Design Issues in
Farmer-Managed Irrigation Systems

Design Issues in Farmer-Managed Irrigation Systems

Proceedings of
an International Workshop of the
Farmer-Managed Irrigation Systems Network

Organized by
The International Irrigation Management Institute
and
The Thailand Research on Irrigation Management Network
and held at
Chiang Mai, Thailand
from 12 to 15 December 1989

Robert Yoder and Juanita Thurston, editors

November, 1990

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

Colombo, Sri Lanka

Rehabilitation of Village Tanks: Redesign or Consolidate?

C. Kariyawasam[§]

OVER THE PAST ten years the Government of Sri Lanka has invested several million US dollars to rehabilitate village tanks. A major component of the rehabilitation process was the redesign of the irrigation system, including headworks. It was observed that in most systems several social and economic problems cropped up in the villages after the rehabilitation. This paper discusses the problems and their causes and suggests that in the case of village tanks it is better to consolidate the existing systems rather than redesign them.

THE ROLE OF TANKS IN SRI LANKA

Because the dry zone of the country receives 75 percent of its annual rainfall during the months of November, December, and January, a large number of reservoirs were constructed in ancient times to store irrigation water. These reservoirs, most of which are over two thousand years old, are grouped into three categories: 1) Major reservoirs, with the command area exceeding 600 hectares (ha); 2) Medium reservoirs, with the command area between 600-80 ha; and 3) Minor reservoirs, with the command area less than 80 ha.

It is estimated that there are over 25,000 minor reservoirs in Sri Lanka. In certain areas the density of minor reservoirs is about one per square kilometer. They are commonly known as village tanks, and are a special feature of the ancient civilization of the country. At present, about 10,000 village tanks are in use and the others are abandoned. Land irrigated by village tanks

[§]C. Kariyawasam is a Senior Lecturer at the University of Moratuwa, Sri Lanka.

produces about 25 percent of the rice requirement of the country. In addition, the tanks reduce land erosion and flood damage from major rivers during the wet months (Kariyawasam 1989).

HISTORICAL DEVELOPMENT OF VILLAGE TANKS

In ancient Sri Lanka each village had a temple, a tank, and a hamlet, and was an independent ecosystem. The tank-irrigated village consisted of three clearly demarcated areas: rice lands, the settlement area, and the fallow area. The tanks were constructed and owned by one or more families. The size of a village tank was determined by social factors rather than by hydrologic, economic, or technical factors. Initially, the villagers decided on the area that needed to be cultivated to meet the demand of the village. The capacity of the tank was defined by the volume of water required to irrigate this area. Then a reservoir was built by constructing a bund across a stream. Generally, these streams had no water during the dry season and construction work took place at this time. The tank bund was made of earth and the spill out of rubble masonry. A dead storage of about ten percent of the reservoir capacity was kept for domestic use during the dry season.

When the increase in population demanded that more land be brought under irrigation the capacity of the tank was increased by raising the bund and the spill. When the capacity was large, an additional sluice was installed at a higher level. This sluice irrigated the area above the normal rice area during years with above average rainfall. During normal years only the area under the lower sluice was cultivated. This process of raising the bund and the spill was carried out until either the limits of the hydrological capacity or the technical ability of the villagers was reached. The villagers had the technical knowledge to construct bunds up to six meters only.

When the population of the community increased further, supplementary tanks were constructed around the main village tank. These tanks were without settlements. Generally, these tanks were designed without any dead storage. The construction of these supplementary tanks and channels was planned so that the villagers' descendants could inherit them. Water-management policies were formulated and implemented by the community (Alwis 1989).

Even though these village-irrigation works were constructed by the villagers, the ancient kings recognized their importance in sustaining the economy and they made it compulsory for the people to operate and maintain the tanks.

VILLAGE TANK REHABILITATION PROGRAM

In the past ten years the Government of Sri Lanka has received financial and technical assistance from several national and international organizations to rehabilitate village irrigation systems.

The World Bank has been the largest donor, providing about US$26,000,000 to rehabilitate about 1,200 village-irrigation works (an average of about US$25,000 per tank) under the Village Irrigation Rehabilitation Project (VIRP).

Under the Integrated Rural Development Project (IRDP) another 1,000 village-irrigation works were rehabilitated. The funds for these projects came from different donors. The total allocation for the rehabilitation of village-irrigation works under the IRDP was US$22,000,000. The Asian Development Bank rehabilitated 600 village tanks in the Anuradhapura District at a cost of US$20,000,000. These figures indicate that the average cost of rehabilitating a village tank is US$25,000-35,000.

Structure of Village Tanks

Village tanks are formed by constructing earth bunds across streams during the dry season. Low ground within the catchment is usually used as a spill. Some of these tanks had two sluices, one at each end of the bund, and rice fields were located close to the bund. When there is sufficient water in the catchment, these two sluices are located at the same level. When the water from the catchment is not sufficient to irrigate the entire command area, one sluice is located at a higher elevation than the other. The area under the higher sluice is irrigated only during the wet years, which is about once every four years. There are some reservoirs with three sluices. In one exceptional case there were five sluices to feed 80 ha. Out of these, two were placed above the others. Some reservoirs have one central sluice. In these systems the rice fields are located a distance from the reservoir and water is carried to the fields by long supply canals.

