IIMI CASE STUDY NO. 2

The Kimbulwana Oya Irrigation Scheme: An Approach to Improved System Management

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Summary: This case study describes the problems which existed in the scheme prior to its rehabilitation in 1979 and the associated irrigation management innovations introduced by the author, who was assigned as a technical assistant by the Irrigation Department that year. Some of the management innovations included the provision of a simplified form of technical guidance to farmers and using organized farmer participation in the operation and maintenance of the system through a Water Issue Board. By gaining the confidence of the farmers and the various line agencies working in the area, the author was able to introduce a systematic rotational distribution of water, advance the cultivation calendar, and increase cropping intensity. He was also able to motivate the farmers to take over the responsibility for the maintenance of the system from the government, and to continue to improve the physical and operational condition of the system.

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FOREWORD

The Kimbulwana Oya Irrigation Scheme is known as one of the more successfully run irrigation schemes in Sri Lanka. The success story of the scheme has been featured in a video film produced under the auspices of the US Agency for International Development. This film made IIMI staff aware of the scheme, and prompted their initial visit to it in early 1985. It became obvious during the visit that it was mainly the dedicated effort of the Technical Assistant, Mr. Sunil Gunadasa, that was responsible for the improved management of the scheme. His answers to questions posed to him provided insight on the unique role he played from the time he joined the scheme in 1979 when it was about to be rehabilitated again. His story was substantiated by the Colonization Officer, the elected Chairman of the Water Issue Board, and some farmer representatives to the board. The board was a body organized by Mr. Gunadasa, which met weekly to decide on all irrigation issues faced by the farmers and the scheme management. These issues ranged from punishing farmers who violated board decisions to planning seasonal cultivation and seeking appropriate assistance from higher officials of various service departments.

Subsequent visits served to verify further improvements in the scheme's management. The physical condition of the scheme, instead of deteriorating was in fact improving. The well-organized farmers had recently taken over the maintenance of the whole scheme, which meant savings for both the government and the farmers. These observations were convincing enough for IIMI to invite Mr. Gunadasa to document his innovative approach to improved irrigation system management through the Special Awards program of the Institute.

Mr. Gunadasa is the second IIMI Special Award recipient. These special awards are given to irrigation professionals who have developed and implemented successful innovative approaches to improve the performance of irrigation systems. The Institute provides assistance not only in documenting but also in publishing and disseminating widely the innovative experience to an international network of irrigation professionals.

Senen M. Miranda
Colombo, Sri Lanka.

EXECUTIVE SUMMARY

History reveals that Sri Lankans have been honored for their great feats in constructing and managing irrigation reservoirs for hundreds of years.

The text highlights the fact that negligence regarding important aspects of communities after mass settlements in 1957 has resulted in the deterioration of irrigation systems. This is shown by the necessity to rehabilitate irrigation systems frequently. Millions of rupees that have to be spent on rehabilitation could be utilized in constructing new systems.

The following aspects are discussed at length to give a clearer understanding on:

1. The nature and level of expenditure incurred by the government in restoration work;

2. The hopes that settlers and landless people have of benefiting from the system in beginning a new life that will lead them to prosperity; and

3. The lack of technical guidance and coordination which led to the ruin of the entire system making it an unpleasant place for the community to live in and for government officials to work in.

The administrative structures tried out and the reasons for their failure are described.

Technical personnel who take pains to understand the problems in the system can, with innovative approaches, build up their credibility and gain the confidence of farmers by providing a simplified form of technical guidance to the farmers. This guidance can be in the form of information on water saving using rotational distribution of water based on a timetable, where water is reliably and equitably distributed to all the rice fields irrespective of their location — whether at the tail, middle or head end of the system.

Large amounts of water can be saved during the wet season by advancing the cultivation season, and using whatever stored water is left at the end of the season to overcome deficits in the dry season. Cropping intensity can be increased from 100 to 200 percent if more assured water is available.

The confidence of farmers can be built up gradually by analyzing available irrigation scheme data regarding rainfall, inflow, water deliveries, and storage in seasonal planning of cropping patterns and water deliveries during critical crop growth stages. Farmers could be guided to comply strictly with cropping calendars having up to three cultivations a year.

Considering the importance of farmer participation in the planning, implementation, and construction of systems, a controlling body composed of elected farmer leaders representing the entire farmer community, and government officers to guide them, was formed. The farmer leaders were the communicating medium between the farmers and government officers in seasonal planning, cropping patterns, and maintenance of systems. Conflicts and disputes were settled by a controlling body called the *Water Issue Board,* which met regularly every Tuesday.

The coordination helped farmers increase their yields and cropping intensities, and save time so that they could get involved with more income generating activities.

The confidence instilled in the farmers made it possible for a government maintained system to be converted into a major communal irrigation system where organized farmers undertook the maintenance of the system, thereby saving government money that would have been spent on maintenance work.

The system, with its well-functioning distribution system, is in a much better condition now than after rehabilitation in 1979, and the benefits derived by the farmers clearly indicate that the efforts and sacrifices they made in the process were not in vain. Technical guidance, coordination, and farmer participation are essential factors supporting the sustainability of an irrigation system.

ACKNOWLEDGEMENTS

I am grateful to the Professional Development Program of IIMI and the Director of the Irrigation Department for providing me this opportunity to document eight years of work on innovative approaches to systems management in the Kimbulwana Oya Irrigation Scheme.

It is with great appreciation that I acknowledge the efforts of Dr. Senen M. Miranda for devoting time to discuss the text and for the encouragement rendered. The encouragement given by Drs. Panabokke, Rao, Groenfeldt, Wickham, Lenton, Merrey, and Raby, and Mr. Berthery are remembered with appreciation. Especially helpful were the comments received from Dr. Merrey on the draft manuscript and the thorough and careful editing done by Mr. John Colmey.

My appreciation is extended to Dewaki, the coordinating secretary, and to Ameeta, who patiently read through the hand-written text and typed in corrections over and over again.

The text is dedicated to my parents who prepared me physically and psychologically to withstand hardships in a useful venture; to my wife Surangani for cooperating with me for a decade to make this venture a success; and to all the officials, and Kimbulawana Oya farmer leaders and farmers who worked with me.

Finally, my thanks to the IIMI staff for the assistance given to me in connection with my housing accommodation, transport and supplies, and for the hospitality extended to me during my stay at the Institute.

AN APPROACH TO IMPROVED SYSTEM MANAGEMENT: A CASE STUDY OF THE KIMBULWANA OYA IRRIGATION SCHEME

INTRODUCTION

In 1979/80 the Government of Sri Lanka initiated the rehabilitation of the Kimbulwana Oya Irrigation Scheme in the Kurunegala District in the North-Western Province of Sri Lanka. The author, a government Technical Assistant (TA), was transferred to the scheme to oversee the rehabilitation and to improve the management of the scheme and direct the benefits of the rehabilitation to the farmers. In carrying out these activities, the author took advantage of the farmer interest in the rehabilitation activities to introduce, test, and demonstrate new ideas for operating and maintaining the scheme. Farmer participation in the rehabilitation work proved to be the first step towards their participation in the day-to-day operation and maintenance (O&M) of the irrigation scheme.

This case study presents the nature of the problems which existed in the scheme prior to rehabilitation and the associated innovations in management which were subsequently introduced. Experience gained through the introduction of these innovations and a number of recommendations for the improved management of similar schemes are also presented.

