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Locally Managed Irrigation Systems

Essential Tasks and Implications for Assistance, Management Transfer and Turnover Programs

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Coverphotograph by Robert Yoder: Irrigation canal at Argali, Palpa, Nepal.

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CHAPTER 1

Background and Overview

INTRODUCTION

HISTORICAL LITERATURE CONTAINS numerous references to irrigation systems managed by local communities. The British Colonial Government, for example, operated a research institution called the "Board of Economic Inquiry, Punjab" and its studies surveying agricultural conditions in Northern India have described the operation of canals by local communities (Board of Economic Inquiry 1933). Dutch civil servants have recorded irrigation practices in Bali and Java and British civil servants have written about tanks used for irrigation in South India. Anthropological field studies and irrigation ethnographies give details of highly organized irrigation communities in numerous countries.

Since the 1970s there have been an increasing number of field studies focusing on management activities of systems that are operated by the irrigators themselves. These range from case studies spanning several agricultural years to rapid appraisals completed in a few days.

The studies have presented examples of effective management and high levels of participation by fanners in acquiring and distributing the irrigation supply. It has also been noted that the irrigators in most cases are paying not only the full cost of operation and maintenance but also much of the capital cost for improving their systems. Collectively, these studies have raised awareness of a vast resource of irrigated agriculture that has received little attention from government agencies in the past decades of rapid irrigation expansion. This paper uses examples from these studies to examine issues related to improving irrigation management where local groups are responsible for irrigation operation and maintenance.

DEFINING LOCALLY MANAGED IRRIGATION SYSTEMS

Numerous typologies are used to define irrigation entities. Size, nature of the water source, the governing body and levels of organization are among the most common. For constructing irrigation systems, irrigation agencies have found it useful to classify systems in ways that facilitate technical and administrative input. For example, separate units are usually responsible for groundwater and gravity system development, and the responsibility for small and large systems generally rests with different groups.

Support of operation and maintenance is possibly better addressed by grouping systems according to management input. Hunt **(1989)** suggests that determining who has the "charter of authority" is a useful way to distinguish among management types. The charter refers to the source of legitimacy for the authority to govern the system. The person or group that holds the charter of authority has ultimate control in shaping the way the system operates. Holders of the charter of authority create or confirm the institutions that shape the system.

Private individuals and companies own and operate some irrigation systems. However, the focus of irrigation development and management interest is centered on the large number of systems that are public property. Increasingly, there is also attention given to systems operated as common property.

Agencies in many countries are given the authority by the government to develop, operate, maintain, and regulate irrigation activities. Where agency staff have the major responsibility to manage most operation and maintenance activities of a system, the system is often referred to as agency-managed. While there are possibly some systems that are entirely managed by agency staff, in most cases, the irrigators have some role in managing irrigation delivery, at least in the channels near their fields. Such systems would perhaps best be termed jointly managed as suggested by Coward **(1980).** While acknowledging the validity of both formal and informal roles performed by fanners in these systems, the term agency-managed will be used in this paper to refer to systems where the charter of authority appears to be largely with the government-appointed agency.

Historically, while centralized states have invested in irrigation development, there has usually been parallel activity by individual cultivators or groups of farmers, sponsored perhaps by local rulers or landowners, who have also constructed irrigation systems. Some of these systems date back to hundreds of years and have well-established institutions for managing operation and maintenance. Though these systems are generally small in size, their vast number collectively makes them a significant factor in agricultural production in many countries. Some systems divert water from natural, unregulated streams. In South India and Sri Lanka, numerous systems, perhaps as many as several hundred thousand, disttibute water from tanks replenished by water harvested from a catchment rather than from a river diversion. Karez irrigation systems (called *qanat* in Iran and *foggara* in North Africa) are found in many countries around the world, with a major concentration in Iran, Afghanistan, and Pakistan. These systems tap the water bearing alluvial fans at the base of mountains and lead it through gently sloping tunnels to the surface, sometimes many miles out in the plains (Rahman **1981).** Lift irrigation from wells and surface sources is expanding rapidly, often with little or no direct assistance from central government agencies.

Martin et al. (1986) used the term "fanner-managed" for systems where cultivators controlled the irrigation enterprise including control of access to water from a natural source. In fanner-managed systems, the authority for allocating the irrigation resource rests with the community of irrigators. Some systems have many, but not all, of the characteristics of farmer-managed systems. Irrigation districts in the western United States, for example, include all land that could potentially be irrigated in their tax base, in some cases even land occupied by municipalities. This gives nonirrigating property owners the right to participate in the management of the irrigation districts. Lansing **(1987)** determined that the priests in the temple system play an important role in managing irrigation in *subaks* (local-level fanners' organizations for irrigation) of several watersheds in Bali, Indonesia. The local government is technically in control of small irrigation systems in Java. Though many local officials are fanners, some operate other businesses. The term "locally managed irrigation system" is used in this paper to encompass all fanner-managed and other systems where the charter of authority is with the local community.

In a locally managed system, the leaders come from the local area, do much of their business there, and intend to stay there. The leadership is committed, in one way or another, to the local scene and the outcome of the irrigation enterprise. Organization in these systems comes about in the broadest sense to coordinate the flow of resources necessary to accomplish irrigation delivery in a way that could not be done individually. Coordination is necessary because of the complexity and interrelatedness of the many tasks that must be performed.

IRRIGATION IMPROVEMENT PROGRAMS

Heavy investment in the 1960s and the 1970s has created many new irrigation systems. But both developing-country governments and donor agencies now recognize that the rate of economic return assumed during the design of recent projects has not always been achieved. Further, since the better sites are already developed, new projects in the future will have even greater difficulty achieving effective returns. The current assessment in some countries, particularly in Asia, is that the most economical advancement in irrigated agriculture can be achieved by improving the performance of existing systems rather than by building new ones (Kikuchi 1992).

Locally managed systems were largely ignored during the period of rapid construction of new systems. Their small size and simple, even crude, construction did not attract much interest except for them to be incorporated into larger schemes or in some cases to be upgraded with entirely new physical facilities. However, as concern in the 1980s turned to improving management and recovering investment in systems constructed in the previous decades, attention has been drawn to the successful operation and sustained maintenance accomplished by some of the locally managed systems.

Locally managed systems have several attractive features. The most obvious is that in many countries they have drawn on few public resources for their creation and, to a large extent, are self-supporting in their continued operation. In agency-managed systems tight operation and maintenance budgets together with poor payment of irrigation fees by irrigators have given policymakers in many countries reason to press consideration of options other than agency management of irrigation.

Another attractive feature of locally managed systems is their decentralized self-management. In some circumstances, this has gained them recognition as a viable alternative to agency management. Though there is some question as to whether new locally managed systems can be created, policymakers generally agree that the existing systems should continue to operate independently. At a time when weak management is cited as a possible reason for less than optimum performance of agency-managed systems, the participatory management style of locally managed systems is sometimes held up as a model.

Case studies of locally managed systems have focused on systems that are operating rather well. This has tended to present a picture of highly motivated Irrigators successfully managing their limited resources under severe conditions. While this is certainly the case in numerous systems in numerous countries, many locally managed systems are not performing up to their potential. Irrigators in a large number of systems seek assistance from irrigation agencies and other departments to reduce their maintenance costs and increase system reliability. The opportunity for improving and expanding locally managed systems is viewed as important for further irrigation development. The number of donor-supported programs to assist existing locally managed irrigation systems has increased in the past few years.

The success of local management has prompted the initiation of programs for turning over to local management some systems that are currently operated and maintained by irrigation agencies. Since some systems were originally built and managed by irrigators and became the responsibility of a government agency only subsequent to improvement activities, these systems are proposed to be "turned back" to local management. Other programs are suggesting that parts of large systems be transferred to users to improve user participation. The suggestion is that the main system could be operated and maintained by the agency similar to a river course from which many locally managed systems acquire their irrigation supply. As with river courses where there are many interrelated systems, these locally managed systems must also become responsible participants in main system management.

Three rather different irrigation development programs — assistance to existing systems, turnover of management and management transfer of parts of systems — are interested in how locally managed irrigation systems accomplish operation and maintenance. This paper draws on examples from field studies to examine issues that relate to these three programs.

Assistance to Locally Managed Irrigation Systems

Thousands of locally managed systems exist in many countries. They have tremendously varied experiences in managing their own affairs. Some have exemplary rules and procedures that are strictly enforced while others are not able to fully maintain their system as a result of which irrigation delivery suffers. At times, well-managed systems face natural calamities for which they need external assistance. Other systems need assistance to improve their performance and to remain sustainable.

Irrigators generally request that permanent structures be built to replace the temporary ones that they are struggling to maintain. Replacing broken or temporary structures in well-managed systems may be all that is necessary, but in other systems the poor physical status of the system may be a symptom of ineffective institutions. Assistance programs need to enable the irrigators to strengthen their rules and procedures and make their operation and maintenance activities more effective.

If a large number of locally managed systems exist in a country, there is a tremendous resource of experience for operating and maintaining systems. Though, frequently, there are similarities in the way organizations are structured or in the rules and procedures they use, there are unique features in each as well. Assistance programs should tap this experience and diversity to offer an array of options for each issue that needs to be addressed. If these systems are to remain independent, assistance procedures must enable the irrigators to carry out the work in a way that builds their capacity for future operation and maintenance.

Turnover of Management

Improving the performance of agency-managed systems has received increased attention as investment in new systems has slowed down. Improvement is perceived as possible because many systems are irrigating far less area than anticipated during the design of the system. Frequently, cropping intensities are also lower than expected and projected increases in yield seldom achieve the level targeted during project preparation.

There are many reasons for this situation. In some cases, the amount of water assumed during design is not available. In others, farmers prefer crops different from those planned because of low market prices. In many cases, the problems do not reflect faults in system management. However, they exacerbate the dilemma managers in many agency-managed systems face where farmers are reluctant to pay the full irrigation fee charged for their use of the system. In many systems the fees collected are not sufficient to cover expenditure for operation and maintenance. After three decades of intensive development and massive investment in building irrigation works, there is little progress toward recovery of the capital invested in irrigation.

In order to improve imgation performance and to transfer the operation and maintenance cost to the irrigators, programs have been initiated in a number of countries to turn over the management of entire systems to the irrigators for them to operate and maintain. The objective is to transform the system from being agency-managed to being locally managed, Turnover programs generally make considerable investment in improving the physical system by repairing or replacing broken structures before turnover. In many cases there is also intensive effort to work with the irrigators to form an organization and establish rules and procedures for operating and maintaining the system.

Systems proposed for turnover tend to be small. Some were initially constructed and operated by the fanners but in the process of receiving assistance they were entered in an agency's roster of systems and continued to receive some maintenance support. The size and nature of most systems proposed for turnover are often similar to locally managed systems in nearby locations.

Incentives for irrigators to take over systems are mixed. Where there are clear advantages for fanners to he involved at all levels of system operation and maintenance, they are likely to be already involved and the incentive to take on full responsibility is high. Where systems are running smoothly, farmers may prefer the status quo. Fanners in systems that are performing below expectation may be reluctant to accept responsibility unless they are given formal authority to change the way the system is operated. In many countries, transferring authority and implementing other incentives that support program goals require changes in national policy.

Transfer of Management

In most agency-managed systems, fanners perform irrigation activities at the field channel or tertiary level. In some cases, increasing fanner participation in system management has resulted in improving the system performance. One method proposed for increasing participation is to transfer full management control of segments of large agency-managed systems to fanners. In such instances, a central agency is to continue to manage irrigation delivery to some point in the distribution network. Below that point, control of all operation and maintenance activities is to become the responsibility of an organization managed by the irrigators. Together with shifting fanner management higher in the system, the relationship between the agency and fanners is to be spelled out in a more formal charter.

Questions are raised by those skeptical of these arrangements. They argue that irrigators under such arrangements would face quite different incentives than those in locally managed systems who acquire their water from natural sources. In particular, they would have less authority to take action when their irrigation supply diminishes and they get little feedback of the results of action above their system. This would result in the irrigators taking less responsibility for poor management on their part and placing blame on the agency for poor irrigation delivery. Others propose to overcome this problem by increasing irrigator participation in management of the main system at the same time that full authority is transferred to them at lower levels in the system.

Country-specific, or even site-specific conditions may influence the view taken. Experience in many developing countries is still limited but largely suggests that escape from the social environment of the agency bureaucracy may not be easy. Tang (1992) argues that participation of fanners in bureaucratic irrigation systems will succeed only if both the organizational problems of the bureaucratic machinery and the structure of incentives facing irrigators are corrected. If the supply of water to the watercourse is highly unpredictable and depends entirely on the arbitrary decisions of officials operating at the system level, it is hard to expect farmers to organize among themselves to undertake operation and maintenance at the watercourse level. Achieving locally managed conditions in the transferred parts of agency-managed systems is desirable but many are skepticalof the viability of this model in all countries.

OBJECTIVE AND ORGANIZATION OF THE PAPER

This paper examines the construction and operation and maintenance tasks that shape the nature of locally managed irrigation systems. While lift irrigation from groundwater and surface sources is among the fastest growing sectors of locally managed irrigation, and irrigation from tanks is an important resource in large segments of some countries, most of the examples are drawn from surface diversion systems. The objective is to identify relevant experiences and lessons for staff who are responsible for working with locally managed systems in the types of programs mentioned above. Several examples are used to illustrate the broad range of institutions irrigators have developed to accomplish essential irrigation tasks.

The discussion shows the implications that these tasks have for irrigation development programs.

The view taken is that in organizing irrigation development where irrigation already exists, one needs to understand and be sensitive to the irrigators' established institutions. Awareness of the range or configuration of rules is useful for the presentation of options that can be tailored to the specific needs. Examples are selected to illustrate the variety and complexity of rules and actions that local groups have found useful.

In many developing countries, construction of most irrigation works is currently implemented by a government agency. This facilitates central planning and financing, especially when foreign donors are involved. It simplifies contracting for construction since the implementing agency is a government body. It also makes appropriation of land and water rights easier in some cases. While such features expedite the development of irrigation, they also lead to the alienation of the very fanners whom the irrigation system intends to serve. With little or no control over the irrigation resource, farmers tend to be critical of the service they receive. The attitude prevails that the system belongs to the government, so that fanners take little or no responsibility for operation and maintenance. The chapter reviewing construction proposes that construction/improvement activities be used as a management training exercise to establish local ownership.

The chapter on water acquisition deals with gaining access and control over water in a natural source. Water rights among users sharing the same source are frequently overlooked in dealing with locally managed systems. Where state governments have not established legislative regulations, local rules have generally evolved which need to be understood by the project providing assistance.

Irrigation allocation and irrigation distribution are two tasks often undertaken almost simultaneously. They are covered in separate chapters to highlight the importance of each. Irrigation allocation is used to refer to the "within system" water rights. They are the rules that govern how each member of the system gains entitlement to use the irrigation supply and how the supply is to be apportioned in time and space among the members. Irrigation distribution is referred to as the method and means of physically delivering the irrigation supply. The objective of irrigation management is to deliver irrigation according to the allocation rules or plan.

Resource mobilization is dealt with in a separate chapter because of its central role in the success of locally managed irrigation systems. The need to mobilize resources is primarily for system maintenance and improvement. The type and intensity of maintenance needed is highly site-specific. There are also large differences in the use of labor and material between cash economies and subsistence communities. The ability of local groups to craft rules to make effective use of their resources illustrates the potential of local management.

The structure of irrigation organizations and the supporting activities of decision making, accounting, communication and conflict management are discussed in yet another chapter. The organizational form is shaped by a variety of factors. The size of the system influences the number of organization levels and the way decisions are made. Maintenance requirements not only determine resource mobilization procedures but have a dominating effect on the role of leadership, type of records kept, and methods of communication.

