply for irrigation through the development of surface and groundwater resources. The assumption was that the farmer-recipients of the water supply would be competent to use the water effectively. On the contrary, it was found that neither the cropped area could match the increased water availability nor crop yields could be desirably increased under this assumption. As a result, more than 50 percent of the irrigated area became water-logged and salinity problems developed.

Therefore, field survey were conducted to determine water use efficiencies. Among other findings, it was observed that nearly 47 percent of irrigation water is lost in the water course during the delivery process and that 21 percent is lost during field application. This means that only 42 percent of the water available at the water course head, is available for crop use. The survey also noticed that only 41 percent of the fields were being irrigated.

The survey also indicated that both cropped area and crop yields can be increased substantially if improved irrigation and cultural practices can be adopted at the farm level. Moreover, better water management could substantially reduce recharge to aquifer, hence, equally reduce the need for sub-surface drainage.

On-Farm Water Management Project

Cognizant of the immediate need for better water management at the farm level to increase crop production, a 5-year pilot On-Farm Water Management Project was launched by the Government in 1977 in order to test various field approaches for launching a long-term and large-scale water management programme. Funds and technical advisory services were provided by the USAID and provincial Agriculture Departments implemented the projects. The Ministry of Food and Agriculture coordinated the programme. The pilot project covers representative areas in all four provinces of the country. The project has so far shown that different ecological zones, "SCARP" and non-"SCARP" areas, sandy and non-sandy soils, small and medium-sized farms, and alternative approaches to water course improvement, precision land levelling and dissemination of improved on-farm crop and water management techniques could be evolved.

The purpose and scope of the project are:

- a) Improvement of 1,500 water courses to reduce delivery losses.
- b) Precise levelling of 175,000 ha of fields to permit application of irrigation water uniformly.
- c) Training of farmers in improved cultural practices and water management techniques.
- d) Establishment of water user's associations on water courses to help improve and maintain the water courses, hence attain efficient utilization of available water.
- e) Training and encouraging private contractors to help farmers in water course improvement and precision land levelling.

Water course Improvement

Water course improvement is the main thrust of the pilot project considering that the water courses constructed 50-100 years earlier even with weir-controlled irrigation system have practically deteriorated. The lacked proper maintainance by the farmers to whom the responsibility was then vested. The introduction of public tubewells to ease the problme of water-logging and augment canal supply in water courses without remodelling of latter, further worsened the situation resulting in high water losses due to overtopping, seepage through ditch banks and leakage at checks and junctures. In the project, the water course is reconstructed to prevent over-topping. Concrete or masonry checks and junctures have been erected to prevent leakage. The ditch banks were properly cut and compacted to reduce seepage. Where soils were too loose to prevent seepage the canal was lined by concrete or masonry. On the average, 10 to 15 percent of the entire length of a water course has so far been lined.

The government provides materials and technical services while the farmers contribute labour for improving the water-courses. In order to benefit the small farmers, the government gives priority assistance to more than 75 percent of the farmers along the water course who operate less than 13 ha of farm land. It has been estimated that more than 50 percent of delivery losses are being saved through this scheme.

Precision Land Levelling

Precision land levelling is the second major element of the programme. Pakistani farmers usually resort to flooding or border method of irrigation which requires a level surface in order to efficiently spread water across the area during irrigation. And since most farms are not level, unnecessarily large volumes of water are necessary to flood the high spots on the surface. The net result is over-irrigation and the lateral movement of moisture within the soils brings about accumulation of salts detrimental to crop growth.

Three techniques of land levelling are currently in use in Pakistan: i) traditional; ii) crawler tractor; and iii) tractor cum-soil scraper. In the traditional levelling method, the farmer uses his own pair of bullocks and wooden scraper blade ("sohaga"). Over a period of time, it is possible to obtain a satisfactory level on very limited field areas using irrigation water as the level measurement. But it is nearly impossible to use this technique of levelling over larger areas.

One of the major factors in the bullock and "karah" operation is the land plane and which do not work effectively on small, squarebunded areas. The "sohaga" is the only plane which is presently used, and its effective length is approximately 1.2 meters. Until effective land planes are used or more effective bullock powered units are perfected, it will be virtually impossible to obtain a level field, hence a uniform application of irrigation water.

The second method extensively used by the agricultural departments is a crawler tractor equipped with a dozer blade. While this technique can move larger volumes earth economically over short distances or for tree and ditch removal, it is impossible to obtain precisely levelled fields with this equipment.

The third method which this project tested is the use of a tractor-drawn soil scraper. The equipment is manufactured by local manufacturing firms at reasonable price.

Whether land levelling is done either by the "karah", tractor-drawn soil scrapers, or, by bulldozers, engineering expertise is absolutely necessary. It is essential that the fields are accurately surveyed and staked prior to levelling. The water management programme provides the engineering skills to enable farmers to level their fields using their own equipment and power sources or equipment which they can hire.

On a reasonably levelled farm land, a farmer can avail himself of four irrigations from the same quantity of water compared with only three irrigations when the land level is poor. This implies that proper land levelling increases the effective water supply by one-third as over-irrigations are prevented. Add to this the benefits obtained from better seed germination and crop stand, reduced losses of fertilizer through leaching, increased land area for cropping (due to reduced number of bunds and ditches) and lower delivery losses.

The project experience in land levelling indicates that about 200 cu.m to 350 cu.m of soil need to be moved around on average-sized field in Pakistan. The cost of soil movement using soil scraper and tractor averages about Rs.4 per cu.m. The Government provides 50 percent subsidy in land levelling to small farmers up to two ha each. For additional areas or for farmers with more than 10 ha of farmland the farmers have to bear the entire cost of levelling although the government provides free advisory services.

Education and Extension Services

Farmers in Pakistan have not, in general, benefitted from the latest innovations and techniques of farming and water management. As such, their production methods are not progressive and their understanding of soil-plant-water relationships is very limited. In matters of irrigation, for instance, they do not discriminate between the upper and lower limits of soil storage capacities nor do they understand the concept of managing the root zone as a storage reservoir not to mention the concept of consumptive use and its association with climate.

It is, therefore, essential that effective means of transferring the modern farming practices be undertaken for which water management programme of this on-farm water management project contains a component on irrigation extension.

The concepts and practices which are stressed in the extension programme include: irrigation methods; maintenance of water courses and field level; cultural and tillage practices for optimum crop production; and soil-plant-water relationships.

The Agricultural University at Faisalabad has been utilized to train agricultural officers of the on-farm water management project and staff of existing agriculture extension departments. In addition, agriculture officers of the project also manage demonstration plots for farmers on improved water management techniques in their own farms.

Other objectives of the extension programme includes demonstrations on increasing yields through water course improvement, land levelling and improved agricultural practices.

Water Users Associations

Informal forms of village cooperation for securing and maintaining mosques, schools, water course cleaning, and other activities already exist in most of the villages of Pakistan. But in order to mobilize these cooperatives into effective water users' associations, a regular improved water management programme must be sustained. The Project, therefore, envisions the formation of Water Users' Associations before any technical support is extended. The plan is aimed at enabling the members elect an executive committee to perform the following functions:

- a) Organize and direct the labour force during construction;
- b) Resolve disputes among farmers relating to realignment and structure replacement;
- c) Assist the project technical staff in proposing changes in "warabandi" and displacement of "nakkas"; and
- d) Establish a water course maintenance programme by hiring a ditch tender.

The ultimate intention is to develop a voluntary cohesion among the members of Water Users' Association. And in order to provide them recognition with governmental agencies, action has already been initiated to formalize their organization through legislation.

Private Contractors

Lack of adequate farm power has been the main constraint in promoting mechanized and improved agricultural practices. There are about 71,000 tractors only in the entire country. The tractor owners are neither able to utilize their tractors full-time nor are they inclined to rent out their tractors to other farmers. Most of the tractors owners are big-time farmers owning 10 ha each or more but representing only 11 percent of total farms. The concept of private contractor has been introduced in the On-Farm Water Management Project to supplement government effort, to utilize fully the privately owned tractors and to generate employment among the engineers and technicians to

promote this cause. The constraint, however, has been the lack of official support and proficiency in precision land levelling. Longer hours are usually put into accomplishing a single job and this costs rise substantially. Alternatives are being tried to keep the costs within reasonable limits and studies are being conducted on time spent-and-volume of earth moved relationship. The tractor operators are also being trained by the Project staff.