Physical Layout

The Kimbulwana Oya Irrigation Scheme encompasses a reservoir equipped with sluice gates to regulate the water supply to a network of channels. There are two main canals (Figure 1). The right bank canal irrigates 564 hectares (ha) through 2 branch channels, 1 distributary, and 54 field channels. The left bank irrigates about 100 ha of mostly *purana* (preexisting) lands and augments two minor irrigation tanks. All offtakes and turnout structures are equipped with sliding steel gates that can be locked. The field channels are laid out across the contour. Numerous drop structures have been constructed to maintain a gradient of 0.0004. Farm outlets consist of Hume pipes of 10 centimeters (cm) diameter. During rotational issues, outlets, which do not have gates, are closed with straw or grass plugs. Water issues are monitored using staff gauges located below main sluices and in the various channels. Staff gauges at the head of the channels facilitate the maintenance of proper discharges to the satisfaction of agency staff and farmers.

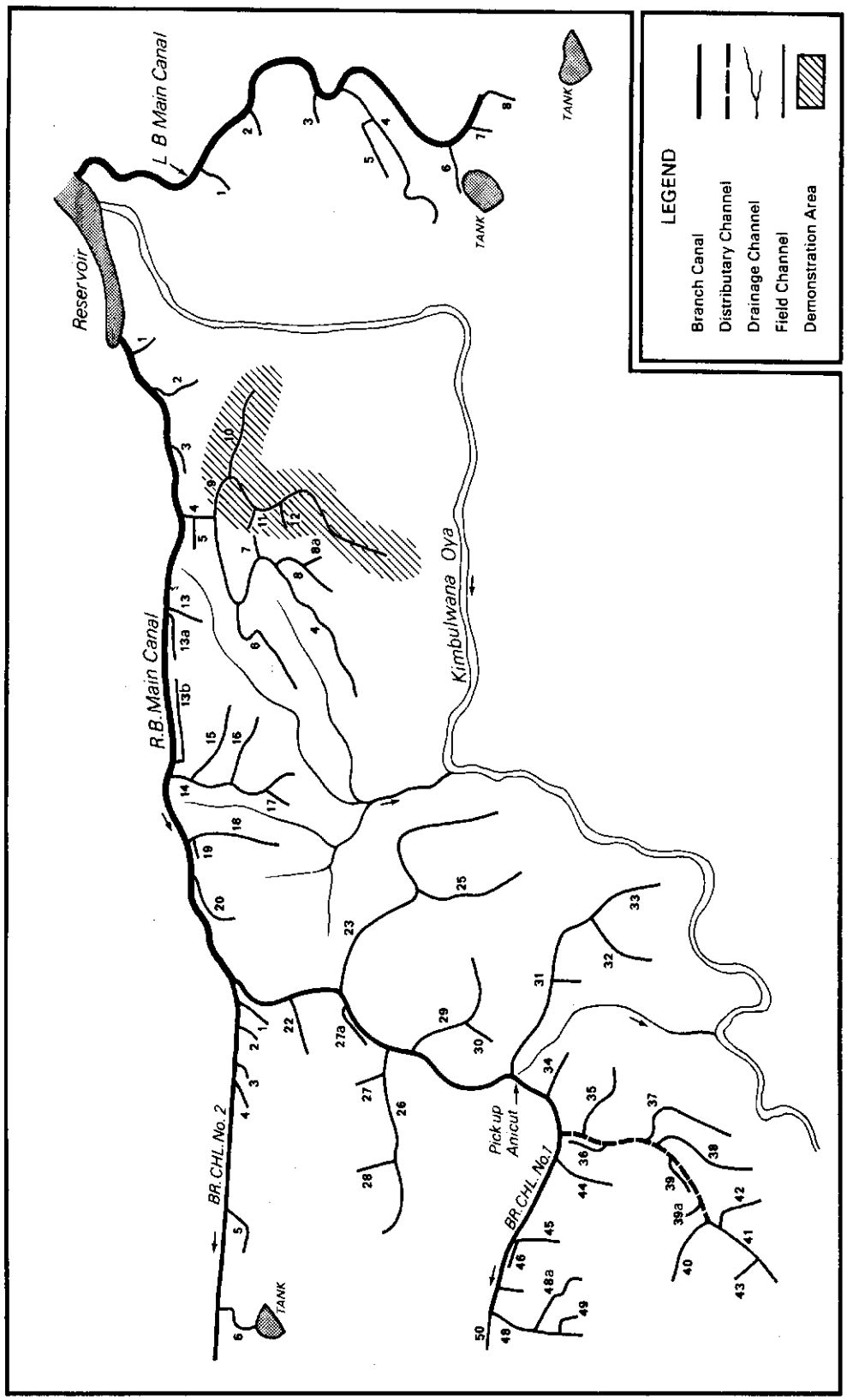
The undulating topography provides good drainage for the scheme. Due to the porous texture of the soils, seepage and percolation rates are high.

There are about 800 owner farmers and 200 tenant farmers. Farmers' plots average about 0.8 ha crown lands and 0.4 ha purana lands. Plots are located mostly along field channels and take water from farm outlets. Farmers generally grow two crops per year. In *maha* (wet season), from September to February, 100 per cent of the scheme is devoted to rice. In *yala* (dry season), from March to August, 80 percent is planted to rice, while 20 percent is planted to non-rice crops like chilies, greengram, cowpea, onions, vegetables, etc.

The area receives about 1780 mm of rainfall annually. The wet season (maha) rains average about 1320 mm. The convectional rains start in mid-September bringing in the first few rains. The rainfall intensity gradually increases with the onset of the Northeast monsoon during the second week of October with the heaviest precipitation occurring in November and decreasing during December. During the period between the end of December and the first week of January, the climate is ideal for grain formation when the nights are cool and the day temperatures are high.

In early April, convectional rains again begin to fall in the North-Western area of the region; the heavier rains occur by mid-April up to the end of May. About 460 mm of precipitation occurs during the relatively drier (yala) season. There is not much inflow to the reservoir but the scattered rains provide moisture to the yala crops throughout the season. The dry spell begins in mid-June with high day temperatures in July and August when harvesting is done.

Figure 1. Layout of Kimbulwana Oya Irrigation Scheme Distribution System.



Management Structure

The Kimbulwana Oya Irrigation Scheme comes under the jurisdiction of the Irrigation Department. A number of other government line agencies with district-wide responsibilities for agriculture, land settlement, agricultural services, and credit also service the farmers in the scheme.

Within the Irrigation Department an irrigation engineer is given responsibility for one or more irrigation schemes depending on the size of the schemes. In addition to general administration duties, he keeps track of the systems activities as time permits. In a small system such as Kimbulwana Oya, the responsibility of day-to-day O&M of the system falls to a government technical assistant who reports to the irrigation engineer. The technical assistant oversees a work supervisor who, with a few casual irrigation laborers, attends to essential maintenance work.

About two months before each cultivation season, the Colonization Officer calls a cultivation (*kanna*) meeting. The Colonization Officer is responsible to a Government Agent, a senior government official appointed to administer government services throughout a district. The meeting is attended by farmers within the scheme and by officers representing the various government agencies. The agriculture department officer explains the extension services and makes recommendations for the season. Officers from other departments submit additional relevant data and information which farmers need to plan their cultivation (new marketing schemes, seed distribution, and availability).

The president of the Cultivation Committee, usually a district land officer (see Figure 2 for organizational chart) or a representative of the government agent, then tries to gain a consensus from the group on a seasonal cultivation calendar. He requests the Irrigation Department technical assistant to present his assessment of the availability of water in the reservoir and the corresponding area that could be cultivated. As the kanna meeting is held prior to seasonal rains, sometimes the extent he recommends is less than 25 percent of the total extent. A decision is taken on condition that as soon as the tank storage reaches a certain level the cultivation will commence. Any other policy matters are also discussed at this meeting.