CHAPTER 2

System Construction and Physical Improvement

PHYSICAL IMPROVEMENTS ARE often necessary when a system is in operation. One reason is to overcome deficiencies that become evident only after the system begins operation. Improvements to overcome deficiencies include those related to reducing the cost of maintenance, better water control and decreasing water loss from seepage and leakage. Another reason for making improvements is the desire to enlarge the system by modifying, improving or adding structures. This is especially true when users build systems by trial and error rather than by engineering design. However, the most common reason for continued physical improvements after constructing a system is to rectify subsequent deterioration that takes place. If maintenance does not keep pace with natural decay of the system it will eventually reach an inoperable state.

All structures must be planned and designed before they are built. Investigation must be done in the field to determine the size and type of structure that best fits the foundation conditions. Materials must be collected and labor expended in preparing the site. The term "system construction" is used here to include all of the work that goes into planning, designing, preparing, and building the physical works of the irrigation system, whether for a totally new system or improvement of parts of an existing one. However, the process of system construction or making physical improvements has the potential for achieving much more than the creation of physical structures.

Construction is an activity with rich opportunity for giving experience in making decisions, formulating rules and procedures, and developing leadership skills. All of these are essential for effective operation and maintenance of the completed physical works. There are other reasons for involving the irrigators in the construction activity, especially in the improvement of existing systems. They have ideas about the priority of improvements that need to be made based on their observation of local conditions over many seasons. When irrigators contribute to the cost of improvements they help control unnecessary expenditure (WECS/IIMI 1990). Possibly the most important is that irrigator involvement in the construction activities is a property-forming activity that enables them to claim "real ownership" rather than a "sense of ownership." Ownership is an important factor in fostering irrigator responsibility for operation and maintenance (Ambler 1992).

Many of the agronomic, physical/environmental, and social variables that must be considered in construction of the physical system are highly site-specific. The nature of the water source, availability of storage facilities, type of crop. and land-tenure relationships are but a few of the factors that must be examined. Selection of the appropriate design, attention to technical detail and quality of construction are important but on their own they are not sufficient conditions to ensure fulfillment of most system management objectives. While the technical aspects of the construction are important, construction is more than assembling a series of technically "correct" irrigation structures at the lowest cost in the shortest possible time. Institutions — the working rules — must also be created to make the structures fully effective.

For many, though not all, locally managed irrigation systems, the process of construction provides a wide range of experience that enables participants to begin what Ostrom (1992) has termed "crafting" institutions for governing their system. This chapter examines how the act of constructing the irrigation works can influence management. It is suggested that in situations where assistance is being provided to locally managed systems or to those that are to become locally managed through management transfer or turnover, the accompanying construction or physical improvement activity be made a tool for building management capacity.

FARMER INVOLVEMENT IN SYSTEM CONSTRUCTION

Groups of farmers living in isolated communities all over the world have recognized the value of irrigation and have worked together to construct irrigation systems. By pooling their resources they have accomplished much more than has been possible by the labor of individual families. Though such situations are often fraught with conflict, the incentive of reliable and increased production has motivated the development of creative ways to manage differences. The need to move ahead with construction in ways acceptable to all participants forces fanners to find ways to make collective decisions. They have adapted the process of institution building to their sociocultural experience in the same way that the structures built have been tailored to fit the physical environment.

Coward (1986) examined the relationship between private investment of fanners' (individuals and groups) in irrigation works and the creation of hydraulic property. He suggested that development of irrigated agriculture is a property-creating process and that the creation of irrigation facilities establishes property relations that determine and shape operation and maintenance practices.

> ***These relations become the social basis for collective action by irrigators in performing various irrigation tasks. Canal cleaning can be seen as a group action being taken by individuals whose relationships with one another are based, in a large part, on the interrelationships which arise because of their common positions with regard to hydraulic property which they have created or acquired.***

The following examples are used to illustrate the effect of creating property relations through construction and the impact this has on operation and maintenance. The examples are drawn from systems where the irrigators constructed the original system. However, there are many locally managed systems that were not constructed by the users. In some cases, agents of the government, a local ruler, or a large landlord constructed and operated the system for a period of time. In some countries, private developers played a major role in building irrigation systems that eventually became locally managed. In recent years, irrigators have taken over systems built by a variety of government agencies. Institutions have also evolved in these cases. However, few studies document the process by which this has taken place or over what period of time.

Locally Built and Managed Systems

People's Ditch Company, Central Valley California, USA. The People's Ditch Company is one of many mutual companies in California's Central Valley incorporated in the 1870s. The charter members' objective was to build and operate an irrigation system to serve the fields they had acquired as settlers. The company issued stock on the basis of one share for every square mile (259 ha) that was to be served by the canal they proposed to build (Maass and Anderson 1978). Initially, they issued 100 shares each with a value of US$100.00. However, the shares were distributed in fractions and, typically, a share was divided among four or more fanners.

Many of the original settlers paid their assessment with labor because they had little cash. Much of the work consisted of digging the canal. In some sections, the canal was divided into Sectors and each stockholder assigned a sector to dig. In others, the estimated cost of the work was assessed and a stockholder could work off his levy at the fixed wage rate per day. In order to pay for an engineer or superintendent of works, and to pay for supplies such as lumber to construct control structures, the elected directors of the company assessed the shares of the stockholders to raise the money.

The total command area for which shares were issued by the People's Ditch Company in 1873 was 26,000 ha. By 1918, the company operated a system of nearly 100 km of main canals which were the collective responsibility of all irrigators. In addition, well over 100km of main and lateral canals were operated by smaller groups of shareholder fanners.

A meeting of the shareholders is held annually. The primary activity is to elect a board of directors for a one-year term. Other agenda items include consideration of any proposed amendments to the company's articles of incorporation and bylaws, proposed changes in the capital stock, and reports from company officers. When the fanners are frustrated with their water supply or when they expect an important decision to be made they attend meetings. Frequently, however, the meetings are poorly attended and a quorum is achieved only by the use of proxies. Poor attendance is taken as an indication of satisfaction with current conditions.

Maass and Anderson (1978) characterize the mutual irrigation companies of the Central Valley in California as "cooperative, democratic institutions that delivered water at cost to their stockholders only...." They described the construction of several systems incorporated in 1873 as follows:

> ***The farmers brought water to the land, laying out and building the canals themselves. For this purpose they incorporated mutual canal companies in which they took shares of stock These shares were then assessed for the cost of building the canals and subsequently for operating and maintaining them, and a farmer's right to divert and***

> *use waterfrom a canal was in proportion to the number of shares he acquired. The share of stock in a mutual irrigation company was therefore distinctive in that it represented not only a proportional part of the ownership of the company, which in the early days had little, if any, value but also a right to receive water and, most important, an obligation to pay a proportion of the costs of building the canal and operating it....*

Thulo Kulo in Chherlung, Palpa. Nepal. The southern foothills of the Himalayan Mountains have deeply incised rivers that drain the snowmelt from the higher mountains. However, the huge water resource that this represents is virtually inaccessible for irrigation by gravity delivery to fields because of the hilly terrain. Smaller side streams are tapped to irrigate the hill slopes. In many cases, canals must be cut into steep slopes in order to lead the water from a stream to the fields. The lower valleys have a warm climate where crops can be grown throughout the year if irrigation is available.

An important factor in developing and operating irrigation in this environment is the ability to mobilize sufficient labor, first to construct the system and then to continually maintain it. Floods in the steep-sloped stream regularly destroy the diversion structure and landslides repeatedly block the canal, requiring the ability to respond quickly to emergencies. In addition, there is the regular maintenance required to clean and reshape the earthen canals that deteriorate quickly. The need for maintenance labor requires unity within the irrigator community. This necessitates establishment and close adherence to rules that embody acceptable equity in sharing the irrigation resource and in the work necessary to bring irrigation to the farm.

In 1925. the land-limited community of Chherlung in Palpa District, Nepal was populated by about 50 families. Their rain-fed agriculture production was not keeping pace with the growing population. Two individuals encouraged others to join them in constructing a canal to lead water from a small stream about 6 km away to irrigate their fields. They argued that if they did not invest in constructing an irrigation system some families would be forced to leave the community within a few years in search of more land. About half of the population agreed to assist with this expensive and risky venture and half remained skeptical about their ability to bring water so far through difficult terrain and declined to invest. So, in response to food shortages, the Thulo Kulo Irrigation System was built by the cooperation of some, but not all, Chherlung residents (Yoder 1986).

Without financial assistance from outside the community, the Chherlung fanners contributed their own labor over a four-year period to complete a small canal They hired local experts in canal building to lay out the alignment and construct the channel through difficult sections. They reportedly sold jewelry and some land to pay for this assistance. When a small trickle of water was successfully delivered after four years of work it confirmed the alignment and proved to the skeptics in the community that irrigation was possible.

In the process of carrying out the construction, the group discovered that they needed a leader with skills in organizing the work — a leader they all trusted to distribute the workload fairly and to keep records of each household’s contribution. They found that they needed to hold frequent planning meetings where they could discuss and eventually agree on the details of the different tasks that needed to be done and to determine who among them was best able to do the job. Because of the enormous amount of work that needed to be done, they needed cooperation from all members. They learned by experience that a working agreement was necessary before proceeding with an activity or else some members would not cooperate. Disagreements and misunderstanding over decisions they had reached earlier resulted in assigning one person to write a record of the discussion at meetings and have all participants sign the record to attest their agreement. Because. many of the fanners were illiterate they initiated the practice of reading the minutes aloud at the end of each meeting before asking those attending to sign.

By continuing to invest in improving the system and also by successfully soliciting assistance from the government in the past few decades to purchase cement and hire masons to line the canal, the system is now reliably irrigating three crops annually in all but a few hectares of the 40-ha command area. Well over 100 families were using the system in 1990. Some families were able to sell surplus grain to neighboring communities. The rules and practices that evolved during construction are still being continued. Most have been modified several times in the intervening years to accommodate the many changes that have taken place.

***Subak Gunung Mekar** Mertasari, Bali,* **Indonesia.** Bali is widely known for its subaks that operate and maintain elaborate irrigation systems for intensive irrigated agriculture. Because of the high demand for water, intricate relationships have been worked out for sharing water along the natural water courses. Allocation of the limited irrigation supply among members within a system is also a sensitive task.

Pitana (1991) describes an example in Bali similar to that of the Thulo Kulo. As recently as 1977, a group of 70 persons from the village of Bunutin in Kintamani District of Bali began construction of a new canal system entirely with their own resources. Construction was initiated to bring drinking water to the village because during periods of drought they needed to carry water 6 km along a steep trail. The canal is about 2.5 km long and more than half its length is through a tunnel.

Because the entire village was to gain access to drinking water, all villagers voluntarily contributed some labor for the construction of this canal. However, the bulk of the work and the payment of hired labor was the responsibility of the group that initiated the work. This group, which does not include all the villagers, formed an organization that they named “Subak Gunung Mekar Mertasari.” Water in excess of village drinking needs was divided among the Subak members and used for irrigating new rice fields. The effort in bringing drinking water to the village and using the excess supply for irrigation were highly successful. This encouraged the group to search for an additional water source to allow expansion of the irrigated area.

The new source is estimated by the villagers to contain enough water to irrigate 75 ha of rice land but requires construction of a tunnel 3 km long. Construction work on this second canal started in 1980. In January 1991, about 1.2 km of the tunnel remained to be dug. Except for consultation with authorities about the right to extract water from the stream, the subak members have not received assistance from outside the community. The villagers gave some voluntary labor in appreciation of a reliable drinking water supply. As with the first canal, however, most of the resources for construction come from the subak members.

A "water master" was appointed during construction and continues to supervise all the subak facilities from the river diversion to the field-division structures. While checking the canal and tunnel the water master makes minor repairs. If major repairs are required, the water master reports to the subak head who calls on additional members to assist with the repairs. The water master also supervises irrigation distribution. The canal is cleaned eight times each year. Shares of water can be traded or sold. The water share carries with it the proportional responsibility of maintaining the system.

Consequences of Farmer Construction

The articles of incorporation for the People's Ditch Company in California established a legal framework for decision making and clearly spelled out the entitlements and responsibilities of the shareholders. Before the company could be incorporated, the organizers had to establish many of the principles that would govern the construction and would later be carried over into the operation and maintenance of the system. Though there were other similar models of organization evolving simultaneously in the California Central Valley, the shareholders had to consider their own situation and tailor the rules to meet their own needs. Since the agreement was worked out before starting construction, shareholders knew the obligations that they had and the possible benefits they would receive.

In the Thulo Kulo and Subak Gunung systems, there were long, intensive discussions among the villagers about the risk of investing in such a massive project. Extensive investigation was made by farmers to determine the canal layout and/or tunnel alignment. Decisions to share the irrigation supply among households in proportion to labor and cash contributions for construction required detailed accounting. Successful recordkeeping built confidence and trust among the participants. As with the mutual companies, the Thulo Kulo and Subak Gunung systems decided that future maintenance would be done in proportion to the share of water held by each household. Thus the effort put into devising an accounting method for labor and cash contribution during construction was directly applicable to recording labor and cash for system maintenance.

As work progressed and additional decisions needed to be made during the construction of the Thulo Kulo and Subak Gunung systems, a forum for orderly discussion and recording of agreements was worked out. These procedures were adopted for system operation after construction was complete. The intense effort necessary to move the Thulo Kulo and Subak Gunung construction ahead allowed each participant an opportunity to develop skills. In the Thulo Kulo, a person was identified with skills for leadership who also commanded respect for his even-handed dealing with his neighbors. He was appointed by consensus to lead the construction work. After construction was complete he was given authority for the day-to-day management of the system.

The farmers of the People's Ditch Company, the Thulo Kulo, and Suhak Gunung risked a great deal and suffered hardships before successfully completing their irrigation systems. The construction experience made a direct contribution to the "crafting" of the rules and procedures essential for management of their systems. A method for mobilizing resources for maintenance and experience with the technology necessary to repair and improve the system were in place before water flowed in the canals. More important, the farmers had learned to work together in making and carrying out decisions. Formulating new rules and modifying rules that are no longer appropriate have become routine at the annual meeting of the Thulo Kulo. Leadership in all three of these systems is accountable to the members and it can be changed by calling for an election.

There are many thousands of systems around the world with stories similar to those of Chherlung Thulo Kulo, Subak Gunung Mekar Mertasari and the People's Ditch Company; stories that show farmers can successfully work together to construct and manage their irrigation system. However, it is also important to recognize that cooperation among local-level groups is not automatic as is illustrated in the following example.

Siran Tar Kulo, *Nepal.*[1] In 1986, an inventory of irrigation systems in the upper watershed of the Indrawati River identified 119 irrigation systems in an approximate area of 200 km^2. Nineteen were selected as candidates for assistance by a government agency because they had not yet developed the full potential of their land and water resources. The Siran Tar Kulo was one of these systems. It was built in 1980 with an expenditure of 3,600 person-days of work and intended to irrigate a total of 24 ha (Acharaya 1989). About 60 households, without any assistance from the state, contributed to the original construction. However, they had serious problems in maintaining the canal and little water was delivered in the first few years.

The canal was broken by landslides during critical irrigation periods each year. Many of the persons who had contributed to the original construction were discouraged because they did not receive water for their fields. Most concluded that they could not maintain the system and refused to contribute additional labor. Only a few individuals continued their efforts to improve the canal.

In the Siran Tar Kulo, most of the consultation and decision making were centered on the small group of fanners near the point where the canal entered the command area. The participants in the original construction did not make a decision to quantify sharing the future water resource prior to starting work. The smaller group near the head of the command area decided on the alignment and invited others to share the work and in return have access to irrigation. When the water delivered by the canal did not get beyond the first few farms, others who had contributed to construction lost interest in continuing their investment. Leadership remained with the small group at the head of the system and was not accountable to the larger group of potential water users.