Organization of the On-Farm Water Management Project

The directorates of the On-Farm Water Management Project were organized in 1977/78 in each province under the Provincial Department of Agriculture. A Water Management Cell was created at the Ministry of Food and Agriculture to coordinate the function of the directorate in the provinces. Each directorate is headed by a project director who is responsible for executing the project activities assigned in the approved project document (PC-I) for his province. At his headquarters, he is supported by a team of specialist staff of the project, including agriculture engineers, soil scientist, agronomist, economist, etc. A deputy director for training attended to the new recruits.

Field work is done by field teams consisting of a team leader, two water course officers, five land development officers and one agriculture officer. The water course officers are responsible for water course improvement according to design and specification. On the other hand, the land development officers supervise the land levelling work after the necessary grid surveys. Agriculture officers work as agriculture extension agents and arrange demonstration plots in level fields to induce the farmers to improve their own water management operation. The field team leader is responsible for coordinating the overall field work.

Future Plan

There are about 87,500 water courses and 14 million ha of irrigated land in Pakistan. It is estimated that nearly 10 million ha need levelling work. The project has thus far improved 53 water courses and 4,000 ha have been levelled by June, 1978.

In the fifth Five-Year Plan (1978-83) of the Federal Government, the project has been given special priority. Some Rs.928 million have been allocated for the improvement of 8,668 water courses and land levelling of 167,000 ha. At the end of plan period, about 34,700 farms are expected to be benefitted.

It is estimated that by the middle of 1983, 1.16 billion cu.m of irrigation water would be available and would be the second major source of irrigation water after tube wells.

A long-term perspective plan recently prepared by Master Planning Division of WAPDA for irrigated agriculture envisions the improved water courses as the largest source of additional irrigation water by the year 2000.

Constraints in On-Farm Water Management

The most important constraints faced by the Projects may be grouped into physical, social, extension education, legal and constitutional constraints.

Physical Constraints

1. Fixed outlet discharge without flexibility for crop water requirement.
2. Uncertainty of water delivery as most farmers do not know when there is canal closure.
3. Increased water supply without remodelling the water courses and informing farmers on available surplus.
4. Inequitable water distribution to the farms located at head and tail of the water course.
5. Unlevelled fields.
6. Water logging and salinity.

Social Constraints

1. Small farm size.
2. Tenure system.
3. Water rights.

Extension Education Constraints

1. Low literacy rate.
2. Thin extension service.
3. Education system not addressed to agriculture.
4. Inadequate research.

Legal Constraints

1. Strict rules in the Canal and Drainage Act of 1873.
2. Absence of penalties/incentives.
3. Absence of water users' associations.

Institutional Constraints

1. Non cooperation at farm level among line departments like Irrigation, Agricultural Cooperatives and IRDP.
2. Insufficient national provincial budget for irrigation improvement and maintenance.

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9. PHILIPPINES*

Victor C. Cruz**

Introduction

The Philippines is principally an agricultural country composed of 7,107 islands. Its total land area is about 30 million ha, some 8.9 million ha of which are potential areas for cultivation. Approximately 3.0 million ha are potential areas for irrigation development. The total irrigated areas as of December 31, 1977 is about 1.3 million ha.

The current National Irrigation Administration's (NIA) Five-Year Irrigation Development Programme (Calendar Year 1978-1982) which is an integral part of Long-Term Plan (up to the year 2000) has a paramount objective of developing annually an average of 135,000 ha for the next five years. Among the activities involved in the programme are the construction of more foreign-assisted multi-purpose projects; national irrigation projects, both locally funded and/or foreign loan assisted; communal and pump irrigation projects; rehabilitation and upgrading of existing systems; exploration and development groundwater as a potential source of water for irrigation; reforestation of the watershed area in Pantabangan, Nueve Ecija; adoption of integrated agricultural development programme in the existing systems and proposed projects; implementation and acceleration of water management and training programmes; formation and development of farmer irrigators' groups/associations and/or cooperatives in foreign-assisted projects and NIA's Water Management Pilot/ Extension Areas; and investigation, survey and feasibility study of proposed projects and other related activities in irrigation development.

The NIA has since taken bold and determined efforts in implementing a sustained water management programme at the farm level. Initially, 40 national irrigation systems were designated as water management pilot areas which serve as testing grounds for water management practices and activities for all regional offices in the country. Necessary service roads and terminal irrigation

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facilities and other similar structures were constructed for the purpose. The average areas covered by each main turnout (MTO) and supplementary turnout (STO) are 33.20 ha and 10.01 ha respectively. The water distribution method practiced in various pilot areas is either rotational or simultaneous. These projects, however, are designed and constructed with the rotational method in mind. One of these projects is the Upper Pampanga River Irrigation Project, (UPRD), Nueva Ecija. It is the country's first multi-purpose water resource development project.

The organization and development of irrigators' organizations in all the pilot areas has been given top priority (Appendix A). These organizations will serve as active partners in attaining success in these developmental undertakings, particularly in speeding up growth and development of irrigated agriculture in the country.

Other current NIA activities in the pilot areas concern conduct of continuing research on water management with the end in view of acquiring useful data and information for the implementation of projects and training for farm-level irrigation authorities and irrigators' group leaders and members.

Status and Problems of Water Management

National Level

Most irrigation projects of the NIA, either locally funded or foreign-assisted, are oriented towards agricultural development. These projects have the main objective of promoting increased production through the improvement of water management facilities, irrigation and drainage and related facilities, expansion of irrigable areas and road networks and the implementation of the Integrated Agricultural Development Programme (IADP).

Under the IADP concept several government agencies and the private sector are active participants in a total effort to increase agricultural production. The programme is envisioned to provide coordinated assistance to farmers in the irrigated areas such as technical know-how on water management, loan and other production inputs, technical know-how on production, organization of cooperatives, infrastructure development such as terminal irrigation facilities and access roads and price support and market outlets for farm produce. Among the agencies involved are the Ministries of Agrarian Reform, Agriculture, Natural

Resources, and Local Development and Community Development. The Agricultural Credit Administration, the Central Bank of the Philippines, Rural Bank of the Philippines, the National Economic Development Authority, the National Grains Authority, and the NIA serve as the executing agencies.

To enhance the promotion of the programme, several pilot demonstration farms (PDF) were established in different pilot systems/projects to serve as show-window farms for water management practices and activities. These pilot farms are operated in close coordination with other government agencies involved in agricultural production. All related farming assistance are delivered through organized groups of water-users covered by the PDFs.

Major problems identified in the implementation of water management activities as an important component of integrated agricultural development programme include, among others, the following:

1. Marked increase in cost of construction materials due to continuing oil price hike with a corresponding increase in funding/budgetary requirements, particularly in projects that are funded locally.
2. Since various government agencies implement their own programmes with the farmers as target, conflicting interest among themselves and/or overlapping/duplication of functions usually occur, particularly at the implementation phase.
3. Inadequate manpower and monetary support in terms of research and irrigation extension activities even as the current expansion programme of the NIA attempts to overcome this problem.
4. The previous organizational structure of the NIA proper carries with it some inertia that usually results in the duplication and overlapping of functions of irrigation personnel even as at the present time several departments have been created/strengthened, e.g., Research and Development and Irrigators' Assistance Departments which are principally involved in water management research and implementation of related irrigation extension programmes.

Project Level

The farmers are encouraged and assisted in forming their own organizations into Irrigators' Groups or Irrigators'

Associations/Federations. Organizational activities are handled mainly by the Association officers and water management technologists of the NIA. The major functions/responsibilities of the Associations are:

1. Participation in the proper operation and maintenance of terminal irrigation facilities such as the main turnout, main farm ditches, supplementary turnouts, supplementary farm ditches, measuring devices and other similar structures.

2. Equitable distribution of irrigation water among themselves and proper utilization according to the actual requirements of plants.

3. Close coordination/frequent contacts among members themselves and between them and the irrigation/agriculture authorities.