Representatives of each agency as well as a number of the elected farmer leaders also sit on a Water Issue Board. The Board meets every Tuesday and discusses issues such as a) fixing of an irrigation issue and availability of water in reservoir, b) irrigation difficulties and remedial measures, c) land disputes, d) crop diseases and preventive measures, e) agrarian inputs availability and supplies, f) unlawful activities related to violations of farmer meeting decisions and penalties imposed, and g) preseasonal planning.

Water distribution (see Figure 3) is done according to a timetable decided by a Water Issue Board. Decisions reached at the kanna meetings are followed strictly by the farmers. If not, the Board penalizes the farmer in question accordingly (described in detail in a later section.

BACKGROUND

History

The Kurunegala District in the North-Western Province of Sri Lanka has long been considered one of Sri Lanka's granaries (see Figure 4). It has provided food for a large part of the country for centuries. The Mahawansa records that Kimbulwana Oya Reservoir was one of the 16 tanks constructed by King Mahasen during his reign between 276-304 A.D. It was renovated by King Kashyapa during 937-954 A.D. and by King Parakramabahu the Great during 1153-1186 A.D.

After centuries of neglect and disrepair, the Irrigation Department, under the postindependence government, restored the reservoir. The restoration was completed in 1957, to provide irrigation to

Figure 2. Kimbulwana Oya system — management structure

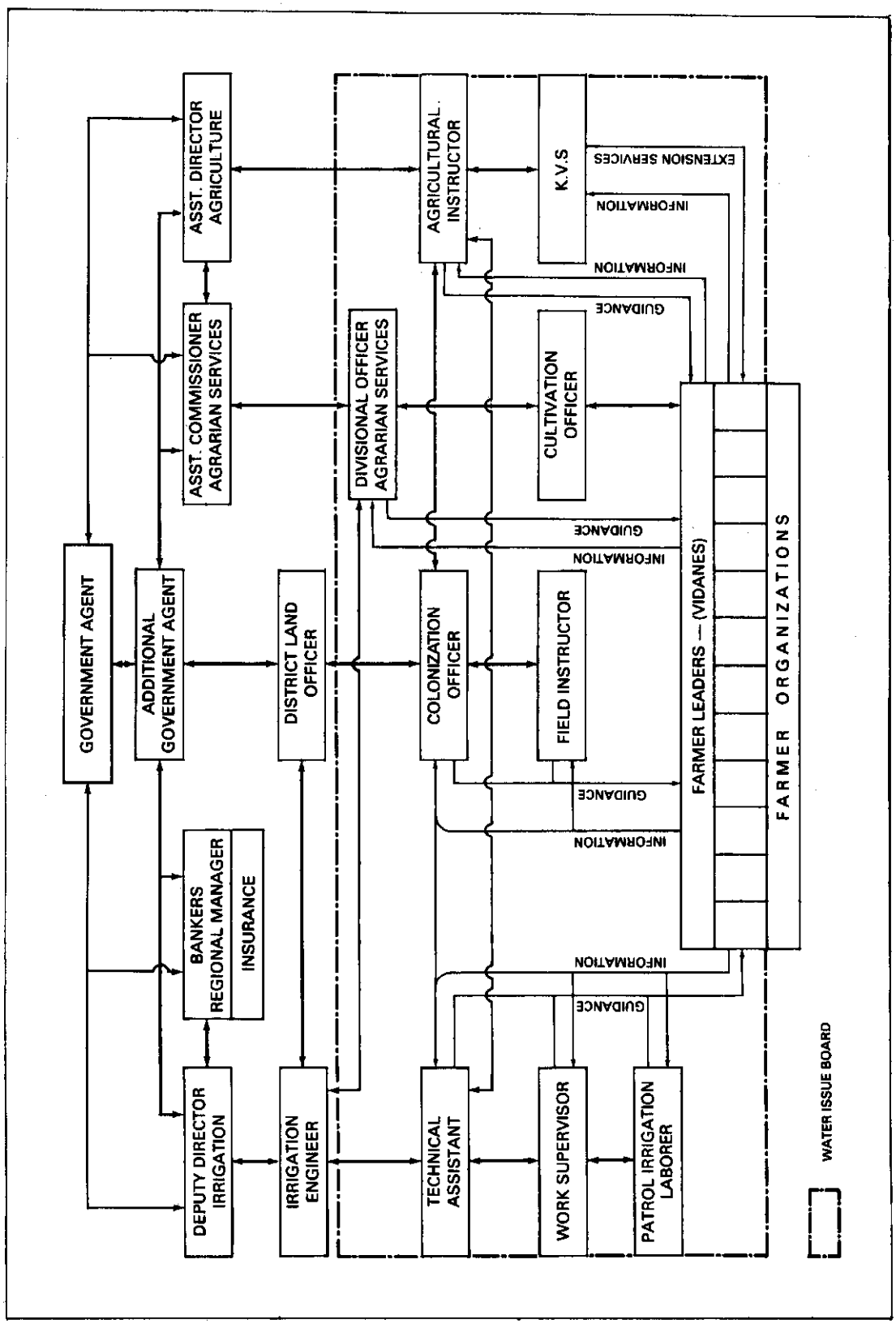


Figure 3. Issue tree diagram of the Kimbulwana Oya Irrigation Scheme.