In most systems water from the sluice is directed to a supply canal. Pipe outlets in these supply canals feed the fields. In some instances several farms share one pipe outlet. There are some reservoirs without supply canals. In these systems water from the sluice goes directly to the first farm. Drainage water from the first farm is channeled to irrigate the second farm, and so on throughout the command area.

Rehabilitation Process

The major cost of the rehabilitation process is the civil construction work. This amounts to about 75 percent of the total cost of rehabilitation. The civil construction work begins with the redesign of the irrigation system and usually involves raising the bund, constructing a new spill or raising the existing spill, redesigning the canal system, and introducing a new water-management plan.

The Irrigation Department is responsible for the redesign and reconstruction of village tanks. The Department recruited several foreign and local consulting firms to redesign the systems. These firms made several changes to the structure of the village tanks which were the major cause for most of the problems that cropped up subsequently. The changes they instituted are discussed briefly below.

Replacement of local technology. Village tanks were originally constructed using low-level local technology. However, the redesign process employed imported technology. The engineers involved in the redesign attempted to incorporate all the features of large irrigation systems into the village tanks. Furthermore, the designers had little or no knowledge of the social and economic status of the village.

Water-management plan. Water-management plans in the old systems were based on social factors and not hydrologic or technical factors. In early times, the social status and caste of the farmer were the major factors that determined the water-management plan. The redesign process considered only technical and hydrological factors in preparing water-management plans.

Land allocation. In the ancient irrigation systems the allocation of land was based on the needs of the individual farmers. For example, a farmer with fewer dependents received less land. Similarly, the location of the land allotted to an individual depended upon his social status. For example, the village head would receive land located closer to the tank. In the redesign process land allocation was based purely on the topography of the command area. Furthermore, in certain old systems each farmer had three farm plots, one at the head, one in the middle, and one at the tail of the system. In this way, if only a part of the command area could be irrigated in any particular year, each farmer got a share of the water.

Cropping calendar. One of the major changes initiated by the redesign was the new cropping calendar. In village-tank systems cultivation is carried out only once a year, in the wet season. In some tanks where there is sufficient storage, a second crop is cultivated. The farmers usually waited until the tanks were full to commence planting. This reduced the risk of crop failure as a result of water shortage. If the tank was more than half full at the end of the season a second crop was planted with the expectation that there would be little rain.

In the redesign a three-crop year was recommended. This had been very successful at an experimental plot. Under this plan, land preparation commences with the first rain which normally occurs after a long dry period. Short-term rice varieties are grown. The first crop can be harvested at the end of the third month of the wet season and a second crop is planted immediately. When the second crop is harvested there is still some water in the tank. The third crop is planted immediately using tank water.

Problems Encountered

High engineering costs. The contracting of experienced consulting firms resulted in high engineering costs. Since most of the donors placed limits on the cost per hectare, farmers from small tank systems were at a disadvantage and several smaller tanks were not selected for rehabilitation.

Because the designers treated these schemes as miniature versions of large systems several new complicated structures were incorporated into the systems which escalated the construction costs.

In the case of tanks whose command areas are less than ten hectares the engineering cost was higher than the construction cost. In the case of large systems the engineering cost is generally about ten percent of the construction cost. This itself suggests that the level of expertise contracted exceeded actual requirements.

Conflicting technology and interests. The farmers, used to traditional technology for the management of water resources, were generally reluctant to accept the new technology.

The interests and objectives of the designers were different from those of the farmers. For example, hydrologists seek to make optimal use of the water, and the agronomist will design for maximum production per hectare. The irrigation engineer will try to irrigate as many hectares of command area as possible. However, the farmers' main objective is to make the maximum profit per hectare.

Water management. Under the rehabilitation, a pipe outlet was provided for each hectare. If the size of the farm is less than a hectare, which is true in most cases, two or more farmers had to share one pipe outlet. This reallocation of pipe outlet caused several problems. Traditionally, the ability of the farmers to cooperate was a major factor that was considered in allocating pipe outlets. In one instance there were two farms of about a half hectare each, side by side. Under the old system these farmers had two separate pipe outlets because they would not cooperate with each other -- their families had not spoken to each other for the past two generations. Under the rehabilitation program these two farmers were asked to share one outlet. This did not work. The first farmer diverted the excess water to the drainage canal instead of sending it to the next farm.

Land allocation. In reallocating land under the redesign the farmers were each given a hectare of land irrespective of what they had earlier. This created two types of problems. First, it disturbed the social structure of the village. Traditionally the amount of land allocated to an individual depended on need and the social status of the farmer.

The second problem is related to periods of water shortage. During these years only part of the command area can be irrigated. As a result, the farmers at the tail end do not get any water in dry years.

CONCLUSION

The previous discussion suggests that if one needs to redesign a village scheme a comprehensive social and economic study to understand the behavior of the farmers is needed in addition to the physical survey. However, such a study will be very expensive, and if attempted, will make every rehabilitation project economically unfeasible. As such, the next-best option available is to consolidate an existing scheme. In other words, it is preferable to strengthen the existing structures and organizational patterns, than to impose major changes.

References

Alwis, J. 1986. Some issues in the improvement of village irrigation works. Economic Review. February 1986: 12-13.

Kariyawasam, C. 1989. Economic impact of microcatchment development. Journal of Irrigation Engineering Division. American Society of Civil Engineers. August 1989: 25-31.