4. Willingness to grant right-of-way for the construction of farm ditches (particularly internal farm ditches).

5. Strengthening of their organizations through the undertaking of a continuing training programmes relative to water management, leadership development, systems operation and maintenance, technical agriculture, etc.

6. Compliance with existing irrigation laws, rules and regulations. (The Water Code of the Philippines provides for the imposition of stiff punishment to violators of irrigation laws.)

7. Acquisition of various forms of assistance (technical of financial) relative to agricultural/irrigation activities, from government and private agencies.

8. Participation in the campaign for irrigation service fee collection, procurement and distribution of farm inputs, information dissemination and other similar activities.

9. Participation in other related irrigation/agricultural activities/programmes.

At the project level, some organized groups/associations have so far been unable to satisfactorily fulfill some of their inherent functions in some areas due to non-compliance of the groups with the water delivery schedule advanced by the system

and lack of involvement/consultation among irrigation authorities, irrigators' groups and other government field implementors in the preparation and development of cropping pattern. The zoning plan and delivery schedules are posted in conspicuous public places for the guidance of the farmers.

Irrigation authorities have been confronted with the difficulty in negotiating for grant of right-of-way with the landowners for the construction of necessary conveyance facilities (main canals, laterals, farm ditches).

In terms of satisfying the needs and aspirations of organized group of water-users, specifically water supply, the situation varies by different locality. In run-of-the river type irrigation systems, the annual variation in flow available for diversion results in smaller irrigation service areas particularly in the dry season. This problem of the diversion type irrigation systems is, however, not shared by the reservoir-type system where seasonal and annual drought conditions can be made to have much lesser effects on yield. So far, better services are offered in systems with good state of conveyance and other terminal facilities and those that are particularly manned by capable and technically trained irrigation personnel.

The major constraints so far identified at the project level are:

1. Dearth of technically trained personnel to handle the operation and management of some national irrigation systems, particularly at the farm level even as training programmes for water masters, gate keepers and ditch tenders are in progress.
2. The poor state of some systems results in low delivery performance enhancing the water supply problem. This is partly attributable to the non-performance/poor performance of some farm-level workers of their maintenance work.
3. Problems on right-of-way (ROW) negotiation for the construction of necessary facilities.
4. Dearth of monetary and manpower support in terms of institutional development.
5. Light or non-involvement of the water-users at the planning phase prior to the construction of terminal irrigation facilities and structures.

6. Some land areas included in the command area are difficult to serve due to topography.

7. Dearth of canal delivery capacity to meet peak requirements.

8. Inequitable distribution of water due to lack of sufficient systems control.

Farm Level

In the simultaneous method of irrigation water a main farm ditch (MFD) serves about 50 ha while water is distributed at the same time in the service areas through supplementary farm ditches. As in the rotational method, irrigation water is conveyed through the main farm ditch and is distributed by rotation in the different supplementary ditches.

The rotational method of irrigation (Appendix B) involves the application of 5 days water requirement to a rotational unit within a rotation area within a pre-set time of about 24 hours. Other rotation units likewise receive irrigation water in succession according to the set schedule. Normally, there is a maximum of five rotation units per rotation area of about eight to 12 ha per unit. Each rotation area is served by a main farm ditch of about 800 to 1,000 m long and about 5 supplementary farm ditches of about 500 to 700 m long each which branch out from the main farm ditch. The head of each supplementary farm ditch is provided with a division box/supplementary turnout with a check structure.

Farm ditches are located and constructed as close to existing lot boundaries. Every rotation is adequately intercepted by a drainage ditch which is connected to a collection drain to major waterways.

Water delivery to the main turnout is controlled by the water tender but water distribution is the responsibility of members of the irrigators groups/associations under the guidance/supervision of the farm-level irrigation authorities. Farmers within the rotation unit are advised to be present during their irrigation schedule to attend to water distribution in his own farm.

In order to equip members and officers of irrigators'/associations with the necessary knowledge and skills, regular training programmes are conducted by the irrigation authorities where

actual water management exercises are conducted to enhance learning process.

The technical and physical problems on some terminal irrigation facilities render them partly serviceable.

Social problems on water-users' practices vary widely, e.g., non-maintenance of farm ditches, inequitable water distribution, difficulty in the acquisition of right-of-way for the construction of farm ditches and non-compliance with the water delivery schedule.

To recapitulate the highlights of on-farm water management and its problems are:

1. Functional and serviceable terminal irrigation facilities are a key factor in promoting proper water management.
2. Sustained education and training programmes for irrigation users with strong emphasis on proper water management is essential.
3. Close collaboration/integration of activities among the NIA and other field implementors is highly desirable.
4. Cropping pattern development and setting irrigation water delivery schedule by the chief of system in consultation with and involvement of farm-level irrigation fieldmen and irrigation groups is imperative.
5. Provision of necessary incentives to irrigators' association members and officers motivates them in strengthening their organizations.
6. Delegation of partial or full responsibility for the operation, maintenance and management of on system to duly organized and registered irrigators' associations has proved beneficial.
7. The actual transfer of ownership of a portion of existing national irrigation systems to viable and registered irrigators' organizations may be considered as an advanced step.
8. The provision of 10 percent discount to water users for prompt payment of irrigation service charges has shown encouraging results.

9. The provision of employment preference to irrigators' group members and officers during construction period has not only been a good source of additional income for them but also strengthen their interest in the association.

10. The farmers' eagerness to see an expansion of the project area is encouraging.

11. There is need to show appreciation to members of irrigation groups who perform maintenance and water distribution properly such as giving rebates in the payment of their irrigation charges.

12. Further strengthening of research and irrigation extension component in terms of financial and manpower capabilities is necessary.

13. Considered effective is the scheme of planning from below, to ensure efficient project/programme implementation and development, particularly in the planning phase involving the construction of irrigation facilities and structures. Affected water users should be seriously consulted and involved. Though considered a longer process desired result is greatly attainable.

14. In any developmental undertaking, it is universally accepted that the human factor is the hardest thing to handle, hence, the NIA farm-level authorities are patient and flexible in dealing with the water users.

Overall, water management programme in the Philippines has a very bright future.

Appendix A.

MODIFIED GUIDELINES ON THE FORMATION/FEDERATION OF IRRIGATORS' GROUPS/
ASSOCIATIONS IN NATIONAL IRRIGATION ADMINISTRATION WATER
MANAGEMENT PILOT AREAS/PROJECT EXTENSION AREAS

<u>No. of Days</u>	<u>Step</u>
2	1st - <u>Initial preparations</u> . Necessary courtesy call/briefing/orientation/discussion with local officials and leaders, local government workers on the overall aspects of the project activities; close coordination with concerned NIA field personnel and fieldmen of other government agencies; and preliminary information campaign.
1	2nd - <u>Formation of core group</u> . This group should consist of strong and influential leaders within the locality to assist the implementing group in the promotion/recruitment campaign and in disseminating information on project activities.
5	3rd - <u>Farm visits</u> . The core group and implementing team to conduct farm visits and survey of prospective members (agro-economic data gathered by the agro-economist of the region may be consulted and evaluated). Available records of irrigation systems may be used as reference for other pertinent data such as: a) extent and boundary of the irrigation systems pilot area; b) inventory of turnouts, laterals, canals and other irrigation structures and facilities (on a supplementary/main turnout level); updated master list of water-users names and addresses, lot numbers irrigated/benefited areas, crops raised, cropping pattern, cropping frequency/intensity, irrigation practices and problems. Other observations may be recorded and evaluated for a more complete information/reference.

At this stage an intensified information campaign should be carried out. Letters of invitations indicating the date, time and place and agenda of farmer-water users' meeting should be distributed. Importance of the meeting should be clearly emphasized with the prospective farmer-members.

- 5 4th - Holding of farmer-irrigators' meeting. This meeting may be conducted either at the main turnout or "barangay" depending upon the convenience of farmers. The "barangay" level meetings are recommended for water-users within the pilot area. On the other hand, the meeting at the main turnout level may include other farmers. At these meetings the setting and announcement of schedules for the conduct of pre-membership education and training programme should be made.
- 5 5th - Pre-membership education and training programme. This activity may be conducted at the "barangay" on main turnout level depending upon the circumstances. Maximum efforts must be exerted by the implementing team to make this step successful in order to prepare prospective members for the job ahead. One of the principal causes of failure of previous associations is the lack of necessary education and training of association members.