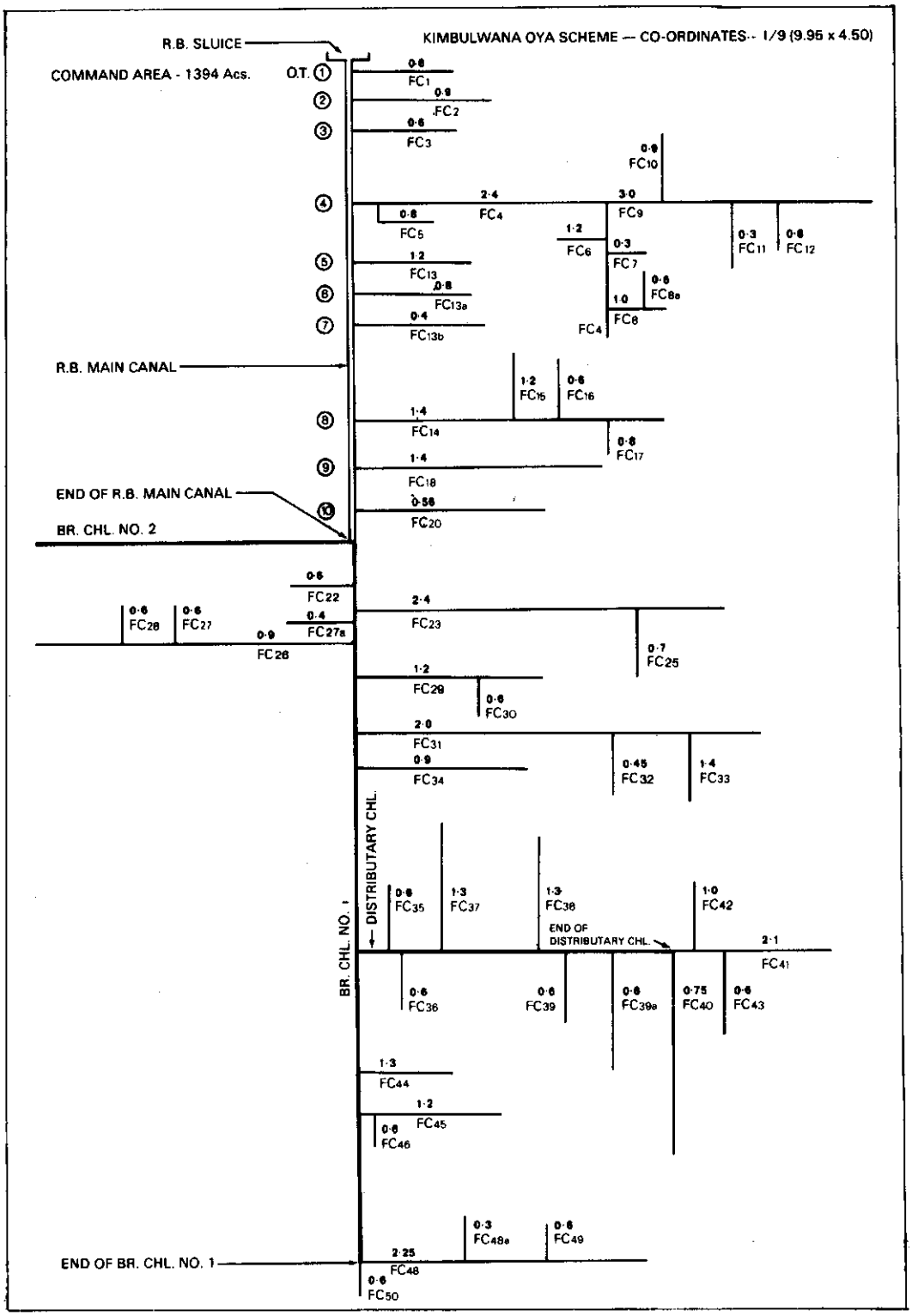
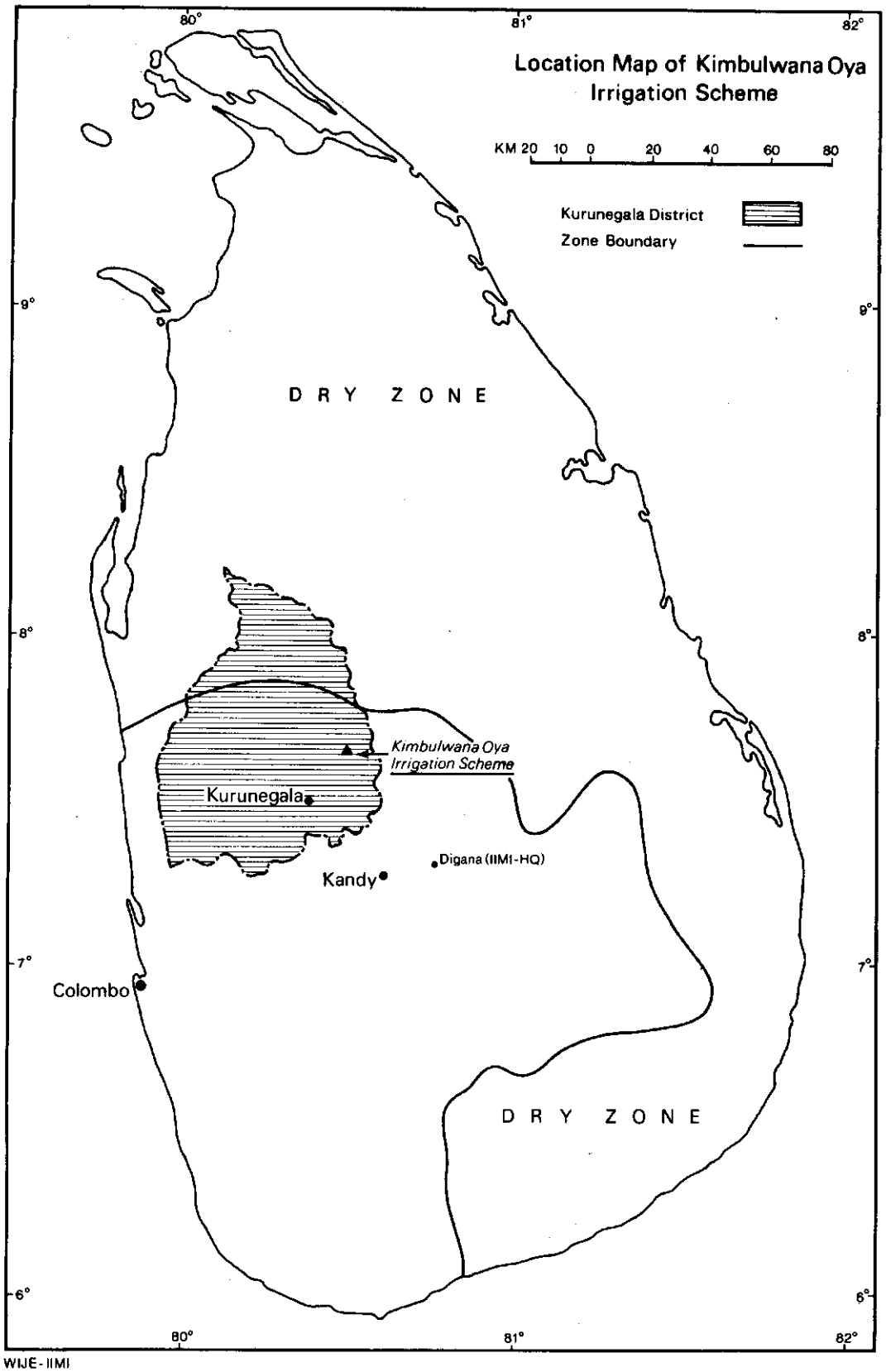


Figure 4. Map of Sri Lanka showing location of Kimbulwana Oya scheme



about 405 ha. In 1965, the tank capacity was increased to 629 hectare-meters (ha-m) by raising the spillway level by 1.22 m. This allowed for the irrigation of 458 ha under the right bank canal and 101 ha under the left bank canal. Two radial gates on the right spillway and lifting gates on the left bank were provided to facilitate spill discharges. The system was then allowed to fall into disrepair, and was rehabilitated again in 1979/80.

Settlers

Beginning in 1956, the government allotted 252 ha of paddy lots to 350 colonists, and 40 ha of purana lands, original settlement lands, were also cultivated. The majority of the settlers came from nearby villages within a radius of about 16 kilometers (km); the rest came from a few scattered villages in the Kurunegala District.

In general, settlers came with agricultural backgrounds and wide experience in farming. About 25 percent had possessed lands under minor irrigation tanks, about 50 percent had depended on rain-fed cultivations, and the balance had cultivated *chena* lands (rain-fed shifting cultivation). In most cases they did not own sufficient extents to provide the basic necessities for their families, due to the breaking up of family land holdings over time and through successive generations.

As in other colonization schemes, the settlers were reluctant to leave their villages due to family ties. Also, settlers from prestigious families did not like to be referred to as colonists. In some cases, settlers believed the new settlement areas to be infested with malaria. However, the settlers whose lands were submerged in the process of restoring the reservoir had no alternative but to accept the lands provided them near the tank.

State of the Scheme in 1965

By 1965, the cultivated area had increased to about 330 ha of colony lands and 61 ha of purana lands. At that time, the water supply was more than adequate. The average rainfall in the area was 1651-1778 mm: 559 mm during the yala season, and 1143 mm during the maha season. The catchment area was forested and had perennial streams flow throughout the season.