While the physical work done to construct the Siran Tar Kulo was considerable, the farmers did not make comparable progress in formulating working rules to guide their activities. Their construction experience was not a property-creating activity for the entire group. No records were kept to quantify the contribution to construction by each household. Decision making and communication did not develop in a pattern similar to the Thulo Kulo and many other systems in Nepal. Though the terrain was exceptionally difficult and landslides

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1 The Siran Tar Kulo was assisted by an action research project implemented by the Water and Energy Commission Secretariat (WECS) in Nepal. IIMI collaborated with WECS in conducting the research. Much of the information for the Siran Tar Kulo example comes from project reports, communication with WECS and IIMI field staff, and from the author's observations.

were expected to continue until the slopes above and below the canal stabilized, construction and maintenance of the Siran Tar Kulo was not more difficult than many other successful hill systems in Nepal.

Several possibilities are suggested for the observed organizational deficiencies in the Siran Tar System. These farmers had little experience with mutual cooperation. Personal grievances influenced group interaction and since they were not yet facing severe food shortages they had less incentive for putting such problems aside than some communities even though it was clear all would benefit from a successful irrigation system. By contrast. farmers of the Thulo Kulo System and many that purchased shares in the mutual irrigation companies in California had few resources and were desperate to make their investment successful. Eight years after incorporating, and before. successful delivery of irrigation, nearly one-third of the stock issued by the People's Ditch Company had been forfeited because the stockholders could not pay the assessments when the cost of the canal exceeded original estimates.

Siran Tar Kulo, unfortunately, is not the only example where farmers have not managed to work together to accomplish their goals. It is quite possible that similar conflicts were present among the farmers of the Thulo Kulo System and that successful solutions were eventually worked out. Indeed, if the Thulo Kulo System had been examined six years after its original construction it may not have appeared any more successful than the Siran Tar Kulo System did in 1986. In the comparison of management in agency-built systems where farmer cooperation is low relative to that of locally managed systems the difference in time given to each for achieving its observed status is seldom considered. The question, however, is not how long to wait for farmers to realize that they need to cooperate with each other and agency staff, but what can be done to facilitate and accelerate this process to achieve effective use of the irrigation system.

CONSTRUCTION AS A CAPACITY-BUILDING EXERCISE FOR LOCAL MANAGEMENT

In many countries. irrigation departments are. highly effective design and construction agencies. Massive investment in new construction in the past few decades mandated development of this capacity. Given the task of developing or improving irrigation systems, the emphasis tends to be on producing a high quality irrigation infrastructure. Concern for future operation and maintenance of the irrigation works tends to be deferred.

The proposition here is that this emphasis be reversed. Developing capacity for future management should be made the central issue and construction should become the instrument for achieving this goal. This requires radical changes in the way most assistance and improvement projects are implemented.

This does not call for dismantling irrigation agencies. Design and construction capacity will be needed for new projects in the future. Operation and maintenance must also continue on systems that are not turned over to users for management. What is needed is a section within agencies that specializes in providing support services for locally managed systems including those where turnover and management transfer are to be implemented.

Construction as Management Training

Locally managed systems have evolved in many different ways. Clearly, not all users of locally managed systems have gone through the process of constructing their own system or even necessarily had much responsibility for making physical improvements. Construction experience is not a prerequisite for irrigators to be able to develop rules or identify ways to govern their system. However, a physical improvement project, perceived as essential by irrigators, may provide the necessary incentive for getting irrigators involved in group decision making and rule formation for them to successfully continue the management of their irrigation facilities.

Irrigators with little previous experience in working together find learning to make and implement decisions slow and tedious. They need a viable objective such as implementation of a construction activity on which to focus their effort. Other incentives may also be important. A policy that allows irrigation service fees to be used locally may be one. In many cases, it is the opportunity to access a substantial grant from the agency that provides the most important incentive for irrigators to overcome differences and agree to work together.

Frequently, agency staff assume that farmers do not have the capacity to invest their own resources in making system improvements. However, judging from the large number of successful locally built systems, irrigators have been willing to make significant investments in the past. Experience, from Nepal (WECS/IIMI 1990) and the Philippines (Bagadion 1988) for example, shows that requiring some investment by the irrigators has several positive effects. First, it helps weed out projects that have such low returns that the irrigators refuse to invest their own resources. Second, when irrigators' own funds are invested they tend to monitor the results more closely and hold each other and the agency accountable for the results. Considerable opposition to such a policy can be expected where this has not been the custom in the past.

If the capacity to mobilize labor and other resources is initially low, the construction activities will need to be phased over a number of years. This presents logistical problems for the agency with a fixed planning and budget cycle. Changes may be necessary in the way budgets are made and accounts kept. However, evidence is strong that the incremental approach, with construction spread over many years, has allowed experience and knowledge to be utilized effectively in successful locally managed systems (Yoder 1986). Spreading construction over a longer period gives more time for rules to be made, tested, and reformulated in the ongoing process of institution building. By making improvements in incremental steps there is opportunity to build confidence and improve local investment.

A legitimate concern in turning over construction to farmers is that they do not have the necessary technical expertise to control quality. It would be impossible, even undesirable because of cost, to encourage and train farmers to become skilled construction workers. Contracts and other arrangements will undoubtedly be necessary to arrange for skilled workers and specialized equipment. Involving farmers in managing contracts may be inefficient in the short term but there are benefits as well. Irrigators do a good job of monitoring the quality and quantity of resource use (Korten 1988). Involvement gives the irrigators a better understanding of the design options and the purpose and limitations of structures. This is important in their preparation for operation and maintenance of the system. Information flow is facilitated which reduces the level of suspicion and complaints from fanners and increases their cooperation.

Management training programs for irrigators should avoid two extreme attitudes. On the one hand, there is sometimes a tendency to develop a working procedure through pilot projects, then attempt to replicate the results widely without modification. The opposite extreme is to assume that systems are so unique that they must all find their own solutions by trial and error. The middle way is to allow each group to make its own decisions, but to give each of them access to the accumulated experience of similar irrigation systems in the area. One way of doing this is to provide opportunities for farmer-to-farmer training visits that expose irrigators to the issues other groups have dealt with and the solutions they have found useful (N. Pradhan and Yoder 1989).

When irrigators from locally managed systems request agency assistance they are generally interested in building durable structures to replace the temporary ones that they struggle to maintain. There is seldom a request for assistance for improving management capacity. However, poorly maintained facilities may be a symptom of a management problem. Problems such as difficulty in accessing declining forest supplies or labor shortage during the critical season when maintenance is required are easily identified. Problems related to leadership or lack of rules and sanctions regarding sharing of the work load are not likely to be mentioned by irrigators. Careful diagnostic analysis is required to determine the causes of problems. Understanding the causes is essential for determining the type and level of support the irrigators will need to implement construction. The support staff will need both technical and management skills and significant field experience.

In many cases where systems are proposed for turnover from agency to local management, improvements are necessary in the physical works before the irrigators will operate and maintain the system. Often this need arises less because the irrigators could not make the improvements themselves than because of their attitude that it is the agency's duty to assist in putting the system into good working order before they will accept responsibility for it. The same is true where transfers of management responsibility are proposed.

There may be little previous experience with construction, and the complexity of structures to be built can vary greatly. Agency staff with management experience may need to outline the steps necessary for implementing construction. At each step an may of options should be presented and the irrigators required to process and decide among themselves on the approach that they will take to implement the work.

It is the multitude of peripheral activities — calling meetings, identifying all irrigation users, deciding how to appoint persons to fill responsible roles and how to hold them accountable for their actions, deciding what is needed in writing, enforcing penalties for not following rules, etc. — that provide the management training opportunity. Support staff must be rewarded for their effort in management training if they are to continue to be motivated. Evaluation of periodic staff promotion must be revised to include their performance in strengthening the less visible organizational and institutional changes as opposed to only the traditional measures of structures built and the budget spent.

CHAPTER 3

Water Acquisition

INTRODUCTION

WATER ACQUISITION FOR irrigation refers to gaining access and control over water from natural sources for distribution to the users of the irrigation system. It is a system-level activity that ranges from simple to complex, depending on the nature of the source and the competition from others wanting to use the same water. Local rules may regulate acquisition but often local rules are supported by a national legal system.

Rivers and 'streams are common sources of water for locally managed systems. A run-of-the-river system does not have intervening storage and the supply is either used immediately or lost downstream. The river may be regulated with one or more dams that create reservoirs to store water. Storage allows water to be saved for use at a later time, for example, from night to day thus avoiding night irrigation, or from one season to the next allowing irrigation when it is otherwise too dry. Groundwater, though often more expensive than surface water on a per unit basis, is increasingly being tapped for irrigation by local groups when other reliable irrigation options are not available. In most cases, tubewells tap directly into a groundwater reservoir and deliver water whenever necessary.

Operation of the pump, lifting water from a surface or groundwater reservoir, controls the irrigation supply entering the distribution system. Gravity river diversions need a structure to limit the amount of water that enters the canal. Some fanner-built systems simply allow excess water to enter and overtop the canal as a control mechanism. Others build a fixed orifice that restricts excess amounts from entering. Most engineer-designed and some locally built gravity systems use adjustable gates to control water entering the system. These control structures are the intake to the main system.

In some countries, water rights to a source are spelled out in great detail. In others, local rules are applied which are largely invisible to an outsider and the delicate balance among systems can easily be upset when a new technology for acquiring water is introduced by one or several systems. This chapter describes several examples where locally managed systems have developed complex relationships for sharing the water in a river basin. These relationships govern their water acquisition.

WATER ACQUISITION

Water rights that determine the rules for sharing of water among competing users and uses constitute an ancient problem that is increasing as water sources, including groundwater, become fully appropriated. The topic is much too broad to be covered in this paper except simply to highlight its importance.

Many governments retain ownership rights to water resources and allow individuals and groups of users the right to use the resource. When government agencies with the mandate to expand irrigated agriculture have not recognized the existence and rights of locally managed systems, there have frequently been conflicts. In a case in the Philippines described by Siy (1987), the locally managed Zanjera systems were strong enough to demand the redesign of a project to accommodate their prior rights. Ambler (1991) describes a case where the downstream users, though established first. were not strong enough to influence agency intervention upstream that disrupted their traditional irrigation supply.

Many locally managed irrigation systems have struggled to obtain and maintain their right to use a source of water. In the process, rules in many different configurations have evolved. In some locations there is strict adherence to riparian water rights where the landowner adjacent to a water source has the right to use it for irrigation. In others, prior appropriation is the dominant rule where the first to develop and use the water has the right to continue to use it regardless of where it is used. Many modifications and combinations of these doctrines are found in use today. The following examples illustrate only a few.

Right of Access to the Water Source

Huerta of Valencia. The word *huertas* refers to intensively irrigated areas that surround or adjoin the towns in Spain. The fields surrounding Valencia have been intensively cultivated since the Middle Ages. Many of the institutions governing Valencian irrigation have their origins in that period. Eight principal canals serve the huerta with an irrigated area in the order of 10,500 ha. Many of the farms are less than 0.5 ha, each, in size; over 99 percent are less than 5 ha, each. Perhaps the most important institution linked to the success of irrigation in Valencia relates to the rules allocating the river water among the canals. The river water is allocated among systems in relation to the needs of each canal — for irrigation, water-powered mills, and certain urban uses in Valencia. The allocation among canals appears to have remained constant for many centuries (Maass and Anderson 1978).

There is an intimate relationship among the canals in their acquisition of water. The rules governing access by each system change depending upon the supply available in the river. When water is abundant monitoring is not necessary and each system can take all that it needs. When the committee of syndics (elected officers of each system) initiates the regime for ordinary low water, each canal is allowed to abstract only its assigned share from the river. This is accomplished by adjusting the gates of the diversion structures to divert fixed proportions of the river flow. The syndics of the three lower canals are responsible for measuring the river discharge. They proceed to each intake and together with the syndic of that canal adjust the gate to deliver the allocated share of the river water.

In periods of extraordinary drought, several additional steps are taken. Diversion of water from the river below the first canal is rotated with those on the right bank taking water for two days and then canals on the left bank taking water for two days. The second action relates to several canals upstream of the huerta of Valencia which developed and expanded after those in Valencia. By agreement that stems from the time of their formation, they must close their diversion canals for four days out of eight when requested by the Valencian syndics. In addition, the uppermost of the eight canals must give up one-quarter or one-half of its supply on Monday and Tuesday each week depending on the severity of the drought. Although the eight canal systems assign guards to close headgates and monitor compliance to the river rotation, the national government's water master has at times had to settle claims of downstream and upstream interests concerning the sharing of the river water (Maass and Anderson 1978).

River basins in Indonesia. Locally managed systems in a river basin usually have long-established arrangements for sharing water among systems during dry periods. Lower systems may depend on controlled leakage past a series of diversions. Building a permanent diversion structure must take this into account. Bellekens (1992) described how farmers modified the flush gate of a government-built weir in Bali, Indonesia, to allow proportional sharing of the river. They raised the gate to its fully open position and built a sill in the gate to the same elevation as the canal intake. Then they inserted a side wall in the gate to adjust the opening to allow proportional discharge division between the canal and downstream users that could be easily checked.

Ambler (1991) describes a river basin in West Sumatra, Indonesia, where there are over 60 locally built diversion structures along the length of the river. The purpose of the diversion weir is to divide the water in the river so that part of it flows into the canal and part of it continues past the weir to lower systems during the dry season. Formerly, local custom forbade putting the weir all the way across this river, to ensure dry-season flows to lower canals along the river. The government chose to upgrade some of the traditional weirs that were considered to be "leaky." There was a conceptual problem with this perception as it did not fully take into account the fact that water supply during the rainy season was not a real issue, i.e., that leaks do not matter when there is plenty of water, and that intersystem issues were important during the dry season — leaks in upstream weirs constituted automatic supply for lower weirs. Upgrading certain canals along the river exacerbated intersystem difficulties.

Systems in the hills of Nepal. The first article of the constitution of the Raj Kulo Irrigation System at Argali states that no one is permitted to construct a diversion in the stream within 90 meters (m) upstream of their diversion (Martin 1986). Such rules are typical in many of Nepal's hill systems. Farmers have the right to divert all of the water from the stream at the point of their diversion but are not allowed to move the diversion downstream to capture a lower spring if another system is already using that water. New diversions are not allowed within a specific distance upstream. Local rules have frequently been contested in court and upheld (Martin 1986).

The diversion of the Tallo Kulo at Chherlung, which runs below but parallel to the Thulo Kulo, was destroyed by a landslide and could not be repaired using local materials despite many attempts. Eventually, the Tallo Kulo farmers negotiated with another system to use their diversion. In return, the Tallo Kulo farmers agreed to improve and maintain the canal and diversion and share half of the water. The Tallo Kulo was only allowed to take its share at night until it was proven that the irrigation supply was adequate for the old system to practice continuous distribution with half the discharge.

Mutual canal companies in the Poudre Valley, Colorado, USA. The Colorado Water Law states that "he who develops a water source first in time, retains his right [to use the water] ad infinitum, as long as the water is put to beneficial use" (Early 1990). The state retains ownership of the water and a water right is only entitlement to its use. The use right is a form of property that can be bought, sold, inherited, or leased temporarily. Private individuals as well as private not-for-profit corporations can hold water rights and provide water to shareholders in proportion to their investments in the corporation. Within the corporation, equity of water access is determined by the corporation's own rules, usually according to the shares owned by the member. Among mutual companies, however, water rights are based on the seniority determined by the date of each filed claim to the water. In the State of Colorado, administration of water is highly legalized. Courts of law are used to file water rights, settle disputes, redress grievances, and assign penalties for damages caused by one party to another.

Water Rights in Assistance, Turnover and Management Transfer Programs

Bellekens' (1992) example from Bali was drawn from an assistance project for locally managed systems. He concludes that

> ***...in building diversion structures on mountain stream, it is critical to consider the pre-existing water rights among the different irrigation systems using water from the stream. A water-tight diversion generally does*** not ***have appropriate provision for equitable watersharing. Equitable in this case refers to traditional water rights which are usually related to many historical factors andfrequently do not imply equal access to water. The irrigators' preference*** is ***for a method that will remain operational and reasonably accurate in dividingflows under fluctuating stream conditions.***

Assistance projects must examine outstanding conflicts among systems before providing resources for improvement. Agency involvement tends to legitimize the rights of the system being assisted and may preclude movement toward amicable intersystem settlement. If improvement work is delayed until binding agreement is reached there will be pressure to negotiate. That pressure is lost after the work starts.