The training programme may be shortened due to time constraints of farmers and other similar problems which usually result to poor attendance.

Other relevant matters on the technical phase of water management, cropping patterns, irrigation laws, systems operation and maintenance, human resources development, simple farm planning and budgeting, and the like should be undertaken at this stage.

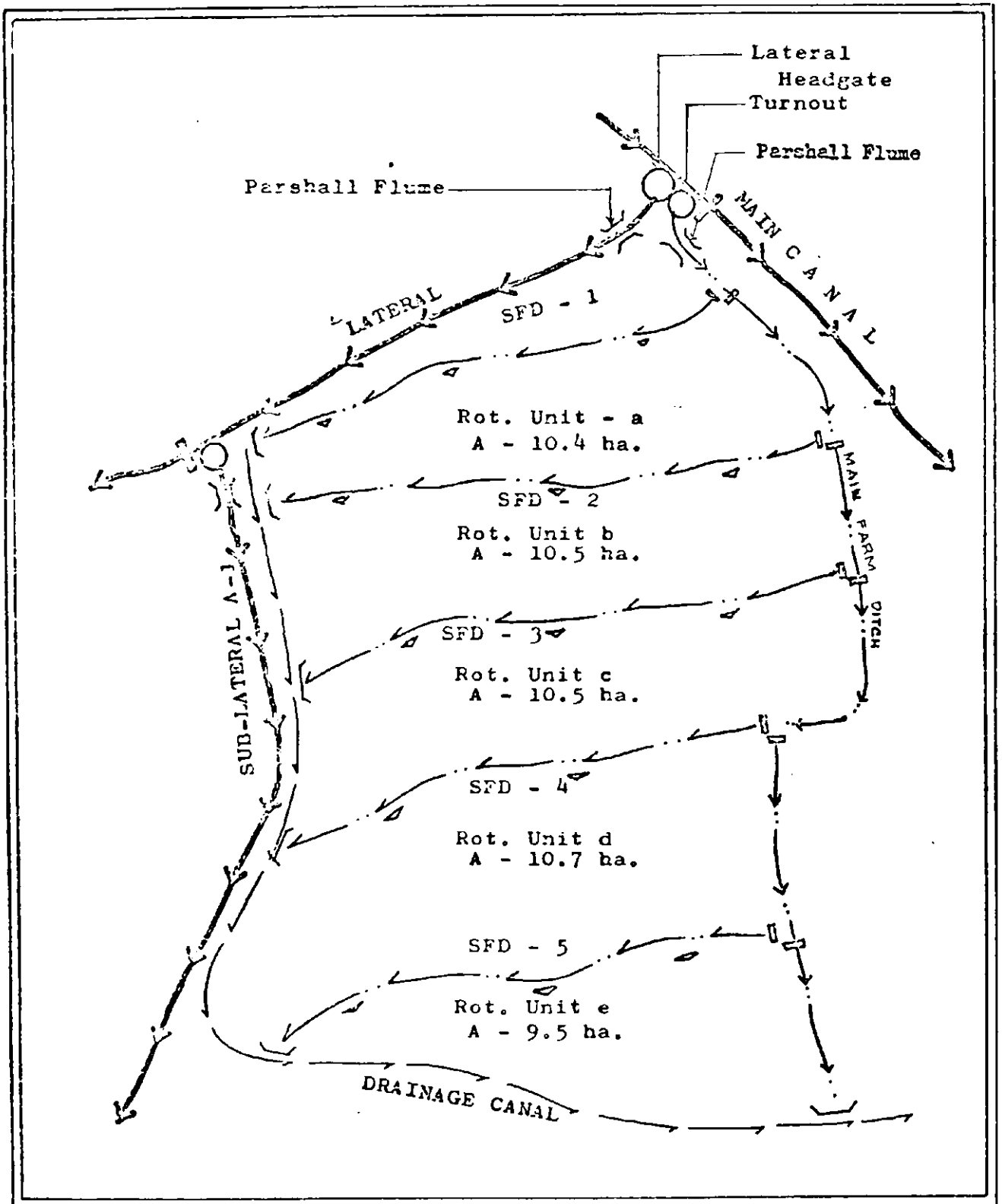
Another important activity at this stage is the formation of an ad-hoc committee from prospective members to review the irrigation association documents.

- 25 6th - Formation of rotational unit groups (RUG). These are formed at the supplementary farm ditch level serving an average area of 10 ha each. Active and able water-users may be selected to lead these basic units. Strengthening and motivating these groups is vital at this stage as their success or failure will be influenced by these foundation groups. Hence, considerable time and effort must be devoted by the field implementors to realize such objective.
- 10 7th - Formation of farmers irrigators' groups (FIG). This phase must be undertaken at the main turnout level serving an average area of 50 ha each. Leaders of the RUG shall form the core of these groups. From among themselves, an active and capable unit leader may be selected to head an individual FIG.
- 1 8th - Formation of farmers irrigators' association. The organization of an irrigators' association at the water management technologist/watermaster covering an area of about 500 ha is necessary. This organization is constituted by farmer irrigators' group leaders or representatives from the turnout areas. A more formal organizational activities should be carried out at this stage.
- 1 9th - Organizational meeting. At this stage, the ratification and signing of irrigators' association documents, election and/or appointment of officers and members of specialized committees and accomplishment of other necessary activities shall be undertaken.
- 1 10th - First formal meeting of the board of directors From among the members of the association, the president and Vice President shall be selected, including the chairmen and members of other specialized committees. The conduct of other related activities such as deciding on the association's bank, signatories on bank documents, selection of office site and completion or registration shall likewise be carried.

- 4 11th - Preparation, processing and review of the association's registration papers/documents.
- 1 12th - Registration of the association with the securities and exchange commission (SEC) by the central office personnel or by the regional officers.
- 1 13th - Organization of the federation of farmers irrigators' association.* To promote the growth and development of the association, two or more of them may be organized and merged with the federation of farmers irrigators' associations at the zone/system level. Officers of representatives of the federation shall form the core of this apex unit.
- 4 14th - Preparation, processing and review of registration papers/documents of the federation of farmer irrigators' association and registration with SEC

Note: A continuing education and training programme at all organizational levels must be undertaken.

* Applicable if Pilot Area radiates to non-pilot areas.



Appendix B. A Typical Rotation Area

9. SRI LANKA

G. G. Wickremasinghe*

Introduction

The problem of on-farm water management in Sri Lanka must be seen in the light of the three types of irrigation systems obtaining in the country. These categories may be classified according to scale and the type of organization, namely; i) major projects; ii) major irrigation schemes; and iii) minor irrigation systems.

The first category comprises projects undertaken after a feasibility study and involves high capital cost and high land ratios. Their command areas are in the dry zone and are mainly for growing paddy in the Maha season (September - April). On the other hand, the major irrigation schemes comprise old storage tanks built by ancient kings nearly large areas of storage. Their maintenance and control are undertaken by a specific department staffed with technical experts. The minor irrigation systems are village-based storage tanks each with a command area of about 200 acres.

Trend in Irrigation Development

Recent changes in irrigation development in the country envisage the diversion of the Mahaweli River to the dry zone area through a distributary system that is combined with storage tanks and reservoirs. Hand in hand with this new trend and strategy, it is also envisaged that flood control, power supply and changing land utilization patterns and crop diversification would follow.

Consequent to the growth in population, a shift in the emphasis towards agrarian development is now leaning towards a policy stressing high priority to the development of available water resources. This emphasis furthers improvement of existing irrigated areas which are within the scope of major and minor works in order to maximize the use of this scarce resource.

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When land development for a growing population and increasing food production was the thrust in the face of bleak foreign exchange during the 60s, irrigation development was somewhat scarce relegated to the background.

With apparent changing pattern of the 70s, and perhaps, to a greater intensity during the 80s, it will be imperative to stress the effective use of irrigation water to increase the productivity. As Robert Chambers has aptly stated, "Farmers may continue to think in terms of productivity and yields per acre, but agricultural planners and others according to natural interest should make the difficult transition to thinking that productivity yields per unit of water."