The population up to that time was composed mostly of bachelors or small families and the allotments available for cultivation were not fully cultivated until about 1965. Sufficient grazing pastures for cattle were scattered throughout the system. Most of the farmers near the headworks fed their cattle on the tank bed, an area of about 61 ha.

Up until 1965, the distribution system functioned smoothly. Every channel was built according to design specifications so that discharges could be made, and every channel had well-defined profiles and reservations to minimize seepage losses. The field channel design allowed a reservation width of 10 meters on the road side and 3.4 meters on the paddy-field side as shown in Figure 5. These reservation widths increased from 10 meters for distributary channels to 20 meters for main channels.

The settlers were united by their faith in Buddhism, which places great emphasis on the community. Settlers worked together and assisted each other on social occasions, such as funerals, weddings, and during cultivation in transplanting, reaping, and threshing. They all took part in religious activities in the village. Cultural presentations and other community events such as folk dances were also common during this period (1965 to about 1975).

Laws which governed equity and social relationships, as well as penalties for violating them, were implemented and imposed strictly and fairly. Government officials under various departments did their work conscientiously and could use their discretion in solving day-to-day problems. They were supported by their superiors who, in turn, enjoyed relative autonomy in running their offices. Political influence did not interfere in the operation of the scheme.

Figure 5. A typical field channel section.

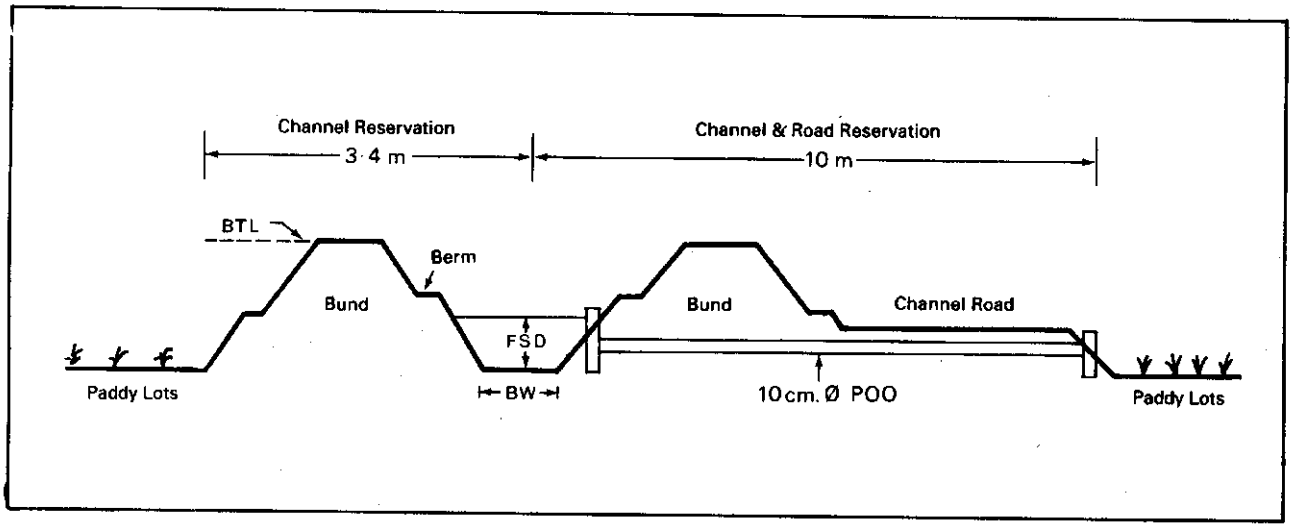
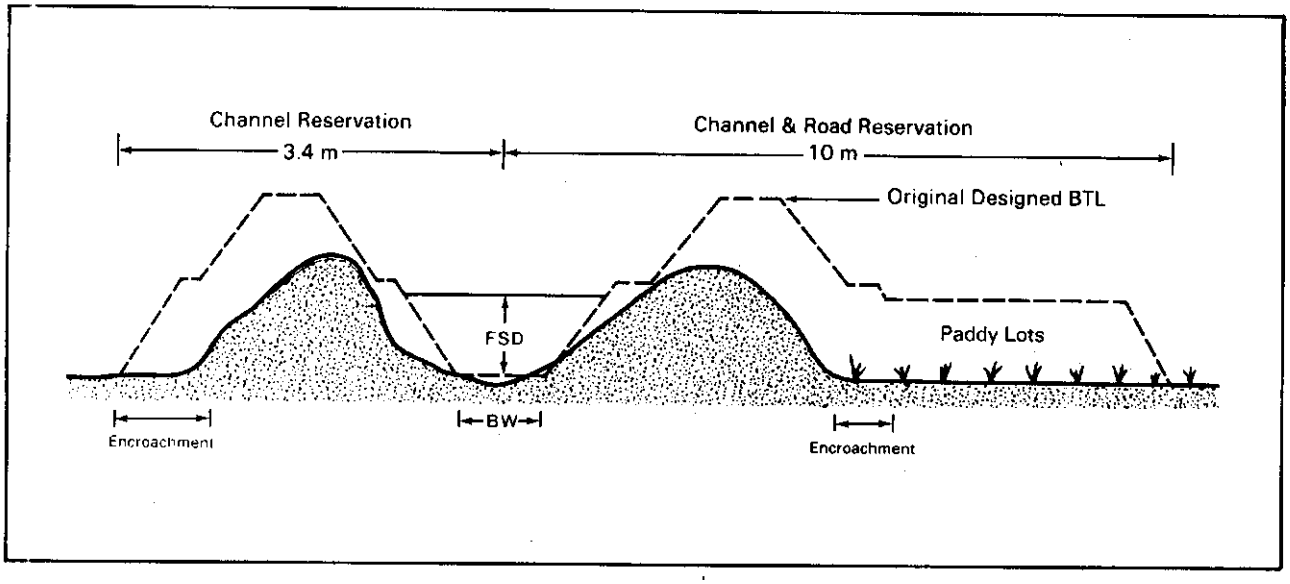


Figure 6. Farmer encroachment on channel bund-reservations.



State of the Scheme in 1979

Physical state. By 1979 the physical state of the scheme had deteriorated considerably. The canals had damaged bunds, scoured profiles, and eroded embankments. As a consequence, the canals' capacity to carry discharges (Q) was far below design. Maximum design Q could not be released through the channels without overtopping or breaching. Water supply at the tail sections was insufficient. Stray cattle were all over the channel system. Figure 6 shows how farmers encroached on channel bund-reservations which were designed to be 10 meters on the road side of the channel and 3.4 meters on the paddy-field side of the channel.

The few maintenance laborers available were unable to cope with the work load that accumulated daily. This included controlling the spread of weeds in the channels, desilting the channel beds, filling the scoured bunds, and operating the channel outlets during water issues. None of the wooden gates within the scheme were functioning. Most were damaged so that the locking devices failed to operate; 80 percent of the drop structures were undermined or else the water flowed around the structure, leading to insufficient head to move water to pipe outlets and to paddy allotments. Many of the channel regulators did not have control gates. Planned water issues to branch, distributary, or field channels, or to the allotments were impossible. This led to frustration among the officers and farmers.