Security of the water right is an important factor in promoting management transfer and turnover programs. If there are continuing disputes over the right to access water or if junior status deprives a part of the system of water during periods of shortage there will be reluctance to take over operation and maintenance duties. Martin (1986) states:

> *To provide incentive for investments to develop irrigation facilities, the system of [water] rights must provide some measure of security that the investors will be able to capture all, or at least a significant portion, of the benefits of the investment.*

CHAPTER 4

Irrigation Allocation Rules

INTRODUCTION

IRRIGATION WATER IS normally acquired from a concentrated source and spread by some *predetermined irrigation plan* over the system's command area. From its origin in a river or reservoir, the flow is divided into smaller units until the rate of discharge is appropriate for field application. In this paper, the activities associated with the physical movement of water through the conveyance system are referred to as irrigation distribution. Irrigation distribution refers to how the irrigation plan is accomplished, i.e., by continuous distribution or by timed rotation, etc. The predetermined plan with its associated criteria and conditions, i.e., the rules that determine how the water in the system is to be apportioned in time and space, is irrigation allocation.

The task of irrigation allocation is to establish a set of rules that determine and control access to the irrigation resource. The examples of different systems given below show wide diversity in these rules. In some cases, the allocation rules include definition of the boundaries of the irrigation system — which fields or which individuals have access to the irrigation supply — in effect, identifying within-system water rights (Coward 1990). In many cases, the rules determine the geographical and temporal distribution of the water. The rules may simply define the order for moving the irrigation supply among distributary canals and irrigators. In some systems, the rules include explicit quantification of the withdrawal allowed from the main canal by a branch canal or by an individual irrigator from the branch canal. The quantification may be volumetric or, as is more often the case in locally built systems, a percentage of the total discharge determined at some designated location according to some specified basis. The bases for allocating the irrigation supply are also diverse.

Allocation Based on Shares

The allocation basis may be the irrigator's (or his ancestors') investment in the original construction of the system or it may be related to the size of landholding. In some systems, the rules state that each canal's or individual's share of the irrigation supply be computed based on a proportion defined as the ratio of individual to total investment or landholding. In the development of *pani panchayat* (water council) systems in Maharashtra, India, each family is allocated an equal share of the irrigation supply regardless of landholding. Order (in time) of appropriation, household size. productivity of land and value of property owned in the command area have also been used as the bases for allocating the irrigation supply. The basis for allocation may be the relative location of the irrigator's field. For example, the rules used may allow irrigation sequentially from the head to the tail of the system.

Different allocation rules and bases for computing shares may be used in the same system in different seasons if the crop grown or available water supply is different. The rules may even change within one crop season depending upon the variability of the irrigation supply. In some systems, adjustment in allocation among irrigators is made to accommodate different infiltration rates. In terraced fields irrigating rice, the allocation to lower terraces may be reduced because they benefit from both surface leakage and groundwater infiltrated from higher elevation fields.

Irrigation allocation rules in locally managed systems continue to evolve to best serve the needs of the irrigators as market prices, available resources, and technology enable different cropping patterns. Changes are also made to protect access to a limited resource as competition for the use of the irrigation supply changes. In examination of the irrigation allocation rules of 18 farmer-managed irrigation systems in the hills of Nepal, none were found to be identical in all respects (Martin 1986). Most had rules defining the right of access to the system though several did not. Most used the size of family landholding as the basis for sharing the irrigation supply; however, several used investment rather than landholding, allowing landless persons to own shares of the irrigation supply. All had uniquely different auxiliary rules that modified the way drought conditions, winter and spring crops, junior rights, etc.. were handled to tit the site-specific characteristics of each system.

Allocation Assumed by Design Parameters

Water duty of the proposed area to be irrigated was used by engineers in the past to design canal capacity. Water duty is simply defined as the amount of water to be diverted from a source to irrigate a particular crop sufficiently to produce an economic yield. For example, a water duty of 1 to 1.5 liters per second per hectare (l/sec/ha) flowing continuously was typical for designing systems for growing rice in parts of Asia. In the United States, the term ***consumptive water use*** came into use in the twentieth century to describe the water requirements of a crop. Consumptive water use, as well as the term water duty, refers to the amount of irrigation required to meet peak evapotranspiration requirements for a crop.

In many developing countries. new irrigation construction is the responsibility of a designated agency that also establishes the allocation rules. The implied rule is often that water will be delivered to the entire area designated during design in accordance with the design water duty. This provides little opportunity for farmers to influence the rules to best meet their crop requirements and reduces the farmer's flexibility in managing his irrigation water (Jensen 1990). Perhaps the simplicity of the implied allocation rules in some agency-managed systems is the reason that they are not explicitly stated.

However, there are examples where complex allocation rules are initiated by irrigation agencies. Indonesia, for example, has a number of distinct allocation methods with rules that are designed to match observed hydrologic and meteorological trends with field conditions. Several examples are given below of allocation rules operating in agency-managed systems.

Irrigation Scheduling as the Basis for Allocation

In the past few decades, a great deal of research was undertaken to characterize the crop response to varied inputs of water. The results, widely known as ***crop production functions***, are used in defining the marginal crop production required in the computation of the maximum profit for management and economic analysis (Howell et al. 1990). The uses of crop production functions are often criticized because they are empirically derived, site-specific, and cannot appropriately reflect other inputs such as climate, crop nutrients, soil salinity, pest infestations, etc. However, work in defining crop production functions and subsequent research did identify that water stress in different growth stages of plants has different effects on harvestable yield.

In principle, it is possible to plan an irrigation program on the basis of information from monitoring the soil water, the state of water in the plant, and/or the microclimate. In water-scarce environments, the ability to determine when to irrigate and the precise amount to apply at each irrigation and during each stage of plant growth allows optimization of water use, provided, of course, that sufficient precision in irrigation delivery is possible.

Irrigation scheduling is the term used to describe when and how much water to apply or to determine when to start and when to stop irrigation application. In irrigation systems with sufficient control and flexibility in the delivery system, irrigation scheduling has become the basis for irrigation allocation. This requires the ability to arrange the irrigation delivery on ***demand*** where individual irrigators determine their irrigation requirement and access the supply. In a true demand system there is little communication necessary with the irrigation supplier. The system automatically adjusts to the increased withdrawal. In many systems where irrigation scheduling is used, it is necessary for the irrigator to request an ***arranged*** delivery by ordering the irrigation some period in advance as determined by the allocation rules (Burt and Plusquellec 1990).

While a great deal of the research reported in the professional literature on irrigation in the past decade deals with irrigation scheduling, there has been much less work done on investigating irrigation allocation rules appropriate to accommodation of scheduling.

EXAMPLES OF IRRIGATION ALLOCATION RULES

Locally Managed Systems

Subak Gunung Mekar Mertasari, Bali, Indonesia. After the construction of the diversion and canal in 1979, water in excess of domestic needs was allocated to the subak members. Since all members had contributed equally to the work each received an equal share. The total supply at the diversion was divided into 74 shares. One share was allocated to the communal land of the village near the diversion, two shares to the communal land of Bunutin Village where subak members are resident, one share to the subak head, and one share for each of the 70 subak members (Pitana 1991).

The irrigation distribution was made continuous to all shareholders. Though the discharge was low this allowed water for domestic purposes to be available in all parts of the village at all times. The allocation rule agreed upon by the suhak members called for equal shares for each person who assisted with construction. The simplest procedure for accomplishing this was to proportionally divide the canal discharge at each canal branch and fanner's field. However, fanners in the lower end of the system did not agree that this method was equitable. Two subsequent changes were made in the distribution procedures (see Chapter 5) to ensure equal irrigation supply at the inlet of each fanner's field.

Raj Kulo in Argali, Palpa, Nepal. Prior to the twentieth century, only rice was irrigated by the Raj Kulo System. Soon after the turn of the century maize was added to the cropping cycle and in the 1950s wheat became the third crop irrigated annually in the same fields. The irrigation allocation rules used are typical of many farmer-managed irrigation systems in the hills of Nepal. Rice remains the dominant crop and the irrigation allocation rules for rice are used to demarcate the boundaries of the system and membership in the organization of users. The charter of authority rests with irrigators owning land entitled to receive water for growing rice.

Each field entitled to imgate rice is designated. Field size is used as the basis for computing the fraction of the total canal discharge in the system to be delivered to each field. This is equal to the ratio of the field area to the total area irrigated by the system (Martin 1986). Thus the irrigation supply for each field is quantified relative to the total supply reaching the command area. The rules for irrigation allocation do not make adjustment for differences in soils or seepage losses from the canal between the head and tail of the system.

By designating the fields allowed to receive irrigation, the system has defined the boundaries of the irrigated area for monsoon rice and has clearly identified who are included and excluded as members of the system. More than double the area growing rice is commanded by the canal hut owners of those fields cannot be members of the Raj Kulo System unless they also own fields to which water has been allocated. Drainage water from the system is used by several to grow rice in fields outside the defined command hut they have no claim to water from the system if none is diverted to the drain. Irrigators using drainage water are prohibited from participating in system maintenance during the rice season to prevent them from laying claim to part of the supply.

After the rice harvest, the allocation rules are changed for irrigating wheat in the winter and maize in the spring. In these two Seasons of the year, any field commanded by the canal can be irrigated and the irrigated area nearly doubles during the seasons in which maize and wheat are grown. As soon as rice seedbeds are established at the onset of the rainy season, the allocation rules revert to those established for growing rice (Martin 1986).

***Thulo Kulo in** Chherlung, Palpa*, Nepal. The Thulo Kulo was constructed in the late **1920s** by the collective investment of **27** families of the Chherlung community. They agreed before starting work that the irrigation supply would be shared in proportion to the investment made by all contributors. By the time the first water was delivered, the investment totaled **5,000** Nepali **rupees** (NRs). This was divided into **50** shares with a value of NRs **100** each. Initially, the capacity of the canal limited water delivery and only a small area could be irrigated by each household. After continuing to improve the canal for a few years, two families had more than sufficient water to grow rice in all their fields but others with fewer shares still required more water. Also other families in the community who had not contributed to the construction were now keen to purchase shares of water.

This led to the establishment of a water market. The committee elected **by** those who owned shares established the price, which included the cost of initial construction and the cost of subsequent canal maintenance and improvement. Individuals interested in purchasing a share made private arrangements with a person willing to sell excess shares. The price actually paid was not always disclosed. Most transactions were a fraction of a share. A treasurer was elected by the shareholders to record change in share ownership for both the buyers and sellers in order to arrange irrigation distribution. The two founders of the system who had contributed most of the funds by borrowing money were easily able to sell their excess shares and recover much of their investment.

In **1978,** a group of farmers with uninigated land in the Thulo Kulo command wanted to purchase water but no individual was prepared to sell the number of shares the fanners needed. The Thulo Kulo organization determined that by improving the diversion weir and canal the discharge could **be** increased. A decision was made to sell ten additional shares, i.e., increasing the **total** number of shares in the system from 50 to 60. Those purchasing the new shares paid the Thulo Kulo organization rather than an individual for their shares and the money was used to improve the diversion and main canal. This endeavor successfully brought enough additional water to expand the command area by **25** percent in one year (Martin and Yoder **1987).**

Different allocation rules are used in the dry season when the water supply in the source is low. The first rule relates to the type of crop that can be grown. Though rice is the preferred crop, the irrigation supply is not sufficient and the irrigation supply is all allocated to a less-water-intensive crop such as maize. Even with the entire discharge of the stream diverted into the canal there is only enough water to irrigate a few maize fields at a time. Instead of using the share system of allocation, full authority for allocation during this period — both in terms of delivery and quantity — is given to the elected system leader. All requests for irrigation must be made to him and, **as** nearly **as** possible and practical, considering the efficiency of moving the supply among canals, he assigns water delivery to each irrigator's field in the order in which requests are received. A field usually consists of several terraces depending on the slope and size. In order to allow equity in timely planting of every fanner's maize, the leader decides, on the basis of requests for water each day, what portion of each farmer's field, i.e., how many terraces, will be inigated in his turn. In this way, water is allocated by turn to fanners, and a portion of their land is inigated. A farmer must then wait for another one or more turns to complete his maize planting.

Thambesi Kulo, Nawulparasi, Nepal. Not all fanner-managed irrigation systems have defined their irrigation allocation as explicitly as those described in the preceding three examples. A system in this category in the hill part of Nawalparasi District in Nepal was studied intensively for 18 months in 1981-82. (Yoder 1986, Martin 1986).

As reported by the 70-year-old former system leader, the system is more than six generations old. A small stream is diverted onto a large river terrace to irrigate 23 ha out of a potential command area of 210 ha. The system is used primarily for supplemental irrigation for rainy season rice. Winter wheat is irrigated on part of the command area and about one hectare of rice is irrigated next to the diversion in the dry season. Except during the rainy season when the entire command area is cropped, most of the land is fallow and is used for grazing.

The system is severely water-constrained. The stream diverted for irrigation has a small catchment and a low base flow between rainfall events. However, diverting the stream into the delivery canal is easy. Conveying the water from the diversion to the upper end of the command area only 100 m away is equally easy compared to other hill irrigation systems. One person working alone can maintain the diversion and conveyance works with several weeks of work in a year. The only serious problem in system maintenance is control of sediment that enters the system. Several fields have been damaged by deposits of gravel that had entered the canal.

Though the Thambesi Kulo is in a similar environment to the Raj Kulo and Thulo Kulo described above, the farmers using the canal do not have clearly defined rules for irrigation allocation. They do not allocate irrigation to individual fields or persons. They keep no written records and have seldom held meetings to discuss operation and maintenance of the system, The rules used were deduced by observing and mapping the irrigation distribution and from the description of system expansion. Fields have priority for irrigation delivery based on their location. The upper area is entitled to receive irrigation at all times and in the lower block of fields the uppermost field received water first. Trial and error have enabled farmers in the tail reach to determine where irrigation will generally be sufficient and the point beyond which planting irrigated crops is not useful.

Siran Tar Kulo, Nepal. The Siran Tar Kulo Irrigation System described briefly in Chapter 2 is another example where irrigation allocation was not clearly defined by the farmers who built the system. Since an agreement was not made before the construction work began on how the irrigation supply would be shared among those who contributed to the construction, the fanners at the head of the command area were able to capture all of the limited irrigation that was delivered.

The government project that provided resources and supervision to improve the canal assisted the farmers in determining how they could best allocate their irrigation resources among the users. This was done by taking a number of farmers from the system on a tour to other irrigation systems including the Raj Kulo and Thulo Kulo described above. After discussing irrigation allocation with farmers in numerous systems, the Siran Tar Kulo farmers agreed among themselves to allocate irrigation shares on the basis of landownership.

Mutual canal companies in the Poudre Valley, Colorado, USA. Water for irrigation in the Poudre Valley comes from four main sources. Run-of-the-river diversions from the Poudre River were first developed in the 1850s through the 1870s. From 1880 through 1900 small reservoirs were built for storage. At various periods from 1900 through 1960 there was intensive groundwater development. In the 1930s, the farmers banded together to lobby for construction of the Colorado Big Thompson Project (CBT). The CBT was constructed by the US Bureau of Reclamation to divert water from the Colorado River Basin west of the continental divide into the Poudre Valley and the lower South Platte Basin. The CBT includes a major storage reservoir.

Individual fanners did not have the necessary resources to develop river diversion systems so groups of fanners formed "mutual ditch companies" to do this collectively. These are stock issuing organizations that operate on a nonprofit basis. Within a mutual company, irrigation allocation is based on the holding of water-use shares. Early (1990) describes the process by which the board of directors of a mutual company in the Poudre Valley determines how much water will be available to each share.