Another recent trend is the alternative farm management practice which envisages drastic changes in the cropping and productivity patterns in the country. This trend will undoubtedly have an impact on irrigation, drainage and on-farm water management. This means that farmers need to be reoriented towards a strategy that would encourage increasing production through a system of water storage meant for a certain season and, possibly extending it. As a matter of fact, this practice is already observed during the Yala season when water stored in Maha is made available in Yala and, consequently, some farmers get a fair share of the water in time of need. This problem is associated with poor drainage though. Crop losses due to water logging and water salinity may be saved through the provision of better drainage.

Development Efforts

Three developments on irrigation techniques are being implemented now in the country. These are:

1. Studies on the lining of canals and channels to reduce seepage losses;
2. Development of crop selection and soil water management techniques utilizing brackish water; and
3. Development of hillsides and control of water distribution for optimum use of irrigation water.

The relative emphasis in irrigation, drainage and on-farm water management is the State's direct involvement - more Government agencies are now assuming greater responsibilities and activities. In addition, government-appointed

headmen now lead communal activities related to socio-economic affairs at village/farm level. The elite of villages are also being utilized more and more in the administration of economic affairs. Even in public construction work in the villages, more government and farmers' involvement is evident. At the provincial level, emphasis is now laid on more construction programmes where significant results have become more visible. This has been accentuated by the decentralization of the national budget funds to provinces enabling construction work to be accomplished more quickly. At the national level, bigger projects under the major schemes emphasize food self-sufficiency, complete with land-settlement projects and crop diversification programmes. This new agricultural development strategy aims at completing the original 30-year development plan only in a 5-year period. The organizational features of development bodies are also being streamlined. At national level, the irrigation development programme has been transferred to a single body. However, at the provincial level, irrigation activities are still part of a general civil works scheme that includes highway construction and maintenance - a problem that is currently being solved in an effort to make provincial-level irrigation schemes directly under the national irrigation authority.

As a matter of fact, in 1978 the Government started to separate minor irrigation maintenance from civilworks and placed it under the Agrarian Services Department which has the institutional and village level structure at farm level geared at catering to the needs of farmers.

Still another emerging feature of the government reorganization scheme authorizes special bodies or authorities which are given statutory power to enforce irrigation organization system, crop diversification and settlement. These projects/authority schemes are patterned after the TVA of the USA and such bodies are multi-project oriented.

The Mahawelin River Basin

The Mahaweli River Basin covers some 4,030 sq.mi. of which some 25,000 sq.mi. and estimated to discharge 6.6 million acre ft. of water annually. The UNDP/FAO team in collaboration with Sri Lanka's specialists have envisaged to utilize 4.7 cu.ft. of the flow for the agricultural development in an area of 800,000 acres lying in the dry zone. Of this total area, 230,000 acres are presently irrigated, but are deficit in water supplies, and 650,000 acres under new lands, have rainfed cropping. The project also considers installing hydro-power plants with a

total capacity of 500 MW for the production of about 2,600 million KWH of energy annually. Naturally, dams and storage reservoirs need to be constructed. In this project, stress is laid ultimately in adopting strict water management policies as it assures an average of 8.5 cu.ft. acres per year.

Already the Tank Modernization Project has been started. Five tanks in the dry zone with an aggregate irrigable command of 31,500 acres are being utilized on a package programme of modernizing irrigation and agricultural extension (Padaviya, Mahakandarawa, Mahawillachchiya, Pavatakulam and Vavunikulam). This project plans to double the income of the farmers settled in these schemes. It is a prototype project ultimately aimed at drawing out the full potential of all land under major irrigation schemes. Some 10,000 small farmers and their families cultivating an average of three acres each will be benefitted.

Problems

There are major problems and constraints in these irrigation projects. Basically, the infrastructural and other attendant facilities available to farmers are poorly developed. The problems arise chiefly from defects in the conveyance system. Hence a perfect conveyance system and rigid control devices are basic necessities for the intermittent irrigation programmes. The scarcity of farm labour during peak programmes of cultivation and the ever rising costs of production due to inflationary trends is another factor to be considered. Institutional arrangements for marketing the products are absent.

Payment of irrigation water fees is another problem which has to be settled. The ancient rights and obligations of a cultivator are the subject of inscriptions which specify the farmers' obligations to pay irrigation fees. Renumeration for water supplies has been commuted to the state supplying the water and a nominal charge is levied from the farmer. However, farmers with irrigation problems are in most instances those located close to the tail end of the channels. It is here where collaboration with neighbouring farmers and other institutions are necessary for equitable distribution of water, hence justification for charging irrigation fees.

This brings the question of training farmers on on-farm water management skills. The ancient system of having a chief person of social standing in the village to enforce this distribution through the office of the "Vel Vidane" has all but

disappeared. But new thinking on the patterns of maintaining this office with democratic trappings has since being mooted. The appointment of grass root-level officers - cultivation officers and irrigators - to distribute, control and regulate the issue of water and to enforce these through the rural courts is now likely to be legalized with the New Agrarian Services Law. Consequently, adequate training of the functions of these officers and the farmer on water management is a must. Another attendant problem is the regulation of water issue. Gate control devices are lacking among the on-farm facilities to permit satisfactory adjustments of water issues even as such a system is cumbersome to operate and would be too costly to maintain considering the small sizes of farms. Perhaps the strengthening of farmer organizations and the restoration of the "Vel Vidane" concept could ease the problem of water issue, including the enforcement of legal actions to stop illicit tapping of water and damage to irrigation structures.

The New Agrarian Services Law envisage water management at farm level to be dealt with by an officer resident in the tract and who is close contact with farmers.

10. THAILAND

Jumroen Panitying and
Arom Khumkomgool*

Introduction

Thailand has 514,000 sq. km of land located in the central part of the Indo-China peninsula with a population of around 43 millions. The population growth rate has been declining from 3.0 percent in 1970 to about 2.8 percent annually since 1973.

Out of total land area more than half is forested and about 36 percent or some 18.6 million ha is used for agricultural purposes. Some 11.7 million ha or about 63 percent of the land for agricultural purpose are cultivated for paddy production.

Agriculture accounts for about 27 percent of net domestic products, about 78 percent of total employment and about 60 percent of export earnings in 1977. The production of rice was estimated at about 14.2 million mt annually as an average for the last five years, of which exports were about 1.5 million tons.

The annual growth rate in rice production since 1973 was only 1.8 percent. This has mostly come from expansion of the cultivated area. Crop production grew at a growth rate of about 5.3 percent against the rate of Gross Domestic Product of 7.3 percent, annually. This may indicate a widening of the disparity between rural and urban areas. About 80 percent of the country population lives in rural area and their economic livelihood relies on agriculture. In order to support the government effort to "raise the income and living standard of the rural peoples in various regions", increase in production from currently cultivated area would be achieved through yield improvement and increased cropping intensity where water is available.

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Irrigation development in Thailand has encouraged greater wet season rice production and stabilized export earnings from the rice, since Royal Irrigation Department was established in 1904. Since then, many irrigation projects were implemented to control the water in wet season and to provide irrigation water to the dry season crops through the construction of reservoirs with hydro-power generation and flood control purposes, provision of diversion structures and distribution canals.

Provisions were also made by the Ditch and Dike Act (1962) to construct canals and ditches for complete water distribution to farm plots. However, the provision of on-farm facilities has been rather scanty.

Because of this neglect in the past, the government has recently pursued an on-farm development programme called the Irrigated Agriculture Development, aimed at increasing irrigated land areas and agricultural production through the Land Consolidation Act (1974) and Agriculture Land Reform Act (1975).

Irrigated Agriculture Development Strategies

The government has launched irrigation works in the areas already used for cultivation as a very first approach in order to solve the immediate problems. Funds available for such investments probably being limited, funding will have to be carefully planned for the various stages of work.

For example, in the central plain which is the country's rice bowl, the farmers used to grow rice utilizing both precipitation and runoff water for irrigation. When irrigation water was needed by the farmers, the government began rendering assistance only with water conservation work as a first approach by compounding and constructing check regulators at both ends of the canals so that water could be diverted to the ricefields.

As water demand became greater due to expansion of ricefields irrigation construction was accelerated based on sufficient data, such as hydrological data and feasibility studies to justify such construction.