Farmers' attitudes. Under these conditions, farmers became increasingly uncooperative. They were frustrated, helpless, and irritable. Yields decreased yearly, which reduced their incomes and increased their debt. Many farmers were forced to lease their land to raise the necessary income to meet their expenses and responsibilities (funerals, weddings, litigation, medical expenses, etc.). By 1979, more than half of the paddy allotments (each farmer had 0.4 ha of highland for his house and 0.81 ha of paddy land) were leased to outsiders. In addition, leases required that the farmer give a large portion of whatever water supply he received to the person who leased his land. They began to lose hope of earning a livelihood and became desperate in their outlook.

In general, farmers did not feel a sense of ownership of the scheme. They hardly attended to the maintenance of the system, and simply waited for the water to arrive at their lots. Farmers often expressed doubt as to whether enough water would arrive until the end of the season. Head-end yields were well below 3 tons per ha (t/ha), while yields in the tail end rarely exceeded 2-2.5 t/ha, even though the Department of Agriculture was distributing seed varieties with 5-6 t/ha yield potential.

Attitudes of government officials. Government officials attached to the scheme were cooperative in trying to improve yields through extension work. However, their efforts were rarely sustained due to the unreliability of the water supply.

It was apparent that government officials at the field level could not come up with solutions that were satisfactory to the farmers. There were a number of reasons for this: a) their authority was limited, b) problems evolved due to improper planning, and c) influential farmers often obtained favors through political means or even by means of intimidation.

Government officials were helpless in prosecuting them as the legal procedures for prosecuting offenders were cumbersome. Prosecution had to be done by the police, which meant that the irrigation officer had to travel 15 km or so to report the matter to the police station. A police officer then had to be brought to the scene, witnesses had to be gathered, and the damage had to be assessed. If everything was in order, the farmer was prosecuted in court. More often than not, after a long court trial, the farmer was acquitted or the case was dismissed due to the weak testimony of the witnesses. In addition, there were numerous incidents when field officers reported offenses to superiors, but by the time an inquiry was held, other cases took precedence.

Within the scheme officers travelled considerable distances to attend to normal duties. When

farmers reported interruptions or unlawful activities, the officers had to travel even farther, thus exceeding their allocated mileage and allowances. As the officers' salaries and allowances barely met their minimum expenses, they could not be blamed for not acting against malpractices. They were also careful to work within limits so as not to lose their rapport with farmers as well as with superior officers.

Effect on irrigation efficiency, Problems arose at the beginning of the season. During the kanna meeting, officers would recommend the acreage to match the available quantity of water. The farmers criticized the department for not providing them sufficient water and for not taking stern action against those who violated kanna meeting decisions. The kanna meeting provided the only opportunity for farmers to voice their complaints against the department.

During the wet season, farmers made it a practice to wait until the water supply was certain and would waste initial rains before starting land preparation and transplanting. These normally began in early November even though the maha seasonal rains would begin in late September and peak in mid-October. By that time some of the farmers would have completed part of the desilting of their field channels and the Irrigation Department laborers would have completed partial desilting of the main and branch channel systems. These efforts were rarely sufficient to make satisfactory issues.

The Department of Agriculture or extension services could supply only a small percentage of the required rice seed and fertilizers as the farmers' orders were too late; administrative procedures required about two months lead time from order to delivery. If the seeds did not come on time, farmers would use whatever varieties that were available. Different varieties with varying stages of growth increased the difficulty of water delivery and led to increased incidence of pests and diseases.

Because all the cultivation in the neighborhood of the scheme began in mid-November there was a conflicting demand for farm machinery, helping hands, and work cattle (used for land preparation). Often farmers were forced to wait until the influential farmers completed work on their plots, which were scattered all over the scheme.

Ultimately, the land preparation period decided by the farmers would have to be extended. Land preparation varied up to 56 days. By this time most of the inflow from seasonal rains would have ceased, which meant that the farmers had to utilize the tank storage for the balance of the initial season's cultivation.

When initial water issues for land preparation and transplanting stopped, the sluices would remain closed and subsequent issues made on farmers' request. Water was sent to the tail-end field channels first. There farmers would receive water for a short time, probably for half a day or so, and the flow would gradually cease as the farmers at the head end of the system tried to divert the flow to their fields. At night, tail-end farmers would go up the system in groups to search for and remove interferences thereby releasing water to the tail end. But on their return they would find the head-end farmers had again directed the flow to their lots. This led to a conflict over water issues, decreasing efficiency over the entire system.

Due to these malpractices farmers usually lost most of the tank storage. When it became clear that many farmers would not complete the season, officials resorted to fortnightly issues. The resulting water stress throughout the schemes led to a further decrease in yields.

Previous Management Experiments and Why They Failed

Vel vidane system. Prior to 1958, the government appointed a *vel vidane* (village headman) to be responsible for water issues and minor irrigation work. The vel vidane was selected from among the settlers, and therefore had access to and support from the farmers in carrying out improvement and maintenance work. He had the authority to prosecute, at the rural court, farmers who did not comply with the community decisions. In general, the vel vidane had only to make a request to the community to enlist beneficiaries under a minor tank to do maintenance work.

There were several advantages to this system. Minor irrigation tanks were maintained in good condition as the vel vidane carried out or supervised frequent maintenance work on the scheme. He was able to maintain discipline among farmers as he was accepted as an authority to prosecute offenses such as allowing cattle to stray, illegal water tapping, or violation of community decisions. And, as a member of the community, the vel vidane was able to develop a close relationship with the farmers.

However, in 1958 the system was abolished, primarily because of the shortcomings of individual vel vidanes. This was partly because the vel vidane received his authority from the government. He did not have to consult or seek guidance from a committee of elders and thus was not accountable to the farmers. When he made a decision, little room was left for others to intervene. Except for a few cases, the government awarded the post of vel vidane to an elder in the community whom people respected. Had he been better supervised, his service may have been of more use to the community.

There was another reason for this abolition. The post was created during colonial times when the village headman and *korale officers* (chief of village headmen) were functioning effectively. When these positions were abolished after independence, the vel vidane position suffered the same fate by 1958.

Govi karaka sabha (cultivation committee) system. After the abolition of the vel vidane system, the government established a system called *"govi karaka sabha"* (cultivation committee). The system was in use from 1958 to 1977. The committee included a few members from the community and comprised a president, secretary, a treasurer, and the usual office bearers. The secretary of this committee played a role similar to that of the vel vidane. The committee oversaw all village minor irrigation work, often on a contract basis.

The chief advantage of the system was the division of power among several community members. However, the system quickly became politically oriented. When the committees began to make extra money by doing inferior quality work in undertaking repairs and improvements, they lost the farmers' confidence. And the farmers became reluctant to seek the committees' assistance in solving their problems.

Had the government provided adequate supervision, control and guidance over the "govi karaka sabha," this system, like the vel vidane before it, might have succeeded.

Cultivation officers. The cultivation committees were replaced in 1977 by government appointed cultivation officers. Like the vel vidane they were chosen from among the community, though sought out for their level of education. Organizationally, they came under the divisional officers of the Agrarian Services Department who trained them to a certain extent. The cultivation officers were empowered to hold inquiries into village-level disputes and could lodge complaints through the Divisional Officer, who supervised them.

In addition to the advantage of living among the community, the cultivation officer had access to the various government departments such as those of Agriculture, Irrigation, and Highways (now defunct), which enhanced his ability to get work done on behalf of the community.

The chief disadvantage was again the tendency for cultivation officers to become politically oriented. The appointment of the officer tended to be political, as the access to government agencies carried with it a certain political power in the village. Supervisors found it difficult to maintain discipline among cultivation officers because of their vulnerability to political influence. Joint ventures at the village level rarely succeeded as officers tended to favor their villages. And there was a wide divergence in the individual performance of the officers.