> *The collective water rights include the sum of the direct diversion flows, the storage water, and the CBT supplemental water. The allocation of this water is generally a stepwise, monthly procedure. It takes place incrementally as diversion water is available from the river. Storage water is known more certainly before the season. . . . The CBT water is also subject to estimations of availability from snow melt.... The CBT water is a buffer supply to even out the effects of drought.*
>
> *The [mutual] ditch companies seek snow pack readings from the Soil Conservation Services and from the Northern [Colorado Water Conservancy] District as early as January for the irrigation season that begins in April. Monthly snow pack assessments continue through April as the runoff begins and the company board of directors begins its monthly allocation of water on a share basis. The incremental process represents the safe, conservative approach to allocation, always allocating only the amount of water that is assuredly available from direct diversions, from small reservoir storage, and from the units of CBT owned by the company. When excess, unappropriated runoff occurs in the months of April and May, with an early thaw, the River Commissioner informs the ditch companies of the availability of free water. [This free] ...water is not charged to the water account of the shareholder and remains free to the opportunistic shareholder who needs to fill the root zone for future crop use or irrigate to promote germination.*

The irrigation company's secretary keeps an account for each irrigation user. The quantity allocated per share each month from each source is added to the account. Deductions are made from the account each time water is delivered. Water is "free" when it can be delivered but does not need to be entered into the account.

The allocation rules of most mutual companies in Northern Colorado include a requirement for uniform delivery of water per share throughout the command area. The losses due to seepage, evaporation, spills, etc., are deducted from the estimated available supply from all sources before allocations are made to the shareholders. In some companies, however, the quantity per share is different in parts of a system. This variation is based on expected return flows that are traditionally available to those areas.

The Poudre Valley imgation community has a well-developed water rental market. This is in response to continuing small imbalances of water supply among farmers. These are caused by changes in the irrigated area, new cropping patterns, development of wells for imgation, development of additional land for irrigation. etc. To help adjust the resulting deficiencies and excesses, water rentals are used.

Under the strict appropriation doctrine, water is attached to the land for which it was originally appropriated. Since water rights from the various sources are owned by the mutual companies and not by individuals, the interpretation of the appropriation doctrine in Colorado is that water is attached to the company's service area as a whole and not to a specific farm. Thus water users own shares in the company rather than water rights. Water dividends or allotments are declared by the company on the basis of share ownership rather than on land owned in the service area. These shares — and the water allotments — are treated as personal property that can be bought, sold, or rented for a season or a shorter period. Normally, rental is only within the service area of the company (Maass and Anderson 1978).

The larger mutual companies maintain a rental service in the company office. A shareholder who has excess water lists it with the secretary and those needing additional water contact the secretary to obtain it. In some companies, the price is fixed by the board of directors and all transactions take place at the established price. Other companies allow shareholders to post the quantity of water they have available and their asking price. Users needing water take the lowest price posted or bargain for lower prices. In times of drought, the shares offered for rent are quickly taken and the price rises. Farmers with low value crops such as forage may find it more profitable to rent their water to a user with a high-value crop. The rental market. while dealing with a relatively small amount of water, makes better adjustment of the land-water relationship than is found in many irrigated areas of the western United States (Maass and Anderson 1978).

Huerta of Valencia. The rules for allocating the irrigation supply entering a canal among users are nearly identical in all eight canals serving the huerta. They state explicitly that water is "married" to the land meaning that transfers among farmers by renting and selling are prohibited.

Under periods of ordinary water supply conditions the imgation supply is divided to all farms in proportion to the land area of each farm. In periods of extraordinary drought, the irrigation supplied to each farm is still basically in proportion to the area of land imgated but may be modified by the water requirements of the crops planted. The requirements are defined by the farmer subject to the surveillance of canal officers. However, as drought becomes more and more extreme, the effective discretion of the individual farmer to define his requirements becomes more limited, and ultimately the rule that water is supplied in proportion to land is abandoned. When drought is so severe that some crops will be lost the supply is shared in proportion to crop needs with orchards and other high-value crops getting preference (Maass and Anderson 1978).

Huerta of Alicante. The huerta of Alicante is located on the east of Spain on a small coastal plain bordering the Mediterranean and is south of Valencia with a similar climate. The area irrigated is about 3.700 ha with over 2,400 farms. Ninety-three percent are less than 5 ha in size and the water for irrigation is in short supply. In addition to the Monnegre River originally diverted to irrigate the area, irrigation water is brought by a private company from wells over 70 km away, from the Segura River 50 km away, and from private wells in the command area.

As in Valencia, fanners in Alicante are affected by water shortages. However, the manner in which the irrigators dealt with abundance and shortage since the thirteenth century is different. Alicante has institutions for transferring water from one farmer to another. The rules for irrigation allocation have "divorced" water from land. The right to irrigation in Alicante is based on the ownership of water shares, not land. Some shareholders do not own land and most fanners do not own sufficient shares to supply their farms. In any period of irrigation delivery, a significant number of shareholders do not use the water to which they are entitled, but sell it to others (Maass and Anderson 1978).

When the famous Tibi Dam was built on the Monnegre River in the 16th century, it was assumed that the reservoir would double the supply of usable water. Half of this supply. the "new water" was assigned to all owners of huerta land who had contributed to the construction of the structure. The basis used for this distribution was landownership. The "old water" to which rights had been acquired before the dam was built, was divided among the old rights holders in proportion to the rights that they owned. The "old water" could continue to be traded but a rule was made that it could only be traded among owners of "new water" thereby limiting the expansion of the irrigated area and keeping down the price of water. The boundaries of the system are still defined according to this rule.

Agency-Managed Systems

In reviewing examples of locally managed systems in a range of agro-climatic regions, we see that with a few exceptions, successful systems in social, economic, and technical terms are those that clearly define irrigation allocation rules. Before exploring the equity and efficiency implications of irrigation allocation for assisting locally managed systems, the rules for two agency-managed systems are presented. These illustrate a dominant goal in many agency systems — emphasis on efficiency in resource use. This requires responsive management capacity and physical works capable of the level of control necessary.

Upper Pampanga River Integrated Irrigation System *(UPRIIS),* the Philippines. The UPRIIS is a 100,000-ha reservoir-assisted canal system located in the central plain of Luzon. It is divided into four districts of approximately equal size which are in turn divided into smaller units. Many of the UPRIIS subsystems were originally constructed and operated as independent run-of-the-river systems. Beginning in early 1970, these systems were rehabilitated and incorporated into UPRIIS as a part of the reservoir-construction project. A double crop of rice is the typical cropping pattern of the part of the system studied by Ferguson (1992). The rainy season extends from mid-June through September and about 70 percent of the 1,800 mm annual rainfall occurs during this period. Rainy season irrigation is supplemental to the rainfall and the dry-season crop is almost entirely dependent upon irrigation.

The National Irrigation Administration (NIA) constructed UPRIIS and is responsible for all main system management. Ferguson (1992) described NIA's irrigation allocation activities. The determination of irrigation allocation begins 1-2 months prior to the first seasonal deliveries with the preparation of an operations plan. This consists of an estimation of the total irrigable area targeted for cultivation and the expected cropping pattern. Typically, the UPRIIS central office programs all irrigable acreage for rainy season cultivation. For the dry season they use a storage volume curve to determine the likely supply available from storage. The rule used specifies the amount of area to be cropped as a function of preseason (31 October) reservoir water surface elevation.

Based on equity, availability of captured drainage, proximity to the water source, topography and soils, the total UPRIIS programmed area is first allocated to the four districts, then to distinct subsystems down to the level of smaller distributary canals. The NIA does not formally program individual farms; a farmer's ability to grow crops depends on gaining access to irrigation deliveries, which are directed toward the programmed area (Valera 1985).

Once the seasonal programmed area is determined, operational planning projects weekly irrigated areas and water deliveries to district and subdistrict units. Planned weekly deliveries are based on the mean water availability (rainfall and streamflow) to the system against the estimated average water requirements, conveyance losses and water use efficiency. After the season begins, the central UPRIIS office schedules actual irrigation deliveries from the reservoir, on a weekly time frame. Field staff report weekly on estimated area under irrigation, rainfall, and irrigation discharge in major channels. These data are recorded by the central office, but are not utilized to revise the operations plan. Instead, planned deliveries are adjusted in response to complaints and requests for additional water from the districts, sometimes accompanied by a brief field inspection of the area.

Ferguson's (1992) study showed that though elements of a flexible irrigation allocation process were in place, the agency response to changes in predicted supply was not systematic and tended to overreact after responding too late. While the fanners of the system varied the use of water by source, season, site characteristics, and the relative scarcity of water, NIA's irrigation allocation plan does not formally consider such spatial and temporal differences. The seasonal plan is formulated on the basis of constant average values. Adjustments are made in the plan over the season but only respond to actual conditions indirectly via complaints from the field. This makes it difficult to efficiently and equitably distribute the irrigation supply to the fanners.

Pasten system of irrigation allocation, Java Indonesia. The pasten system of irrigation allocation has its origin with the Dutch. The procedures which evolved as modifications were made to respond to field conditions found in various parts of the country. Kelley and Johnson (1989) describe a modified pasten method of irrigation allocation used in East Java. This is the "relative palawija factor" (RPF) which allocates available irrigation to each tertiary block in proportion to the water requirements of the crops in the block.

Basically, there are two types of decisions in this process that relate to irrigation management. The first is a planning exercise where the potential availability of water over the year or season is estimated and appropriate cropping systems are determined to optimize use of the anticipated water. This is done by using historical, hydrological, and meteorological information for each system. The second part relates to daily operation after the cropping pattern is established, to determine quantity and timing of irrigation delivery (IIMI 1987).

To determine appropriate irrigation delivery, the full water requirements for each crop-growth stage are estimated using a "relative water requirement" index. These are specific crop water needs expressed in terms of previously established requirements for nonrice (palawija) crops such as maize and soybean. Rice, for example, is given a relative water requirement of 4.0 from transplanting through flowering, compared to maize which is by definition 1.0. The entire irrigated, cropped area is thus converted into a relative nonrice area. This relative area is then multiplied by the "pasten water requirement factor," a simple water duty. This factor is often taken as 0.25 l/sec/ha but can be varied according to the soil texture. The result is multiplied by a distribution system loss coefficient to determine the final block-level irrigation requirement.

Irrigation allocation takes place by reconciling the block-level irrigation requirement to water availability. To do this, the total system deficit factor is calculated by dividing the discharge available for irrigation in the source by the sum of all tertiary block irrigation requirements. The supply that can be allocated to each tertiary block is then found by multiplying the irrigation requirement of that tertiary block by the system deficit factor. Thus the total allocation becomes equal to available total supply, and the demand of each tertiary block is reduced in the same proportion.

This allocation procedure is to take place every 10 to 15 days. Theoretically, the revised allocation targets are available for every structure and tertiary block at least every two weeks allowing efficient matching of the supply to the demand.

EQUITY, EFFICIENCY AND ADEQUACY CONSIDERATIONS IN ALLOCATION RULES

The examples illustrate that a wide range of rules are used to allocate irrigation resources among users of a system. The rules are used in some cases to establish boundaries and limit access. In agency-managed systems, the goal is often to share the irrigation resource as widely as possible and the tendency is to establish rules that emphasize efficiency in water use. Locally managed systems tend to emphasize equity and adequacy first. This is especially true when the irrigators have invested in constructing the system.

Locally Managed Systems

Irrigation allocation rules establish the equity principle by which members of the system share the inigation resource. When the process for determining rules is controlled by the irrigators, refinements continue until acceptability is achieved. The Subak Gunung System in Bali defined equity as equal water sharing. The local perception of equity included accounting for losses in delivery. Adjustments in irrigation distribution continued until this was accomplished at each irrigator's inlet. In the Raj Kulo and Thulo Kulo systems, however, no adjustment is made for the losses due to spills, domestic use, seepage, or evaporation within the command area. Reduced discharge per share due to location is accepted as equitable by their definition.

Irrigators at the end of a long distributary canal in the Raj Kulo do what they can to reduce the losses by cleaning or even lining sections. However, they do not have a right to demand more water from an upstream member to compensate for losses. The members of the Raj Kulo could collectively decide to modify the allocation rule to give "equal water per share" as in Subak Gunung. However, they would first compare the cost of achieving such accuracy with the cost of increasing the supply. To overcome problems in irrigation distribution, the Raj Kulo enlarged and lined parts of the main canal leading to the command area. By increasing the irrigation supply, even the most disadvantaged member is now able to receive adequate water from his share. Where a source is available to augment the supply, such improvements are possibly cheaper than the continuous measurements and monitoring necessary to assure equal irrigation delivery.

In the systems of Valencia, the canal communities say that their irrigation allocation rules are for the purpose of ensuring that all members enjoy the benefits of irrigation with "equality and equity." They use equality in two separate senses. In one, it refers to the participation of landowners in determining the canals' operating rules where there is absolute equality — one person, one vote. When the term is used to refer to the quantity of water it means proportionate equality. The rules guarantee that all fanners will be favored equally when there is sufficient water and suffer equally when there is drought. In extreme drought conditions emphasis is placed on fixed proportion to the relative needs of crops in the farms and service areas of several laterals and canals (Maass and Anderson 1978).

The absence of rules — possibly because the system was relatively new and acceptable rules had not yet emerged — in the Siran Tar Kulo allowed a few families in the advantaged location at the head of the command area to capture the entire irrigation supplied. Lack of confidence that acceptable rules could be worked out and enforced to ensure equitable benefit to all, reduced participation by potential irrigators when assistance was offered by a government agency.

In the Thambesi Kulo System the allocation rules reflect priority in appropriating access to the water in the stream. Though unequal in division of the resource, it is considered fair by the users because they have accepted a "first in time, first in right" rule. By dividing the delivery into rotation units they have attempted to improve the delivery efficiency but have retained their equity principle by allowing some part of the uppermost fields with prior rights to receive water at all times. Fields within each rotation unit have the right to take all of the available irrigation supply by turn from head to tail of the unit.

While the allocation rules in Thambesi Kulo do not specify that fields or individuals are excluded from the system, there is an accepted precedent that identifies the order for taking water. Each farmer has the right to determine if irrigation is adequate in his field before allowing delivery to proceed to the next lower field. Farmers with fields that are not able to receive a reliable and adequate supply have no recourse but to plant crops on the basis of expected rainfall rather than on irrigation. Farmers at the lower end of each rotation unit must decide whether they want to plant irrigated crops and risk not receiving irrigation or whether they want to plant rain-fed crops.

Transferable Shares

The allocation rule in the Thulo Kulo System implies equity on the basis of investment. Maass and Anderson (1978) point out two concerns about equity when the irrigation resource can be separated from land as in the Thulo Kulo System. One is speculation, a situation where water is purchased with the intent of selling it at a higher price without using it. Alternatively, it is possible for individuals with access to capital to capture a larger share of the market, thus reducing the efficiency of the system. In the Thulo Kulo System both of these problems are avoided by requiring maintenance responsibility in proportion to ownership of water shares. Since maintenance costs in the Thulo Kulo increase more rapidly than gain from adding irrigation shares above some minimum level, there is financial incentive for divesting of all but the minimum shares necessary for adequate irrigation by labor-intensive methods. Since a market for short-term allocation has not developed, speculation in irrigation shares is less profitable than in other investments, such as land.

Maass and Anderson (1978) indicate that local regulation of allocation rules makes it possible for irrigators to control behavior adverse to their collective interests. In Alicante, the irrigation community has adopted membership and voting criteria that limit the influence of the interests that are likely to be most antagonistic: the large holders of old water rights and proprietors of very small, uneconomic-sized farms. Thus even without the maintenance mechanism as in the Thulo Kulo, Alicantians have control of the water market. Maass and Anderson (1978) also conclude that the system in Valencia, where irrigation is allocated proportional to land, is no more equitable than the water market in Alicante and is certainly not as efficient.

Martin and Yoder (1987) compared the principle of irrigation allocation based on land area in the Raj Kulo System to that of the Thulo Kulo System based on investment. Both systems have additional land available for expansion of irrigated rice, the primary crop. Both have high maintenance costs that are shared proportionally according to the allocation of irrigation shares. However, expansion of membership in the Raj Kulo. as defined by the right to use irrigation for growing rice, has not been allowed in many decades while the Thulo Kulo imgated area has expanded rapidly in response to the market for water shares.