The following items were taken into consideration:

- a. Improving water availability and storage;
- b. Improvement in distribution networks;

- c. Provision of on-farm facilities;
- d. Operation and maintenance facilities;
- e. Irrigation and drainage practices;
- f. Land consolidation and levelling;
- g. Education and seminar; and
- h. Training and extension.

Supporting Services

Since the main goal of an irrigation project is to increase agricultural development and farmers' income, the agricultural development programme is considered an integral and inseparable part of the irrigation project from the time project formulation begins.

In this connection, agriculture supporting services which are established by other agencies concerned are involved in the project implementation.

These are agricultural extension services; agricultural cooperative services; and irrigation water management services. In order to achieve the full benefits from irrigation projects, some projects in Thailand have been established or being carried out based on integrated development ideas. Therefore, efforts are required to integrate and also synchronize all sorts of works to be performed by various agencies concerned through competent agri-institutional structure's optimum use of water, land facilities and other resources.

For land consolidation projects, for instance, the Provincial Land Consolidation Office and Committees are established under the organization of the Central Office (Committee).

For the attainment of the project target, it is considered vitally essential to render integrated and synchronized guidance and assistance of the various agencies concerned.

Major Problems Facing Farm-Level Water Management

Realizing that the operation and maintenance of the irrigation systems are as important to its success as are the original design and construction, the Royal Irrigation Department (RID)

has exerted all possible efforts on the establishment of functional water management organizations, in strengthening personnel capabilities and in bearing considerable amount of operation and maintenance costs from its annual budget. However, necessity of the second crop irrigation has brought about more sophisticated technical requirements in both the system operation and maintenance. Delivery of water upon demand requires intensive system operation while construction of tertiary system needs more budget for annual maintenance and repair.

From the Government's standpoint, the farmers' contribution in sharing a part of water management cost will be more desirable in Thailand to enable the Government to put more investments in new irrigation projects. But it is apparent that before farmers can contribute their own, the Government needs to share more responsibility in the post-project water management until farmers' capability can be substantially established.

Irrigation Associations

Formation and Coverage of Irrigation Association

There are many so-called water users' associations established in the country after the completion of irrigation facilities under the supervision of RID. At present, the main and secondary irrigation systems are under control of the government. At the farm level the water users' associations are supposed to manage water, including the operation and maintenance of on-farm facilities. Unfortunately, however, they are not functioning as they are supposed to be due to lack of financial and technical support. Sooner or later, the Government must utilize fully these associations to operate and maintain the irrigation on-farm facilities considering that Thai farmers have since been enjoying free use of water.

In this connection, there are pros and cons on the issue of irrigation fee in Thailand. One school of thought advocates that since rice farmers are already taxed by the Government when the former export rice, they should be exempted from paying the irrigation fees. On the other hand, others feel that because neither the RID nor the Land Consolidation Office have no funds for maintaining and operating the on-farm facilities, irrigation fees should be a reasonable source of income for such operation and maintenance costs. Unless this water fee concept is adopted and for as long as the irrigation water users' associations are incompetent to operate and maintain the facilities, the latter

will be rendered useless in no time at all.

In the meantime that this issue has not resolved, it is imperative that the Government must strengthen its irrigation operation and maintenance office, particularly the personnel in charge of supervision and assistance to the irrigation associations.

National Policy

Already, the Central Committee for Land Reform and Land Consolidation has issued an 8-point regulation in 1978 outlining the procedure for water charges as follows:

"1) This regulation is called the Regulation of the Central Committee for Land Consolidation on the rules and procedures for the collections of periodical maintenance charges and the subscription charges for the irrigation supply in the projected area (1st issue) B.E.2521.

"2) This regulation is put into effect as from the 20th of December B.E.2521 onwards.

"3) All the landowners or landowners by right in the projected area will have to meet the expenses of the periodical maintenance charges for the common use of buildings, irrigation systems as well as roads or farm-lands' delivery passages; and also the expenses of irrigation supply according to the periodical notification from the Committee specifying particular rate and date of such payment, based upon the following rules:

"3.1) Not less than 1 year after the completion of an irrigation project's implementation, the landowners or the landowners by right must start their payments to the Committee.

"3.2) Collections of such charges will be made once a year at an equal rate per rai* on each area, regardless of the varieties of crops produced or the different percentages of land in use. The fraction of 1 rai shall be regarded as 1 rai, but less than 1/2 rai fraction will be left uncharged.

"4) The Central Land Consolidation Office, with the approval of the Minister of Agriculture and Cooperatives, will

* 1 rai equals 0.16 ha or 0.395 acre.

assign the cooperative offices in the projected area to collect the payments and keep the money as mentioned in item 3) and under the annual operational plans of the cooperatives offices approved by the Provincial Land Consolidation Committee. The Cooperative officials will be responsible in the disbursement of such money in the irrigation supply and drainage, repairs and maintenances of the irrigation and drainage systems, of roads and/or farmlands' delivery passages and other public utilities for common use in the projected area.

The Operations of the cooperative offices will adhere to the rules and regulations of the cooperatives.

"5) The provincial land reform offices will notify in writing the rate of charges as mentioned in item 3) as well as the time for payment to each of the landowners or landowners by right, using the format hereto attached. They must also enlist the amount to be paid and period of payment and inform each landowner and notify the cooperative offices concerning item 4).

"6) The cooperative offices, being assigned according to item 4) must report twice a year at least the receipts and expenditures in this connection to the provincial land reform offices and the Central Committee for land reform.

"7) In case natural disasters occur to the crops so immensely that it is beyond the landowners' ability to protect them, the Central Committee for Land Reform may consider an exemption or discount of the charges as may be deemed proper.

"8) Any landowner failing to pay the charges as notified by the Provincial Land Reform Offices, the cooperative offices assigned as in item 4) must give a written reminder to him to effect immediate clearance of outstandings. After such reminder, if still no action is made by the landowner, the cooperative offices shall notify the Provincial Land Reform Office for further report to the Central Committee for legal action."

In conformity with the national policy on irrigation water charge collection as outlined above, agriculture development projects in Thailand are being re-oriented to enable them to incorporate the inclusion of farmers' autonomous water management systems.

In the near future, water management as well as water fee collection will be transferred to the agri-cooperatives to become an important part of their activities.

Therefore, during the transition period, at present, efforts are being put on farmers' education and training.

Farmer Education and Training

Cognizant of the importance of farmer involvement in the operation and maintenance of on-farm irrigation systems and hopeful that irrigation fee charges will soon be instituted, the Government has recently implemented a programme to train and educate farmer-recipients of irrigation services not only on management skills but in an integrated and comprehensive manner.

The Agricultural Extension Department has already fielded agricultural extension workers to conduct fortnightly meetings with farmers in the villages on the Government's plan to strengthen village-based associations relative to efficient water use and maintenance of irrigation facilities, including the obligations of farmers in the proposed collection of water fees. These aspects of the village campaign are, of course, tied in with the regular function of the extension workers in improving farming techniques and promoting agricultural cooperative services.

The Task Force Approach

A two-level task approach in training the farmers is utilized by the Government agencies involved. At the pre-organization stage, the first task force consists of agricultural staff of the Irrigation System Head Office in the area of operation, including a water master and a zoneman. The initial job of the task force is to undertake seminar sessions among the farmers on the concept and functions of the System's service unit, water users' associations, on-farm irrigation water management and integrated development approach. Subsequent training sessions on specific subject areas in conjunction with the agricultural extension activities and the promotion of cooperatives.

The second task force is organized as a 3-men team among the villagers consisting of responsible farmers who are trained specifically to serve as nucleus in the village. Each team is composed of a common irrigator, a foreman, and a local leader. This task force team subsequently plays the role of the original task force composed of government people. However, they are closely assisted and guided by representatives of the concerned government agency in the System Head Office. In the performance

of the work of the task force team, they are able to identify local leaders ("chak" leaders) and common irrigators whom the villagers eventually nominate for further training. The training programme for the "chak" leaders and common irrigators consists of lectures, field demonstrations and inspections on modern organization and management schemes of water use, nature and functions of service unit organizations, duties and responsibilities of farmers and an outline of integrated agricultural development programmes.