REHABILITATION: AN OPPORTUNITY FOR CHANGE AND IMPROVED MANAGEMENT

Rehabilitation

As stated in the introduction, in 1979/80 the Government of Sri Lanka undertook the rehabilitation of the Kimbulwana Oya Irrigation Scheme. The scheme had to be rehabilitated to put it back to functional physical condition. The scheme had lost the specified levels of channels, embankments, and concerete profiles; structures had settled and cracked, rendering them useless. The initial allocation of Rs 3 million (about US$ 136,000) for rehabilitation and construction work was reduced to Rs 1 million.

The author was transferred to the scheme as a government Technical Assistant (TA) to oversee the rehabilitation and to improve and sustain the management of the scheme. At the time of his arrival, only three months remained to complete the initial preparatory work and workplan. This involved making on-the-spot decisions regarding improvement and repair work to ensure that it would fall within the allocated amounts and produce a functioning scheme. New pipe outlets and cast-iron gates were installed on improvised existing structures. Essential repair work was done on existing structures.

Because the usual procedure in executing work of this nature was to execute it under a contract basis the author considered a number of factors in organizing the new rehabilitation effort.

First, over 95 percent of the rehabilitation work that had to be done on the distribution system could be attributed to a lack of farmer participation in operating and maintaining the system, to a lack of farmers' awareness as to the ownership of the system, and to a lack of coordination with the government sector in formulating policies and decisions to overcome minor conflicts. Thus, maximum farmer participation was considered essential if an appropriate and sustainable rehabilitation was to be carried out. This would also offer the opportunity to improve farmers' discipline.

Second, it was necessary to provide financing to farmers for their livelihood during the period when water issues had to be curtailed to execute the work. Thus, rehabilitation and repair and improvement work were planned to be executed in two stages. Stage one would take place during the 1979 dry season, from April to September, and cover that part of the system under the main channel and field channels 1-20. During this period, issues were curtailed in the Unit 3 area to about 344 ha. Stage two would take place during the 1980 dry season, and cover those parts of the system under branch channels 1 and 2, distributary channel 1, and field channels 21-50. Water issues were curtailed to an extent of about 324 ha.

Involving the Farmers

Due to the closure of parts of the systems, the author decided to employ the farmers to do the work. He also granted them permission to grow a subsidiary crop (peas and cowpea) on condition that this activity would not interfere with the construction work, and that the farmers would not try, illegally, to obtain water intended for Unit 2 area.

When the information spread through the community that the farmers would be employed in the construction work, over 400 registered as ad hoc type laborers. The TA carried out registrations at the Scheme's Unit Office for the convenience of the farmers.

Due to the widespread interest on the part of the farmers to take part in the construction, four times the required labor strength was available. It was important to show the farmers that the selection of laborers was conducted fairly. A number of steps were taken in this direction. First, the TA made a list of all available farmers. Second, the TA asked only the right number of farmers to work on dates when the Department needed them. Third as far as possible, an effort was made to accommodate those farmers with allotments under their respective field channels to work with the

department. Fourth, an effort was made to ensure that all the farmers in the Unit 3 area would get an equal number of days in the payroll so that they were treated and assisted financially in a fair way. Fifth, the TA refrained from hiring children, elderly people, and others whose output could not match the amount paid to them. Last, when professionals were to be employed as metal quarry laborers, masons, carpenters, and supervisors, the department was to be given the option to employ them irrespective of the area of their residence.

Organizing the Work

With over 80 percent of the structures in need of repairs, various types of work were necessary throughout the scheme, including: provision of downstream protection of structures to prevent them from being undermined and collapsing; the construction of drop walls to existing structures where settlements, owing to continuous leaks, had been detected; and the replacement of cracked or damaged field pipe outlets. And this is only a partial list of the multitude of repair work needed.

Labor teams were organized under competent supervisors. They had to expose every drop structure, where leaks were expected, to search for possible cracks and waterways, anthills and vents that were causing failures to structures. They had to excavate the foundation and remove damaged sections. A transport team followed and supplied the required amounts of metal, sand, and rubble at convenient places close to the structures that needed repairs. A concreting team followed with shuttering and concreting. The wetting of concrete, removal of shutterings, the transport of extra materials, the backfilling of structures and turfing, and other finishing up work was all done subsequently.

This approach had two advantages. The work was completed ahead of schedule. And farmers gained a greater awareness of the technical aspects of the systems, how deterioration occurs, and what was necessary to maintain the system.

Maintaining Discipline Among Laborer/Farmers

The organization of labor was done in such a way that no employee could leave the site without the supervisor's knowledge. The TA assigned one supervisor for every 50 laborers. Employees signed an attendance book on arrival and on departure. Attendance was marked in the morning and afternoon before and after the lunch break.

Movements of material were recorded when issued from main stores, during transportation, and on arrival at the respective field sites. Record was also kept of usage, balance at the end of the day, and materials returned to stores. All the custodians had to sign for accountability. The professional workers had to verify the usages at the end of the day. Hence, frauds and malpractices were avoided. Instructions received from supervisory staff and the quantity of work done were recorded in Log Books.

All those employed were treated equally, and disciplined when necessary. Wages were given to them at proper times, and festival advances, etc., were arranged despite the administrative inconvenience.

Benefits Derived from Farmers' Participation in the Rehabilitation

The strategy of using farmers who had paddy allotments under the field channels to repair the channels was very effective. This inspired the farmers to endeavor to find solutions to their existing problems, and they took an added interest, in the knowledge that benefits would accrue to them.

For example, farmers assisted the TA in preparing the estimates for repair work of the leaks in structures, especially where underground cracks, washways, and settlements were unforeseen. Although some of these structures were not specifically mentioned for repairs, farmers exposed these points so that remedial measures could be taken.

When earth-work required clayey core walls, farmers pointed out the fields where suitable materials were available, thus avoiding the use of sandy, inferior quality filling materials. In doing earth compaction work, farmers were keen to do a thorough job. In using concrete mixes of sand, metal and cement, farmers ensured obtaining the proper mixtures.

As most of the construction shifted from site to site, it was necessary to find temporary field stores to store tools. In these cases, farmers willingly took custody of the stores and kept them in their compact houses. This relieved the department of the burden of building temporary huts throughout the scheme. When tools such as crowbars, picks, axes, or adzes were in short supply, farmers willingly brought their own to use.

During construction, farmers observed that the embankments which were newly filled with turf were damaged overnight by stray cattle. In these cases the farmers cooperated with the department in setting down suitable preventive measures.

There were other benefits that resulted from farmers' participation, particularly in terms of minimizing wastage. During construction farmers took advantage of the opportunity to point out problems or show disappointment about: a) wastage of government property; b) collapse of foundations due to the delay in follow-up work; c) stoppage of work due to lack of transport; d) work postponement due to lack of supplies such as cement, steel reinforcements, cast-iron gates, blasting material, or shuttering planks; and e) work postponement due to lack of skilled manpower and professional workers like carpenters, masons, quarry workers, or supervisors.

In the presence of adequate labor strength more labor-intensive construction could take place. Instead of demolishing existing turnout structures and putting up new expensive replacements, the existing ones were improved and strengthened whenever possible. New cast-iron controllable components were incorporated in them. Lengthy retaining walls which were about to collapse and were scheduled to be demolished were underpinned with concrete work to put them in usable condition. Much of this would not have been possible without the farmers' participation, due to budget restrictions.