The concern of Raj Kulo members has been to increase the irrigation discharge per share by making improvements in the system. This has allowed them to switch from rotational to continuous irrigation distribution to all plots simultaneously. Since the transfer of water is not allowed in the Raj Kulo there is no individual financial incentive for irrigators to use their water efficiently in order to give up part of their supply so that other farmers can grow rice. In the Thulo Kulo there has been rapid expansion in the number of members and in the area irrigated. Individuals have a cash-sale incentive that is much higher than the savings from reduced operating costs made possible by increasing the individual irrigation supply.

Agency-Managed Systems

Irrigation allocation in UPRIIS in the Philippines and the pasten method of allocation in Indonesia are practiced in response to the desire to use irrigation resources efficiently. Both propose to use localized information about crop water requirements to schedule irrigation delivery accurately. Successful delivery according to such an allocation rule will save water generally lost by more uniform application scheduling. The design of the physical structures in UPRIIS allows a great deal of flexibility in operating the system. However, accuracy in information collection, management of massive flows of data that have validity for only short periods, and incorporation of this information into the decision process with appropriate feedback to the field for operation have not been highly successful.

Ferguson (1992) says that the problem in UPRIIS is one of not planning for contingencies where variability is the norm. Instead, the managers tend to fall back on historical averages. Dynamic decision making is needed that uses information from the field to anticipate problems and respond before a crisis develops. This would reduce the biased feedback from irrigators.

IIMI (1987) reported two major sources of error in the implementation of the pasten irrigation allocation. The first relates to poor field data. Research found that estimation of cropped area within a block was often in error. Costly resurveying to determine actual block size is necessary to overcome this problem. The second was large discrepancies between planned and actual delivery. This is not a fault of the allocation method but rather of managing distribution.

Both of these examples reflect a persistent weakness in the process of irrigation development. Irrigation allocation rules and a basis for allocation are sometimes selected that require management responses which cannot be readily achieved in their proposed settings. This leads to uncertainty at the farm level. Farmers start using options other than those laid out in the allocation plan when their experience tells them they cannot depend on the plan being fulfilled. One option is to make cropping decisions as though the irrigation system did not exist and use whatever irrigation is available as a bonus. Another is to lobby heavily for extra irrigation, which leads to the biases seen in UPRIIS.

IMPLICATIONS OF ALLOCATION RULES FOR ASSISTING LOCALLY MANAGED SYSTEMS

Levine and Coward (1989) conclude that irrigation users perceive a pattern of irrigation allocation as equitable if claims to water are based on social principles that are accepted as fair and right. However, the principle of fair and right is the ideal and what is acceptable, the practical reality, is usually a compromise among the interested parties. Determining the goals and patterns of fairness in sharing resources acceptable to irrigators should be the starting point of dialogue when irrigators are offered assistance for improving their irrigation system.

Farmers' views differ on what is fair and acceptable. Sometimes what is acceptable to one group is not acceptable to the larger society. In the Raj Kulo, women and low-caste farmers are not allowed to work on canal maintenance because of Hindu concepts of purity and pollution. This means they cannot fulfill the obligation part of the irrigation allocation rule and must instead pay a fine for being absent from work. A low-caste landowner and system member raised the issue of discrimination against him in an annual meeting but received little support for the changes he suggested.

Identification of Existing Irrigation Allocation Rules

While the distribution system is highly visible, the rules that control the distribution are seldom articulated by the irrigators. As a consequence, even intensive field studies often do not fully describe the rules used under all conditions in a system, though they are usually explicit and well-defined by the practices of the users. Inability to identify not only the nature of irrigation allocation rules used by farmers but the basis for defining shares or access under differing field conditions for each crop is a serious problem for agency staff supervising assistance projects.

Because the physical structures in many locally managed systems are primitive, there is often a bias by outsiders suggesting that a single, simple rule defines irrigation allocation at all times and in all situations. For their part, irrigators tend to forget that outsiders do not understand the intricacies of their management system. Intimidated by the higher status of officials, they may fail to communicate the details of the rules and procedures they use to operate and maintain their system.

If agency staff start field work with awareness that rules almost certainly exist and develop systematic questions about how irrigators respond to different irrigation delivery situations that they face each crop season, they can break the ice and begin to identify the rules being used. Repeated visits and greater probing during interviews are needed to develop a complete picture of the allocation rules. Participatory Rural Appraisal has developed effective techniques for enabling farmers to express their practices (Chambers 1992). These would be appropriate in some situations but care is needed to enable disadvantaged groups to express their practices rather than for them to be intimidated.

If irrigators are given responsibility for implementing the improvements as suggested in Chapter 2, they will be able to either adapt the improvements to fit the rules they are using or recognize that the rules need modification, or both. While this reduces the need to identify the details of the allocation rules, it increases the opportunity for modifying repressive rules that may become even more entrenched by the legitimizing effect of the assistance project.

Modification of Allocation Rules

When government assistance was given to the Raj Kulo in Nepal in 1982, there was an expectation on the part of the government that maintenance needs would be reduced and water delivery improved. This was to result in an increase in the area irrigating rice. Before receiving assistance, the fanners agreed that a larger area could be irrigated if the irrigation supply was increased. However, no mechanism was in place to monitor the change in supply nor was the Raj Kulo organization pressed to change its rules to allow system expansion. After project completion it was easy for the farmers to insist that previously they, did not have enough water to irrigate properly but now there is just enough. They refused to allow system expansion. If the allocation rules had been understood and negotiations carried out for assistance contingent on modification of the rules and if potential irrigators had been made a part of the negotiation, it is likely that expansion would have taken place (Yoder 1983).

Assistance projects generally require some input from irrigators in the irrigation improvement process. Since irrigation allocation rules generally link access to irrigation with responsibility for operation and maintenance costs there is opportunity to strengthen local institutions by utilizing these existing rules. This also affords an opportunity to examine the rules carefully for discrimination of marginal members in the community and to negotiate change. However, there must be awareness that possibly a long and largely undocumented history has shaped the allocation rules and that change may be strongly resisted.

Assistance to established irrigation systems requires that projects should work through the irrigators' organization and within the existing rules. If the organization is weak, the assistance exercise should be designed to strengthen it. If the organization is strong, there is less danger that conditions or practices that do not fit the existing rules will be imposed on the organization.

IMPLICATIONS OF ALLOCATION RULES FOR MANAGEMENT TRANSFER

Irrigation allocation in agency-managed systems tends to be the exclusive domain of agency staff. Fanners in agency systems are seldom involved in the process of data collection, analysis and decision making required in systems using scheduling techniques for irrigation allocation such as in UPRIIS of the Philippines or the pasten system in Indonesia. Transferring the management of parts of such a system to fanner groups will require intensive organizing and training for the group to be able to carry a role in scheduling. Such effort, however, will not be warranted unless irrigation delivery in the main system can be assured according to the plan. Farmers will not continue collecting data or participating in meetings to give voice to a decision unless it is evident that their input is making a difference in the performance of the service they receive. This highlights the importance of effective management at the main system level and the value of irrigator involvement in decision making above the parts that they manage directly. It also suggests that systems with an adequate and reliable irrigation supply are likely to be the best candidates for turnover.

Management transfer assumes that irrigators will be able to coordinate irrigation distribution activities with agency staff at a higher hydrologic level within the system than before transfer, This is not likely to be possible unless the irrigation allocation rules are functional and implemented with reasonable reliability. As a condition for management transfer the irrigators should assist in reviewing and, if necessary, modifying the allocation rules that apply at all levels in the system.

IMPLICATIONS OF ALLOCATION RULES FOR TURNOVER

Many irrigation systems built and operated by agencies do not have explicitly defined irrigation allocation plans. They expect to operate according to criteria — water duty or estimated crop water requirements — established during the design process. Information on the available irrigation supply and the area that can be served by it was often not reliable during the design period. Even after some years of operational experience, with conclusive evidence of high deviations from design assumptions, there is seldom a mechanism for modifying the irrigation allocation plan. It is unlikely that fanners will agree to take over part or all of a system until functional allocation rules are implemented and tested. Since turnover is expected to result in local management, participation in the process of modifying the allocation rules is a good management exercise for irrigators.

Reasonable reliability of the irrigation supply and reduction in maintenance costs are frequently high priorities among farmers. As seen in the examples from locally managed systems, equability in sharing irrigation benefits and costs is important and usually has higher priority than production and efficiency goals. The ability to monitor and verify that irrigation delivery matches the allocation is important to irrigators whenever they must pay for operation and maintenance.

CHAPTER 5

Irrigation Distribution

INTRODUCTION

THE IRRIGATION DISTRIBUTION activity involves moving the controlled irrigation supply from the intake to the farmers' fields. Numerous ways have been devised by irrigators in locally managed systems to accomplish this task. Operation of the distribution system shifts from one mode to another depending on the season and crop being irrigated or even within a season if the available irrigation supply changes.

Different methods of irrigation distribution and the logic for shifting among them are examined in this chapter. While locally managed systems are not always successful in eliminating conflict, some of the methods and rules used for monitoring distribution have potential for application in systems considering management transfer and turnover.

DISTRIBUTION

Successful irrigation distribution fulfills objectives reflected in the cropping plan or in the rules for allocating the irrigation resource. The following examples illustrate that irrigation distribution is another variable in the complex relationship that determines irrigation performance.

Except under conditions of an abundant water supply, some level of monitoring is essential to determine whether irrigation distribution is fulfilling the irrigation plan. Monitoring takes different forms depending on the technology and procedures being used and the management level at which information is processed and decisions made. As a general pattern, systems where allocation rules simply divide the irrigation supply proportionally require less monitoring than demand-based systems that expect feedback from field conditions to adjust irrigation distribution.

Irrigation Distribution in Locally Managed Systems

Subak Gunung Mekar Mertasari, Bali, ***Indonesia.*** After tapping their first water source and successfully building the canal and tunnel, the community's domestic water supply problems were solved. The remaining water was available for irrigation. Villagers who had worked during the entire period of canal construction formed the subak and allocated the irrigation supply among themselves with an equal share to each member.

Irrigation distribution was first made by installing proportional dividers at the bifurcation of each canal. The irrigation supply was divided on a proportional basis with the openings in the dividers adjusted equally for each subak member. There was no compensation for water losses (Pitana 1991).

Since domestic use, seepage and evaporation decrease the available discharge to be divided among users in the lower reaches of the canal relative to those in the upper reaches, the quantity of water per share was not uniform over the system. As a result, farmers at the end of the canal could not grow rice on as large an area as farmers near the source. The subak agreed with farmers having fields in the lower reaches of the canal that this was not an acceptable solution for distributing their scarce resource.

Frequently. a system using such a distribution method, as will be seen in the Thulo Kulo example below, only monitors the proportional dividing structure to see that it is functioning properly. In this case, however, farmers compared the utility of the irrigation supply by monitoring the area of rice land that could he irrigated. It was agreed that farmers in the farthest part of the system were getting less water than those with fields near where the system entered the command area.

In 1980, they changed the openings of the proportional dividers to accommodate the estimated losses in the canal (Pitana 1991). Much as an engineer would approach such a problem, the farmers estimated the seepage and evaporation losses for the varied length of each canal, allowed for extraction for domestic use and made systematic adjustments in the ratio of openings at each canal bifurcation.

Though theoretically this method should have been acceptable to all farmers. it was difficult to determine losses. After a month of trial, complaints from fanners, who had given up part of their share to augment the shares of those in disadvantaged positions, led the subak to again modify the proportional dividers.

This time they measured the discharge and adjusted for equal delivery to each subak member's field. This involved intensive monitoring of the discharge using a volumetric measure. A two-liter can was used to measure the flow through each member's outlet. The relative discharge was adjusted by trial and error at each proportional divider until the time required to fill every can was equal. At the time of this adjustment the subak concluded that a member's share of the irrigation supply, given the total supply available at that time, was two liters in 36 seconds. This final adjustment was a laborious task that required many repeated trials. When all were satisfied that the distribution was equal to all parts of the system, the openings in the proportional dividers were set and further adjustment was not allowed.

This final adjustment was made during the low flow period when water was most critical. When discharge in the system increases, delivery to each field is no longer equal because the discharge characteristics of the canals and dividers change. However, this is not contested because the increased irrigation supply makes such differences less important. This level of concern for equity in irrigation distribution is not unusual in Bali. Working hard to find an acceptable solution for all members reduces the level of conflict and improves participation in all operation and maintenance activities.

Central Nepal hill systems.[2] The method for irrigation distribution in Nepal's farmer-managed systems varies from system to system and within a system depending on the crop being grown and the level of available irrigation supply over the growing season. The two main determinants of the distribution method are the supply of water relative to the farmer's perception of the irrigation demand for the crop, and the water application technique appropriate for the crop. Other factors also considered in the selection of the distribution technique are the absolute supply of water arriving at the command area, the average of the distances between farmers' houses and their fields, and the ability to manage the conflicts that might arise over the distribution of irrigation.

For growing rice, farmers in the hot, low valleys of the central Himalayan hills prefer an irrigation supply that allows water to flow continuously in the field canal so that they can divert it into their rice field at any time and in any quantity. They conclude from their experience that rice grows best when there is a continuous flow of water into the paddy in sufficient quantity to allow some overland drainage to keep the paddy water cool and from becoming stagnant. Few systems have water supply conditions allowing them to be operated in this manner.

Most systems are able to start the rice irrigation season with distribution in a continuous mode, i.e., flowing in all the canals and into most field inlets simultaneously. Earth and stone are the only structures dividing the flow among channels and into fields in some systems during this perikd. As the supply diminishes, conflicts arise as each farmer adjusts the stones to capture more of the water in the system for himself. Often, irrigators need to guard the turnout to their fields so that other irrigators do not reduce the flow to augment the supply to the latter's own fields. Farmers in the Raj Kulo System of Argali reported that until they improved the supply to the system in the 1960s, there were periods in most years when they needed to sleep by their turnouts at night to guard their water.

Fanners were observed using three techniques to reduce conflicts in irrigation distribution. Under certain conditions proportional dividing structures were installed to extend continuous distribution. When the irrigation supply diminished and continuous distribution was not practical, rotational distribution was used. Some communities have used a totally different approach. They had hired one or several persons to manage the distribution without assistance from farmers. Examples will be used to illustrate each of these.

Often, farmers agree that the water supply is adequate to meet the irrigation demand, provided that each irrigator takes only his entitled share. Under such conditions the farmers of the central region of Nepal have arrived at the same technical solution for distributing water equitably as have farmers in many countries? They install a proportional divider in the canal

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2 The irrigation distribution practices reported here wen observed in the hill region of Nepal's Western Development Region. Eight systems were intensively monitored for eighteen months and many others visited periodically. See Yoder (1986) for a report on the quantitative analysis of irrigation distribution in three of the system.

3 Indigenous proportional dividers are reported in many locations: Northern Pakistan (Dani and Siddiqi 1987), Northern India (Coward 1990), Bhutan (Pradhan 1989). Sri Lanka (Leach 1961), Bali (Geertz 1980 and Sutawan 1987), South Sumatra (Pusat 1984). West Sumatra (Ambler 1990), North Sumatra (Siregar 1989). the Philippines (Yabes 1990), Northern Thailand (Uraivan Tan-Kim-Yong 1983) and Spain (Maass and Anderson 1978). This list is far from exhaustive. It is expected that with diligent observation one would find similar devices in most counties where the conditions are appropriate for effective proportional division of the irrigation supply.

during an irrigation delivery rotation. Scrips, provisional certificates that are negotiable, stating the amount of time the owner can receive water are available at the office. The scrips are printed in twelve denominations of delivery time from one hour down to one-third of a minute. When it is announced that the next irrigation rotation is about to start, farmers go and collect the scrips to represent the shares that they own. A farmer who does not need all of his water in the next rotation can sell some of his scrips to a farmer who needs more water.