Since the new training approach to educating the farmers has only been recently instituted in a few areas of the country, an assessment of its impact and likely outcome has yet to be made.

Major Obstacles to Better On-Farm Water Management

Some of the difficulties encountered in the Government's effort to improve on-farm water management and which the new training programme hopes to solve may be enumerated as follows:

- a. The establishment of service unit organizations cannot be made in compliance with the construction schedule and pre-organizational training and the campaigns cannot be started earlier due to the insufficient manpower.
- b. Discharge measurements have not been recorded accurately at the on-farm facilities because some areas still lack water measurement devices.
- c. Monitoring of farming progress and crop condition are not being conducted. A weekly report is desirable particularly during land soaking and preparation periods.
- d. The farmers have little or no concept on saving water - perhaps an inertia of their long exposure to receiving free water in the past many years.

APPENDICES

1. LIST OF PARTICIPANTS

China, Rep. of	Mr. Chun-Tse Cheng Senior Engineer Council for Agricultural Planning and Development Taipei
Hong Kong	Mr. Yang-Chung Lin Agricultural Officer, Agriculture and Fisheries Department Hong Kong Government Kowloon
India	Mr. Vijendra Singh Additional Chief Engineer Irrigation Department Lucknow
Indonesia	Mr. Otje S. R. Bratamidjaja Head of Soil and Water Conservation Subdirectorate Soil and Water Directorate Directorate of Food Crop Protection Jakarta
Japan	Mr. Satoru Takeuchi Section Chief, Disaster Prevention Division Structural Improvement Bureau Ministry of Agriculture, Forestry and Fisheries Tokyo
Korea, Rep. of	Mr. Dong-Man Kim Head First Design Department Agricultural Development Corporation Seoul
Nepal	Mr. Purushottam Prasad Gorkhaly Chief Farm Irrigation and Water Utilization Division Department of Agriculture Kathmandu

Pakistan	Mr. Mohammad Ashraf Akhtar Water Management Engineer Water Management Cell Ministry of Food and Agriculture Islamabad
Philippines	Mr. Victor C. Cruz Chief Systems Management Engineer National Irrigation Administration Quezon City
Sri Lanka	Mr. Gauthamapala George Wickremasinghe Commissioner of Agrarian Services Ministry of Agricultural Development and Research Colombo
Thailand	Mr. Jumroen Panitying Irrigation Officer Grade 6 Royal Irrigation Department Bangkok Mr. Arom Khumkomgool Civil Engineer Grade 6 Royal Irrigation Department Bangkok

2. ITINERARY AND SCHEDULE OF ACTIVITIES

a. Phase I. Thailand, 11th - 17th June, 1979

Date/Time

Activity

Mon., 11th June

Arrival of Participants in Bangkok
Stay at New Amarin Hotel

Tues., 12th June

8:20 a.m.

Assemble in hotel lobby

8:30 a.m.

Leave New Amarin Hotel

9:00 a.m.

Arrive at Royal Irrigation Department
for Orientation and Briefing at
the Conference Room

9:15 a.m.

Introduction of participants
by Mr. Manu Leopaïrote,
Director,
Thailand Management Development
and Productivity Centre (TMDPC)

9:30 a.m.

Welcome of participants
by Mr. Charin Athayodhin,
Deputy Director General,
Royal Irrigation Department (RID)
Brief comments, Mr. D. A. Cruz, APO Staff

9:45 a.m.

Coffee Break

10:00 a.m.

Briefing on Irrigation in Thailand
by Mr. Suthep Tingsabhat, Chief,
Program Coordination and Budget
Division, RID

11:00 a.m.

Briefing on Water Resource in Thailand
by Mr. Damrong Jaraswathana, Chief,
Hydrology, RID

Noon	Lunch at RID Club
1:30 p.m.	Briefing on On-Farm Works and On-Farm Water Management in Thailand by Mr. J. Pruntel, ILACO/EMPIRE M&T
5:00 p.m.	Return to New Amarin Hotel
6:30 - 8:30 p.m.	Cocktail and Dinner hosted by Dr. Prabhas Chakkaphak, APO Director for Thailand, Director General, Department of Industrial Promotion at Erawan Hotel

Wed., 13th June

7:20 a.m.	Assemble in hotel lobby
7:30 a.m.	Leave New Amarin Hotel
10:00 a.m.	Visit Samchook sub-project Visit Local Tiller Factory
Noon	Arrive at Land Consolidation Construction Unit (Sing Buri) Briefing and Lunch
2:00 p.m.	Visit Chanasutr and Boromdhart sub-project
5:00 p.m.	Arrive at Guest House of Chao Phya Irrigation Project and stay overnight
7:00 - 8:00 p.m.	Film Shows

Thurs., 14th June

7:30 a.m.	Leave Guest House of Chao Phya Irrigation Project
10:00 a.m.	Arrive at Mae Klong Irrigation Project Headwork Briefing and Lunch
1:30 p.m.	Visit Mae Klong Irrigation Project Area
5:00 p.m.	Arrive at Guest House of Mae Klong Irrigation Project and stay overnight
7:00 - 8:00 p.m.	Film Shows

Fri., 15th June

8:30 a.m.	Leave Guest House of Mae Klong Irrigation Project
10:30 a.m.	Arrive at Sri Nakarin Reservoir
1:30 p.m.	Leave Sri Nakarin Reservoir
5:30 p.m.	Arrive at New Amarin Hotel

Sat., 16th June

8:20 a.m.	Assemble in hotel lobby
8:30 a.m.	Leave New Amarin Hotel
9:00 a.m.	Arrive at Conference Room of Royal Irrigation Department
9:05 a.m. - Noon	Debriefing
12:30 p.m.	Return to New Amarin Hotel
Afternoon	Free

Sun., 17th June

7:30 a.m.	Leave New Amarin Hotel
8:30 a.m.	Arrive at Bangkok Airport
11:05 a.m.	Fly from Bangkok to Tokyo aboard JL 474

b. Phase II. Japan, 18th - 28th June, 1979

Date/Time

Activity

Sun., 17th June

6:45 p.m.	Arrival of participants at the New Tokyo International Airport (Narita) aboard JL 474
	Proceed to Akasaka Shanpia Hotel

Mon., 18th June

9:15 a.m.	Assemble in hotel lobby
9:20 a.m.	Proceed to APO Headquarters
9:45 a.m. - 12:15 p.m.	Greetings by Mr. Harumi Takeuchi, Secretary-General of APO
	Prsentation of Country Statements on Problems of On-Farm Water Management

12:30 - 1:30 p.m.	Welcome buffet luncheon at the International House of Japan (courtesy of Mr. Takeuchi, APO Secretary-General)
1:45 - 2:15 p.m.	Return flight confirmation, APO Headquarters
2:15 - 5:15 p.m.	Continuation of Country Statements
5:15 p.m.	Leave APO Headquarters for Akasaka Shanpia Hotel

Tues., 19th June

9:15 a.m.	Check-out and assemble in hotel lobby
9:20 a.m.	Proceed to APO Headquarters
9:30 a.m. - Noon	Briefing on "Farm-Level Water Management in Japan" by Dr. M. Okamoto, Professor, Irrigation and Drainage Department, Iwate University
Noon - 2:15 p.m.	Lunch break
2:15 p.m.	Leave APO Headquarters for Tokyo Station by chartered bus
3:16 p.m.	Leave Tokyo Station aboard "Bullet" train (Kodama No. 267)
5:39 p.m.	Arrive Toyohashi station Proceed to Toyohashi Grand Hotel

Wed., 20th June

8:20 a.m.	Check-out and assemble in hotel lobby
8:30 a.m.	Leave hotel by chartered bus
9:00 - 10:00 a.m.	Visit the Office of Toyogawa Irrigation Project for briefing
10:30 - 11:00 a.m.	Visit the control station for irrigation in paddy fields in Gejo area
11:30 a.m. - 12:30 p.m.	Lunch break in Toyohashi City
1:00 - 1:30 p.m.	Observe the main diversion work for Ohshimizu Branch Canal and farm pond
1:40 - 2:00 p.m.	Observe green houses at Higashiakazawa

2:15 - 2:30 p.m. Visit the control station for irrigation
in upland fields in Oitsu area