Last, considerable benefits accrued to the Irrigation Department in gaining a reputation for taking a genuine concern in the farmers' problems. Also, the procedures followed in organizing and carrying out the rehabilitation were incorporated in involving the farmers in the O&M activities to follow. Most importantly, their participation marked the first step in enhancing their feeling of ownership and responsibility for the system.

THE INTRODUCTION OF ROTATIONAL WATER DISTRIBUTION

Despite the successful rehabilitation of the scheme, the author recognized that a number of changes in the use and management of water would be necessary to increase yields to an acceptable level. Adequate water supply is not enough in itself if the water is wasted or is not applied in adequate amounts during critical stages of cultivation. Similarly, yield can be depressed if the cultivation season commences at the wrong time.

Other factors which lead to poor yields include the insufficient or inappropriate use of agricultural inputs such as fertilizers, weedicides, and pesticides. However, management of the water supply has the greatest influence on the crop yield, at least in Kimbulwana.

In 1979, the author undertook a study to find out the causes of the deficiencies in the water distribution system of the Kimbulwana Oya Irrigation Scheme. This involved determining the basic characteristics of water distribution in it.

The area specified for cultivation was 559 ha, all of which was used for rice. The total amount of

water used to irrigate once, as per tank sluice discharge, equalled 105-123 ha-m. The amount of water delivered on farm after subtracting 20 percent for estimated conveyance losses equalled 98.7 ha-m. This is equal to a depth of water of 0.17 meters or 17 cms over the total 559 ha. In other words, with the amount of water released from the tank, it was possible for every field to have 17 cms of water. And yet farmers were experiencing a water shortage.

Farmers were provided with 10 cm Hume pipe outlets to their 0.8 ha allotments. By having a head of water of 10 cm., a pipe outlet could deliver a discharge of 11.3 liters per second (liters/sec). If this discharge could be maintained for 12 hours, a 0.8 ha allotment could be irrigated to a depth of 7.62 cm. However, because the farmers were accustomed to receiving water simultaneously under a field channel over the entire system, no channel could deliver the necessary discharges to irrigate the entire extent under it.

To get a better understanding of this situation a *demonstration area* was selected in Unit 3 area under FC 4 turnout (see Figure 1), served by field channel no. 9 with an extent of 82 acres. A full supply discharge of 63.72 liters/sec was sent to this channel. The pipe outlet level heads were checked and ranged from 5 cm to zero and below. When the head was closed to zero, the delivered discharges were very low and were simply being absorbed into the soil without surface flow. However, when sufficient head of at least 5 cm was maintained, the surface flow was faster. Hence, paddy fields were filled one after the other and losses were minimized.

It was estimated that with the assumed seepage and percolation rate of 25 mm/day on dry soil, only about one-third of the extent under a channel could be irrigated at a time.

The author then met with the farmers to explain how they could obtain the necessary water supply to meet their cropping requirements. They were shown the layout of their channel system and the associated soil texture and topography. He explained that simultaneous issues wasted water because of the sandy nature of the soil. Under such circumstances the high seepage and percolation rate did not allow the small flow to cover the area on time. Further he explained that if water issues were confined to only part of a channel at a time, by irrigating one-third of the extent, the discharge could be increased to the pipe outlets due to the increase in water head. Under these conditions, the four days then required to irrigate their fields could be reduced to 12 hours.

In response the farmers admitted that the sandy soils in their tracts wasted water when they tried simultaneous issues. However, they were concerned that unless they tried to get water to their fields at the earliest possible opportunity, they would suffer from acute shortages of water. Because of their past experience, the farmers also doubted the feasibility of releasing issues by sections. As to be expected, those farmers at the head of the channel were upset because they had grown accustomed to having an unlimited water supply to their lots. However, most of the tail-end farmers expressed interest in the possibility that they could get water for at least 12 hours or so without interference.

At the end of the meetings most of the veteran farmers were still doubtful about the venture.

Demonstration of Proposed Rotation

The farmers were subsequently invited to observe a demonstration of the proposed water issue. The demonstration area was in turnout no. 4 of field channel no. 9 with an extent of 11 ha at the tail end. The demonstration was scheduled from 7.00 a.m. to 7.00 p.m. As this was during a cultivation season with low tank water level, the demonstration had to be done carefully. Although intentions were good, if something went wrong the department could have been blamed for wasting precious water during a shortage.

In order to ensure that the pipe outlets would have sufficient heads of water, the following steps were taken: 1) the head sluice gate was opened at 4.30 a.m., 2) flows were monitored to ensure that there was sufficient head maintained at turnout no. 4 by 6.00 a.m., and 3) field staff ensured that field channel no. 4 was ready for commencement of water issues at 7.00 a.m.

About 12 allotments were to be used for the demonstration, but only a few farmers turned up to see the demonstration. Field channels ran to full supply depth to deliver 3.8 cm (1.5 inches) water. The departmental patrol laborers were stationed in the area and recorded the extents irrigated at 4-hourly intervals. The department employees recorded their observations as follows:

1. At about 4.00 p.m., 3 hours before the end of the water issue, about 30 percent of the demonstration allotments had already received water for the entire 0.8 ha. These allotments were irrigated through 10 cm diameter pipes with a head of about 15 cm.

2. At about 7.00 p.m., when issues were stopped, another 30 per cent of the allotments had received sufficient amounts of water. These lots had allotments served by 10 cm diameter pipes of 3.65 meter length, with a head of 0.5-7.6 cm.

3. The remaining 40 percent of the allotments received enough water to cover 75 percent of their area when issues were stopped. These had heads of water less than 2.5 cm.

By nightfall several farmers came to the demonstration area to see the results. Since the department employees were on the lookout, no interference took place, and the farmers could see that sufficient amounts of water had been delivered to their fields within half a day.

Since the demonstration in the FC 9 area solved most of the problems related to wastage of water and helped shorten the time spent on irrigation and supervision of issues, etc., it was considered worthwhile to try the same procedure in the rest of the rehabilitated area under FCs 1-20.

In the subsequent weekly Water Issue Board meeting, the method of issuing section by section was discussed at length. At the meeting farmers were informed that: a) all the pipe outlets would be relevelled and placed so as to maintain a head of 10 cm; b) consideration would be given to the field layout and soil conditions even though the pipe outlets had equal delivery heads; and c) the deliveries would vary if the pipes were leading into high paddy fields.

So at the subsequent water issue committee meeting, the procedures that were to be effected in order to make equitable deliveries to individual lots through the 10 cm Hume pipes were explained. All the farmers were requested to be present during the laying of pipes in their respective field channels. Gradually all the channel sections falling under each rotation were sorted out and the pipe outlet levels altered to equalize deliveries.

The next step in convincing the farmers to accept rotations on a regular basis, was a demonstration issue on a larger scale. The next demonstration issue covered the entire Unit 3 area comprising 1-20 FCS. The issue was done after summoning a meeting of the entire Unit 3 area where farmers and channel representatives were requested to keep watch over the issue to prevent any interference. At the meeting, the author pointed out the success of the earlier demonstration and asked the farmers to stick to the issue schedule. They were also told that requests for additional issues would not be encouraged by the committee.

Gates were opened and field channels to the area under demonstration were filled. The first rotation was from 7.00 a.m. to 7.00 p.m. Departmental laborers were put on watch as in the first demonstration. Issues went smoothly, and as laborers had to leave at the close of official working hours, channel representatives were asked to supervise the night issue.

Farmers' Initial Disapproval of Rotational Distribution

Initially, the farmers were unhappy with the rotational distribution method. They made several complaints during field inspection against the continuation of water issues to the other two channel sections.

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