An informal market is conducted principally on Sunday and Thursday mornings. There is no posted price or hawking. Huerta men stand around in small groups and talk in subdued voices about the price of water and in the process negotiate sales. The prices paid by a farmer for a one-hour script or fraction of one varies over the morning as the supply and demand relations develop.

The irrigation syndicate also owns some water as a means to provide an income to cover operating expenses. In addition, the syndicate sells scrips that have not been claimed within the prescribed period. These shares are offered on Sunday morning at a public auction. The auction has a moderating effect on the price of shares in the informal market.

Under normal conditions, Alicante's water is distributed in two canals simultaneously. Each has a fixed discharge of 150 l/s achieved by using a balancing reservoir. The irrigation supply in each canal is rotated among different laterals with a rotation period of 23.5 days. A farmer takes the full discharge from a stream for the duration of his irrigation determined by the script he has acquired for that particular rotation. With a constant discharge and duration of rotation, approximately the same total volume of water is delivered by each canal in each rotation period.

In Alicante, the ditchriders open and close all gates — control gates for laterals and headgates for farms. The ditchrider collects the scrips from farmers in exchange for the water they deliver, and at the conclusion of each rotation they render a full accounting to the community's head office of all water released from the regulating basins. Maass and Anderson (1978) report that there were surprisingly short periods of running water not covered by scrips. When they did occur they almost always correlated with breaks or disruptions in the delivery system. The irrigation allocations as represented by the scrips held for each rotation matched the recorded delivery extremely well.

The community makes an effort to provide irrigators with information so that they can make informed decisions in purchasing water. This includes having the ditchrider present at the time of informal trading and during the auction. The ditchrider can tell a farmer approximately when water is likely to reach his farm. A bulletin board is used to post information about the water level in the storage reservoir, how much irrigation was delivered during the previous rotation, names of successful bidders, the number of hours each purchased, and the prices paid (Maass and Anderson 1978).

Mutual canal companies in the Poudre Valley, Colorado, USA. In the mutual canal companies in the Poudre Valley irrigation is delivered from various sources and requires close control of the water and precise records of deliveries to users. Each company predicts the available supply per share before the season starts and updates this continually as the river discharge and the status of water in reservoirs change. Farmers plan their crops and irrigation demand on the basis of the shares of water owned and the expected price of shares they can rent. The

Periods of 24 hours or multiples of 24 are avoided so that individuals do not receive their irrigation at the same time each period and that all will have a turn at night.

Since rotation is practiced when the irrigation supply is low. the duration is important and often computed to the closest minute. In some systems, there is a rule that the national radio time announcement be used as the reference for rotation and all fanners are expected to own or share a clock or watch to be able to comply. In one system, the organization owns a watch that is handed from one irrigator to the next, together with the rotation list at the completion of each irrigation turn. The rotation list states the starting time for each farmer's irrigation delivery.

In the third irrigation distribution method observed, one or several trusted persons had to irrigate all fields in the entire system. In the case investigated, the water supply was not sufficient for continuous delivery to all fields at once though it was adequate for complete irrigation of the command area. The irrigators realized that there would be fewer conflicts and that they would not need to spend as much time in their fields, especially at night, if a few people handled the entire distribution in an impartial way. The arrangement in this case was a contract with several irrigators from the system. The contract was approved by all the irrigators. Monitoring was done by individual fanners to ensure that irrigation was complete in their own fields but they were not allowed to interfere with the distribution. Contracts for water distribution are also sometimes given when the fields are far from the residence of most of the irrigators. In such cases, it is convenience rather than the reduction of conflicts that is important.

Huerta of Valencia. Typically, the service areas of the Valencia canals are divided into three parts and the irrigation supply is rotated among the three for periods proportional to the area. Within each service area the canal discharge is divided into laterals by permanent and frequently ungated proportional dividers called *lenguas* (Maass and Anderson 1978). The proportional dividers automatically separate the flow into correct proportions regardless of the discharge.

The control structures at the head of rotation units are gates that can be locked. Only the canal guards are authorized to operate the gates. Within the lateral, during ordinary low flow periods, each farmer takes the water as soon as it reaches his headgate and he is allowed to continue using it until he decides he has had enough water.

During periods of extraordinary drought, the water in the river is taken alternately by left or right bank canals for two days at a time. This halves the time available to irrigate but doubles the discharge for the duration of the irrigation period making it easier to move water to the far end of the canals. As the water supply diminishes, the time between successive irrigations may become so long that fanners are no longer allowed to take all the water they want. Fanners are then given a time limit, generally fifteen minutes, for irrigating each half hectare. This is enforced by the ditchrider. Under such conditions there is usually not enough water for complete irrigation and each farmer must decide which crop to favor.

Huerta of Alicante. In Alicante, most farmers own some water shares but most do not have enough to irrigate all their land at a given time. Some shares are also owned by the irrigation syndicate. A share is designated by the duration of time a farmer is allowed to receive water during an irrigation delivery rotation. Scrips, provisional certificates that are negotiable, stating the amount of time the owner can receive water are available at the office. The scrips are printed in twelve denominations of delivery time from one hour down to one-third of a minute. When it is announced that the next irrigation rotation is about to start, farmers go and collect the scrips to represent the shares that they own. A farmer who does not need all of his water in the next rotation can sell some of his scrips to a farmer who needs more water.

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Most companies deliver water for three to five days each week. If the demand is high they deliver water every day. The rules vary among companies hut in most, fanners must place a delivery request with the company office by noon on Saturday to receive water in a planned irrigation delivery that begins on Monday. The larger canals deliver by divisions. Water is turned into the upper division as soon as the water arrives and sequentially to each division down the system until eventually all divisions are delivering water to fanners at the same time. At the end of the delivery the upper division is shut down first. The last division may finish deliveries a day or so after the first division has shut down. The canal superintendent adjusts the major canal checks each day during a delivery to assure that all divisions and major laterals receive adequate water to fulfill fanner requests (Maass and Anderson 1978).

Each division has a ditchrider who also measures the water at the head of his division to determine that there is enough inflow to supply the fanners who have placed orders. The ditchrider opens, closes and adjusts headgates to make sure that the water is delivered to the proper users. In most companies, the ditchrider locks the headgate to keep the fanner from either opening it to take a larger supply or closing it early and possibly flooding a downstream farm.

Small companies with a service area less than 2,000 ha represent about 60 percent of the companies in the area. These generally deliver the water to farmers on an informal basis. One person functioning as superintendent, recordkeeper, and ditchrider handles water distribution problems as he travels up and down the ditch, setting headgates to deliver water to the farmers. He knows how many shares each water user has and how much water each is entitled to receive and he can adjust deliveries to make the most effective use of water available in the canal. When demands get too great for the water available, the superintendent sets up specific delivery times for fanners or he institutes rotations or other means of rationing water to meet demands. Most fanners will be served within a few days of when they order water (Maass and Anderson 1978).

Pithuwa Irrigation System *Chitwan,* Nepal. The Pitbuwa Irrigation System was constructed in 1968 by the Department of Irrigation and was expanded later. Though the physical works are still the property of the government, management of operation and maintenance has been turned over to the irrigators. The farmers also control expenditure of the maintenance budget issued by the central government.

Duringtherainy season, irrigation is distributed continuously to all 16 of the branchcanals most of the time. During periods of shortage, the main system committee manges a rotation system by preparing a list that allocates the time for groups of outlets to receive water. The allocation is based on a preseason register prepared by each branch canal. Fanners in each branch register the type of crop and the area of each they will plant that season. This identifies the share of water they are entitled to within the branch. The sum of all proposed areas in a branch is the basis for computing the relative share of water each branch should receive from the system. Since water is often in short supply, this allows the scarcity to be shared proportionally according to the cropped area. The area each farm family declares for planting also determines their share of the system maintenance work.

During periods of water shortage and for winter and spring crops, the irrigation supply is rotated among the branch canals according to the allocation schedule. While farmers are not bound to planting the area they registered and can receive irrigation for additional land when water is available, during periods of scarcity they only receive the share of water for which they registered. The branch canal committee is responsible for controlling the distribution within the branch. They set up a timed rotation during periods of shortage (Baxter and Laitos 1988).

Agency-Managed Systems

Irrigation distribution in Java, Indonesia. As mentioned in Chapter 4, irrigation allocation in agency-managed systems in Java is based on some form of the pasten method. The field-level demand is used to allocate the available irrigation supply among tertiary blocks. This procedure takes place every 10 to 15 days. The distribution system is designed to allow the discharge to be adjusted in each canal according to the allocation.

To allow the necessary flexibility in irrigation delivery that the allocation plan suggests, virtually every canal bifurcation is fitted with adjustable gates that can control both head and discharge. To monitor the delivery, there is provision for discharge measurement in canals. Because of the large number of structures, standard designs are used and it is assumed that the gate operator will fine-tune the gate setting to meet the target discharge.

The operating procedure is to adjust the gates as soon as the new target discharges are released, i.e., every 10 to 15 days. Except for fluctuations caused by changes in the supply from the river. the discharge should be constant throughout the period. The field staff are to monitor the discharge and make the necessary minor adjustments to achieve target discharges.

A study undertaken by IIMI (Murray-Rust and Vermillion 1989) reports a number of difficulties in the implementation of these distribution procedures in Java. In the systems studied, 15–40 percent of the structures are in sufficiently poor condition so that their utility is reduced. As many as 20 percent of the measurement structures were broken in the best systems and up to 75 percent in some. Those that were operational were often not calibrated to assure accuracy. Thus the actual control and monitoring of the irrigation delivery were much lower than anticipated by the policy.

The study further reports that the lowered level of control leads to sufficiently large daily variations in discharge throughout the system so that it is impossible to make the necessary gate adjustments to maintain the target discharges. The downstream canals show the highest variability in discharge. Field reporting of actual water conditions generally states that the allocation plan has been implemented while observation shows large discrepancies.

IRRIGATION DISTRIBUTION IMPLICATIONS FOR IMPROVEMENT PROGRAMS

Often, irrigation allocation and distribution are used synonymously to refer to water delivery. Emphasis is placed on the action of moving the water without evaluating the underlying rules that regulate distribution. Separating the rules from the action allows inspection of both and provides a tool for monitoring irrigation delivery performance.

Together with irrigation distribution procedures. monitoring methods need to be developed to test irrigation delivery against the planned allocation. Suitable punitive laws must also he prepared for not complying with the rules. For example, if the agency fails to deliver water within the specified range of quantity and timing, there might be a reduction in irrigation fees. The penalty if irrigators do not follow the irrigation plan should also be clearly identified. In other words, there must be a balance between the rights and responsibilities in all groups — the agency staff as well as the irrigators. The ability to implement sanctions will depend on both the irrigators' organization and the agency staff. Affective implementation would be a signal of successful management.

Assistance to Locally Managed Systems

Monitoring is built into the irrigation distribution process of most locally managed systems. One reason that proportional dividing structures are popular when discharge and water demand conditions are right is the ease in monitoring irrigation delivery. Compared to most adjustable gates with turbulent nonlinear underflow, proportional dividers are easily checked and relatively accurate. Timed rotational delivery is easy to monitor but has a higher cost associated with managing the water in the field. In Nepal, surveys showed that fanners spent five times more time managing rotational irrigation delivery than continuous delivery using proportional dividers (Martin 1986). In addition, during rotational distribution fanners need to be present in the field during their turn, day or night, or they will lose their irrigation.

With notable exceptions like the mutual companies in the United States and the simpler case of Subak Gunung of Bali, most locally managed systems have devised means of delivering shares of the irrigation supply without resorting to volumetric measure. In many cases, the supply is simply divided proportionally without regard for crop water requirements or other intervening losses. In others, as in Valencia, consideration is given to crops by changing the allocation rules during drought and delivering irrigation according to crop needs rather than according to shares of the resource.

The 2,500-ha system in Alicante has achieved and sustained remarkable success in maintaining a constant discharge distribution system. Two elements are important in Alicante's irrigation delivery. The size of each delivery stream is small enough for it to be still manageable by one fanner and the discharge rate is constant. The large stream size makes it possible for rapid coverage to distant locations in fields. The constant discharge rate allows experience to develop in determining the time required to imgate a particular field. This experience is important when advance orders need to be placed for delivery. Both of these factors help increase application efficiency.

Assistance projects should facilitate selection of structures designed to provide ease in meeting the irrigation allocation rules and to allow effective monitoring by all irrigators. Designing for a great deal of flexibility to allow high efficiency in irrigation delivery may be counterproductive. There is danger that flexibility will overwhelm the ability to monitor and will create conflicts that reduce both effectiveness and efficiency in irrigation delivery.

Turnover and Management Transfer

Most locally managed systems have well-defined allocation rules that are fully understood by all irrigators. Frequently, even young children can identify how many shares of water belong to their family fields. There are examples, however, like Thambesi Kulo System where only rudimentary rules exist to define rotation blocks. While all Thambesi Kulo fanners could describe the rotation they used few could explain why. The system operated much like many agency systems in Nepal where the head-end fanners receive water first and take all they can use. Fanners at the lower end of the system must decide, based on past experience, whether it is worthwhile planting a crop that requires irrigation.

In many agency-built systems, the management staff fail to fully communicate the irrigation allocation plan to the fanners. This leads to the uncertainty in planning field activities and the inability of fanners to monitor the delivery status, a situation which in some cases may be intentional. Murray-Rust and Vermillion (1989) reported that in systems studied in Java using the pasten method of irrigation allocation, 90 percent of the fanners interviewed did not know the official crop plan or planting schedule. This has important consequences for turnover and management transfer programs. Without experiencing reliable irrigation delivery, most irrigators will be reluctant to take on greater management responsibility unless they also have freedom to redefine the rules and irrigation delivery procedures.

If fanners are to take over full management control of a system they will need to have experience with developing allocation rules and will need to be able to exercise sufficient control over irrigation delivery to implement their plan. This is even more difficult when fanners have management control over only part of the system and need to coordinate with the agency that controls the water source. The Poudre Valley systems in Colorado illustrate that this can be done if there is sufficient communication with the agency and commitment on the part of the agency to deliver water according to the allocation plan.

Knowledge and familiarity with the allocation plan alone are not sufficient. Maintenance must be adequate and unauthorized deliveries controlled. The underpinning of most successful locally managed systems is a disciplined organization that has been able to control access and free riders and to mobilize labor for maintenance. It cannot be assumed that shifting management to the local level will automatically result in management improvements unless these other essential conditions are met and incentives to follow the rules are in place.

Locally managed systems have demonstrated that they have the ability to implement complex rules sequentially to match changing conditions within a cropping season. Turnover and management transfer programs do not need to emphasize simplicity. However. allocation rules must be widely agreed to — therefore, known to all irrigators — and all possible effort must be made to ensure irrigation delivery according to rules. Locally managed systems are successful under difficult conditions when results follow directly from the irrigators actions, i.e., when cause and effect are clear. As stated by Levine and Coward (1989),

> *...decisions should be based upon the probabilities of effective implementation, not on possibilities. Modern irrigation experience has more than its shore of systems designed on the basis of possibilities that were not realized.*

CHAPTER 6

Resource Mobilization

INTRODUCTION

LOCAL RESOURCE MOBILIZATION is described as activities of local people in mobilizing their internal resources as well as regional or state resources (Ujjwal Pradhan 1988). If local irrigators, using their political linkages, can draw on financial and technical assistance from the state, this too is considered local resource mobilization. Irrigators of locally managed irrigation systems have become quite adept at lobbying for resources external to the system. However, the objective in this chapter is to try and understand the purpose and methods used by local groups for mobilizing resources from the local community.

Irrigators in locally managed systems usually devise a way to verify that they have received their expected outcome when their costs are directly related to irrigation benefits. If leaders and staff responsible for operation and maintenance of a system are accountable to the irrigators, the irrigators monitor their work.