2:35 - 2:45 p.m. Observe the pipe-line irrigation system
in paddy fields in Ushiroda area

2:45 p.m. Leave Toyohashi City for Nagoya by
chartered bus

5:30 p.m. Arrive Hotel Chiyoda, Nagoya

Thurs., 21st June

7:25 a.m. Check-out and assemble in hotel lobby

7:30 a.m. Leave hotel for Nagoya Station

8:08 a.m. Leave Nagoya Station aboard "Bullet"
train (Kodama No. 361)

8:45 a.m. Arrive Maibara Station

Proceed to Dainaka Lake Polder by
chartered bus

9:30 a.m. - Noon Visit Dainaka Lake Polder

Noon Leave for Maibara by chartered bus

1:45 p.m. Leave Maibara Station aboard "Bullet"
train (Kodama No. 229)

2:12 p.m. Change train at Kyoto Station

2:17 p.m. Leave aboard "Bullet" train
(Hikari No. 131)

3:53 p.m. Change train at Okayama Station

4:13 p.m. Leave for Uno by fast train

4:46 p.m. Arrive Uno Station

4:55 p.m. Leave Uno Port by hovercraft

5:18 p.m. Arrive Takamatsu Port

Proceed to Okura Hotel

Fri., 22nd June

8:50 a.m. Assemble in hotel lobby

9:00 a.m. Leave hotel by chartered bus

10:00 - 10:20 a.m. Observe the Okada Canal of the Kagawa
Irrigation Project (equipped with
automatic checking device for securing
necessary water level for diversion)

10:40 - 11:20 a.m.	Visit the control station of the Kagawa Irrigation Project at Kotohira-cho for briefing on the Project and concentrated control of intake and diversion flows
Noon - 12:50 p.m.	Lunch break at Ikeda-cho
1:00 - 2:00 p.m.	Visit the Ikeda Dam for briefing on the Yoshinogawa Integrated Development Plan and the role of the Ikeda Dam
3:30 - 4:10 p.m.	Observe the Mannoike (reservoir)
5:00 p.m.	Return to Okura Hotel

Sat., 23rd June

8:10 a.m.	Check-out and assemble in hotel lobby
8:20 a.m.	Leave hotel by taxi
8:55 a.m.	Leave Takamatsu Port by hovercraft
9:18 a.m.	Arrive Uno Port
9:26 a.m.	Leave Uno Station by fast train
10:04 a.m.	Change train at Okayama Station
10:23 a.m.	Leave aboard "Bullet" train (Hikari No. 102)
11:53 a.m.	Arrive Kyoto Station Proceed to Kyoto Park Hotel

Sun., 24th June

Free time

Mon., 25th June

9:50 a.m.	Check-out and assemble in hotel lobby
10:00 a.m.	Leave hotel by taxi
10:52 a.m.	Leave Kyoto Station aboard super-express train (Hakucho)
5:24 p.m.	Arrive Niigata Station Proceed to Minami Plaza Hotel

Tues., 26th June

8:50 a.m.	Assemble in hotel lobby
9:00 a.m.	Leave hotel by chartered bus
9:30 - 10:30 a.m.	Visit the Shirane-go Land Improvement District
10:30 - 11:20 a.m.	Observe the Large-Scale Land Consolidation Project in Shirane-go
11:30 a.m. - Noon	Visit Mr. Kanauchi (farmer)
Noon - 1:00 p.m.	Move by chartered bus while observing the upper stream and the Harigasone headwork on the way
1:00 - 2:30 p.m.	Visit the Nishikanbara Land Improvement District
3:00 - 3:20 p.m.	Visit the Ohkozu diversion works and the Nishikawa Irrigation Pump Station
4:15 - 4:45 p.m.	Visit the drainage pump station at the mouth of the Shinkawa (river)
4:45 p.m.	Leave for Niigata by chartered bus
5:30 p.m.	Return to Minami Plaza Hotel

Wed., 27th June

8:00 a.m.	Check-out and assemble in hotel lobby
8:10 a.m.	Leave hotel by taxi
8:48 a.m.	Leave Niigata Station aboard super-express train (Toki No. 8)
1:09 p.m.	Arrive Ueno Station
	Proceed to Akasaka Shanpia Hotel by chartered bus
(Rest of afternoon)	Free time

Thurs., 28th June

9:20 a.m.	Assemble in hotel lobby
9:30 a.m.	Proceed to the Japan Productivity Center (JPC)
10:00 a.m. - Noon	Summing Up and Concluding Session (Adviser: Dr. M. Okamoto)

Noon Leave the JPC by taxi
12:30 - 2:00 p.m. Farewell buffet luncheon at the
Tokyo Aoyama Kaikan (Courtesy of
Mr. S. Furugori, Director-General,
Agriculture, Forestry and Fisheries
Productivity Conference)
2:00 p.m. Proceed to Akasaka Shanpia Hotel by taxi

Fri., 29th June

[For For those participating in Phase III (ROC)]

11:50 a.m. Assemble in hotel lobby
12:00 p.m. Leave hotel for the Haneda Airport
by chartered bus
3:05 p.m. Fly to Taipei aboard CI 15

[For all other participants]

Return to respective countries

c. Phase III. Rep. of China, 29th June - 5th July, 1979

Date/Time

Activity

Fri., 29th June

5:40 p.m. Arrival in Taipei from Tokyo aboard
CI 15
Proceed to Golden Star Hotel

Sat., 30th June

9:00 a.m. Call at China Productivity Center for
orientation
10:15 - 11:30 a.m. Call at Council for Agricultural
Planning and Development for
briefing on Agricultural Development
Noon Reception Luncheon hosted by
Mr. Wang Sze-Cheh, APO Director for ROC
Afternoon Free time

Sun., 1st July

7:30 a.m. Leave Taipei for Chiayi
Noon - 1:00 p.m. Lunch at Chiayi

1:00 - 2:30 p.m. Proceed to Tsengwen Reservoir
3:00 - 4:30 p.m. Visit Tsengwen Reservoir
4:30 - 5:30 p.m. Leave Tsengwen for Tainan
(Accommodation at Chengkung Hotel, Tainan)

Mon., 2nd July

8:30 - 10:00 a.m. Visit Chianan Irrigation Association for
briefing on:
1) Organization and management of the IA
2) Irrigation plan and cropping pattern
3) Operation & maintenance of irrigation
systems with reservoir water sources
10:00 a.m. - Noon Visit Wushantou Reservoir Irrigation System
Noon - 1:00 p.m. Lunch at Wushantou
1:00 - 5:00 p.m. Visit farm-level irrigation systems
in the Chianan area
(Accommodation: Tien-Tzu Hotel, Chiayi)

Tues., 3rd July

8:30 - 9:00 a.m. Leave Chiayi for Touliu
9:00 - 10:00 a.m. Visit Yunlin Irrigation Association for
briefing on:
1) Organization & management of the IA
2) Irrigation system with surface and
groundwater sources
10:00 a.m. - 3:00 p.m. Visit farm-level irrigation systems in
Yunlin area (Lunch at Huwei or Peikang)
3:30 - 6:00 p.m. Visit Touliu and Linnei Canal Intakes and
en-route to Sun-Moon Lake
(Accommodation at Sun-Moon Lake
Tourist Hotel)

Wed., 4th July

7:30 - 8:30 a.m. Sight-seeing tour around Sun-Moon Lake
8:30 - 11:00 a.m. Leave Sun-Moon Lake for Taoyuan
11:00 - Noon Visit Taoyuan Irrigation Association
for briefing on the organization
and management of the IA
Noon - 1:00 p.m. Lunch at Taoyuan

1:00 - 4:00 p.m.

Visit Shihmen Dam, Taoyuan Canal Intake
and farm-level irrigation system with
water supply from farm ponds
(visit Chih-hu en-route to Taipei)

Thurs., 5th July

8:30 - 9:45 a.m.

Evaluation, Golden Star Hotel Dining Room

9:45 - 10:15 a.m.

Courtesy call at SYNOTECH Corporation

10:15 - 12:00 noon

Visit National Museum

12:00 - 6:00 p.m.

Free time

7:00 p.m.

Dinner reception by SYNOTECH Corporation

Fri., 6th July

Participants return to respective countries