LOCALLY USED RESOURCES

Many locally built irrigation systems mobilized most, if not all, of the cash, labor, knowledge, and materials and equipment necessary for system construction from the local community. The mutual canal companies in the Western United States, the Thulo Kulo System in Nepal, and Subak Gunung System in Bali are examples where such mobilization bas taken place. Though there are perhaps hundreds of thousands of locally managed systems currently operating throughout the world, with the exception of groundwater systems, few new ones are being built. Most locations feasible for imgation by local technology without mechanized lift have already been developed.

Resource mobilization for maintenance and system improvement is a major and continuing activity in most locally managed systems. Prachanda Pradban (1989) describes mobilization of six types of resources in his comparative study of 21 fanner-managed irrigation systems in Nepal. These are:

* Labor,
* Cash in lieu of labor,

* Cash assessed to purchase supplies,
* Stone and forest products,
* Equipment, and
* Local expertise and knowledge.

Labor is the primary resource contributed by irrigators in all of the systems. Paying cash in lieu of labor is an option in most. Cash, assessed on the same basis as irrigation allocation, is raised to purchase nonlocal supplies like cement, wire, and pipes. Stones and forest products acquired locally are used for maintaining diversions and for building conveyance and control structures. Pradhan reports that bullock carts are requisitioned for hauling materials in some systems. Finally, local expertise and knowledge are a vital resource in successful construction and maintenance.

Most systems have rules and procedures for implementing "routine" maintenance on a regular basis. Emergency repairs are often handled differently. The basis for resource contributions by irrigators may be according to the size of landholding, water share, household, status of the fanner as perceived by the community, land tenure, or productivity of land. The following examples examine the rules and procedures used by several locally managed systems to mobilize essential resources for operation and maintenance.

Chhattis Mauja Irrigation System[4]

System *description.* The Chhattis Mauja Irrigation System diverts water from the Tinau River at Butwal, Nepal. The main canal is 11 km long with 44 branch canals. Irrigation is delivered to about 2,500 households living in the 3,500-ha command area. The system was originally constructed by local landowners in the mid-1850s. From the late 1940s through the 1970s migrants from the hills cleared the dense jungle and settled in the upper command area. The 550 km^2 catchment of the river is in the southern Himalayan hills but the irrigated area is on the piedmont plain just south of the hills. Rainy-season floods repeatedly damage the diversion and intake canal. Bedload consisting of small stones, gravel and sand are deposited in the upper reach of the canal and fine sediment travels the length of the canal. Repair of the diversion and removal of sediment are ongoing activities.

Irrigation allocation is by shares based on the request of each branch canal. Each irrigation share carries with it the responsibility to contribute one share of all maintenance and improvement expenses for the main canal and diversions. Each share also gives one vote to the irrigators of the branch in deciding the affairs related to management of the main system. In 1989, there were 175 shares claimed by the 44 branch canals. Proportional equivalence of benefits, costs and representation has worked well primarily because of the need to mobilize a large amount of labor, cash, and materials for maintenance.

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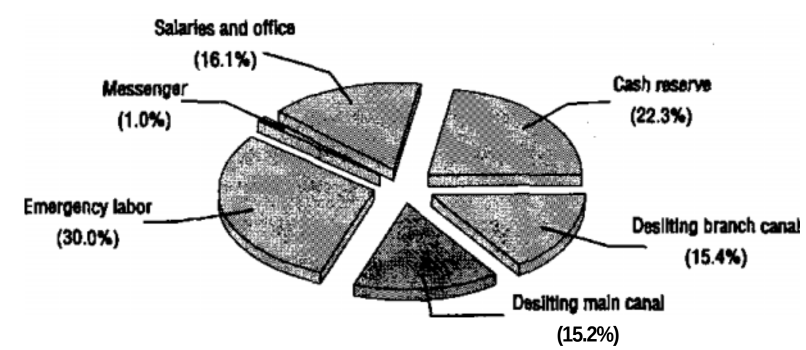
4 Information for this example draws from a study by IIMI staff in Nepal in 1988 and 1989 (Yoder forthcoming)

The charter of authority for operating the Chhattis Mauja System rests with the General Assembly, It is composed of representatives from each branch canal — one for each irrigation share. While meetings of the General Assembly are. open to all irrigators, only the representatives appointed by each branch are eligible to vote.

Resources used. In 1987/88, about 7,600 person-days were spent in desilting the main canal and another **7,300** person-days in cleaning the branch and field canals. Main canal desilting took **13** days and on average **760** persons were working each day. According to the secretary's report to the General Meeting, an additional **18,900** person-days of labor were requested for emergency repairs of the diversion and intake canals. When the expenditure to pay salaries for managers and messengers, office overhead, and payments of cash instead of labor and cash fines were included, the fanners of the Chhattis Mauja System paid about US$40,000 to operate and maintain the system in the 1988/89 cropping year. The following figure gives a breakdown of how these fanner payments were used.

Use of US$40,000 labor and cash payments made by the Chhattis Mauja farmers in the 1988/89 monsoon, winter, and dry seasons.



Source: Yoder, 1992.

Each branch canal is assessed at US$2.20/water share each year to pay the salaries of the main system messengers. In **1987,** US$24/water share. were collected to purchase wire for improvement of the diversion. In addition to labor and cash, forest products and stone are gathered for use in repairs. During the **1988** monsoon season, the diversion structures were repaired 34 times. It was estimated that over 100 **tons** of brush and branches were used in the repair work. Rapidly growing species of woody-brush with little commercial value as fuel or building materials are used for the repairs. Collecting brush from the hill slopes above the town of Butwal for maintenance, however, has contributed to erosion.

Rules and procedures. The payments due from branch committees are read in the General Assembly meeting each year. In **1988,** a total of about US$1,300 was collected from branch canal organizations for absentee labor. All payments for absentee labor, fines and other assessments must be made before desilting work can be assigned to the branch canal organization. This has been an effective method of forcing irrigators to make their payments by a certain date. By longstanding tradition, and now written into the constitution as well, if irrigators from a branch canal do not participate in the annual desilting work their outlet can be closed. If an outlet is closed it will only be reopened by the executive committee after receipt of the full payment of arrears plus a fine.

Currently, the system-level rules empower the executive committee to hire one or more managers to direct the day-to-day affairs of maintenance and irrigation delivery. The manager is given authority to distribute the work load for canal desilting, call for labor to carry out emergency repairs, and monitor that the work is properly carried out and, if not, assess penalties. He also informs the irrigators if they need to bring tools to the work site.

Hill Irrigation Systems in Nepal

Many locally managed hill irrigation systems mobilize large amounts of labor from their members. Almost all of the labor and cash are used for system maintenance and improvement. Daily maintenance in the form of plugging small leaks in the earthen canal or repairing the diversion is so common that it is generally considered a part of system operation. One or more individuals may be employed to patrol the canal or the task may be rotated among all the members. In most systems, there is little maintenance work required in the command area and irrigation distribution is generally a family activity. So, most operation and maintenance expenditure goes into diverting and conveying the irrigation supply from the source to the upper reach of the command area. This cost is generally shared by all irrigators using conventions to which they have all agreed.

The following table presents the average annual labor contribution by members of six systems in Nepal's central hills. This includes labor for routine maintenance as well as emergencies. The source of information was the written attendance record of each organization. A larger sample would show a much greater variation in labor requirements per hectare. The systems listed are among the more difficult to maintain of those observed in the hills of Nepal.

In addition to labor, significant cash assessments have been required for improvements in some systems. Cash is primarily used to purchase materials such as cement or pipes. It may also be used to pay skilled laborers not available in the village, such as masons or experienced tunnel diggers.

While direct cash and labor contributions by member irrigators constitute the most common method for paying irrigation operation and maintenance expenses, other sources of income have also been observed. In the Thulo Kulo System of Chherlung. water was sold by increasing the number of shares in the system by 20 percent in 1958. The cash income to the organization was used to improve the diversion and canal in order to deliver more water. In 1984, the canal organization installed a grain processing mill powered by water from the canal. After six years of operation the installation cost was paid and the net income from milling grain has since been used to help defray operation and maintenance expenses of the irrigation system.

Average annual labor contributed by irrigators in hill systems in Nepal.

Organization/ System	Record	Av age mobilized labor		
	Years	Days	Days/ha	Days/family
Chherlung, Palpa				
Thulo Kulo	3	2,440	70	23
Tallo Kulo	7	1,979	111	32
Argali, Palpa				
Raj Kulo	18	1,909	41	12
Kanchi Kulo	5	608	54	22
Saili Kulo	4	1,208	81	24
Maili Kulo	11	827	52	11

Source: Adapted from Martin (1986).

Where labor and cash requirements for maintenance are high, as in Argali and Chherlung, assessment for payment by individual farmers is proportional to the share of the irrigation supply they are entitled to receive. Rules are generally explicit and written in the minutes of meetings where all the irrigators are invited to attend and participate in the decision-making process. Many systems excuse the elected system leaders from physical work but most include them for cash assessments. Rules for emergency repairs are almost universally based on the household rather than shares of water used for routine maintenance. The Raj Kulo System and others can also include nonirrigators — those that use the canal for domestic needs — in their call for labor when there is an extraordinary emergency, though this has not been necessary for a number of decades.

Use of a household basis for mobilizing labor for emergencies was a hotly debated issue in the Raj Kulo System's annual meeting in 1982. Small landowners complained that this practice was unfair because they were obliged to contribute as much as large landowners while receiving less benefit. Though the majority of members were small holders, they concluded that the practice was necessary to ensure sufficient labor during emergencies. While they decided to keep the rule, they modified the definition of an emergency. All repairs that could easily be completed without danger of water stress to crops were to be done on the same basis as routine maintenance, i.e., labor mobilization according to irrigation shares. An emergency is only to be declared if there is danger that crops will suffer. In a similar situation in Indonesia, Ambler (1989) reports that repairs that can be completed in two days are considered routine but if more than two days are required emergency mobilization of all irrigators is required.

Most systems observed in Nepal levy cash fines when members do not contribute labor as required. For routine maintenance, the fine is generally set at the local daily wage rate for labor. This allows persons with other income options to pay cash without penalty. Since most hill residents are subsistence fanners, some cash income to the organization is desirable. However, for emergency maintenance the penalty rate is generally increased to encourage more persons to attend work in order to complete repairs on time. Emergency maintenance often involves working in dangerous conditions — many systems report accidents that have resulted in deaths — and shirking is heavily penalized.

Mutual Canal Companies in the Poudre Valley, Colorado, USA

Irrigators were heavily involved with the construction of canals of the mutual companies. They contributed labor, equipment, and horses for hauling. The contribution of time by members as voluntary leaders continues today (Early 1990). However, most of the major companies have a specialized maintenance group and do not require labor from the irrigators for routine or emergency purposes. Usually, the company manager hires a maintenance foreman to oversee the work. There may be several persons on the maintenance crew all year and permanent employees who have operational duties during the irrigation season also join the maintenance crew during the off-season. Maintenance work continues throughout the year, including equipment repair in the workshop when weather conditions do not allow outdoor work.

Funds for improvements and major construction come either directly from assessments on water shares held by stockholders, from commercial bank loans, or as loans from state agencies. At the annual meeting of shareholders, the activities and expenditures of the past year are reviewed and a new budget is passed. The budget must include payment of capital and interest from earlier loans, projection of any new project, and the normal operation and maintenance expense. The shareholders must then decide, on a share basis, on the assessment that will be necessary to cover the budget. Voting is according to the shares of stock in the company owned by each member. Thus a farmer's operating costs, his water deliveries, and his representation in decision making are computed on the same basis — the shares of stock that he owns. A standard procedure in many of the companies is to require stockholders to pay about 40 percent of their annual assessment before water is delivered.

Other Systems

Dani and Siddiqi (1987) describe resource mobilization in the Aliabad Irrigation System located in the Hunza Valley of North Pakistan. Aliabad was established during the late nineteenth century when the Mir of Hunza authorized construction of an irrigation channel to lead water from the Ultor Glacier to the relatively flat area down the valley. In this arid environment, all agricultural crops, including fruit and fuel-wood trees, are entirely dependent on irrigation.

Each year, the canal is cleaned and repaired and every household in the village is required to participate in these activities. The canal is divided into portions that are assigned to subsections of the irrigation community for repair. Minor repairs are made by the persons assigned to patrol the canal but major problems are handled by mobilizing the user-group. Users downstream of the breach are required only to assist in the emergency repairs. As in the Chhattis Mauja case, Aliabad irrigators can pay cash for a labor exemption.

In Northern Thailand, Uraivan Tan-Kim-Yong (1983) reports details of resource mobilization for several people's irrigation systems. She emphasizes the value of local leadership as a resource in itself. Effective leadership makes productive use of labor and materials. She describes meetings of the system leaders shortly before annual repairs are to begin where the discussion is largely about planning the work strategy, and determining necessary labor, materials and equipment. Leaders are selected for their experience and knowledge in repairing the weir and canal, so their decisions are seldom questioned.

Uraivan Tan-Kim-Yong (1983) describes three resource mobilization principles that are followed in the Muang Mai Irrigation System. This system imgates about 560 ha of rice and in addition some orchard crops. The first method of mobilization is used to call a portion of the irrigation laborers for routine activities such as canal cleaning and repairing the diversion weir. Members have an obligation to contribute one person-day of labor for each *rai* (0.16 ha) of land they cultivate. While work under the first method of mobilization is underway, each family decides when they will contribute and the work force varies from 100 to more than 300 on a given day. Strict accounting of attendance is kept for this.

The second form of mobilization calls for the entire work force to be mobilized. This is usually only called during emergencies or if canal cleaning or weir repair needs to be completed quickly. Often, this is requested at short notice. Though all are expected to work, this is carried out on a voluntary basis and no record is kept of who participates. The third labor mobilization principle is only used when the government is providing assistance in improving an irrigation system. The irrigation leaders call for a portion of the members to work for pay as hired laborers under government supervision. If the improvement project is for the Muang Mai System, members of the system have first priority to be hired as laborers.

IMPLICATIONS FOR ASSISTING LOCALLY MANAGED SYSTEMS

In recent years, the national policy in many countries has made subsidized assistance available for irrigation development. Irrigators from locally managed systems have seized this opportunity to improve their systems. They solicit help for improving their irrigation works in order to increase the amount of water available, make delivery more reliable, and to decrease operating costs. In most cases, well-directed assistance can make an important contribution to the reliability and sustainability of locally managed systems. When forest products and other local materials that have traditionally been used for maintenance are no longer readily available, substitutes such as rock-filled wire cages are necessary. However, these cost more and require new skills. Irrigators often want to replace temporary structures with permanent ones. Frequently, this is justified but there are several factors in addition to cost that must be considered. Access to supplies and skilled labor for future maintenance are two concerns.

Coward and Martin (1986) caution that in providing assistance to locally managed systems, there has been a trend for shifting initial and recurring costs from the private sector to the public sector. Not only are locally managed systems provided with sophisticated structures for which they are required to pay little or nothing, but the burden of maintenance is also transferred to the agency. In too many cases, the members of the agency staff become the managers and hire fanners to perform maintenance activities that they have previously performed on their own. Coward and Martin argue that there is a need for public assistance but that it must be provided in a manner that reduces initial and continuing public costs while reinforcing the capacity of local groups to mobilize resources which they control.

Another reason for careful consideration of public assistance is the high variability in the capacity of locally managed systems to manage mobilization of their own resources and their ability to use assistance effectively. All the examples given above are of systems where resource mobilization is highly successful. All have developed the level of organization and leadership they needed and have established the necessary rules for effective maintenance. Assistance to the Chhattis Mauja or Thulo Kulo systems, for example, can be made directly through their established organizations.

Frequently, however, in systems where assistance is most needed the organizations are weak and have not been able to establish effective operating rules or the necessary control to enforce rules. In cases where the local organization is weak or fractured, a community organizing approach with honest brokers who have good social interaction skills have been successful in strengthening local organization (Reyes and Jopillo 1987; and Bruns 1992). In assistance to locally managed systems, the project needs to discern not only the type of physical improvement necessary but also the use of the assistance activity to strengthen the institutions that must, in the future, operate and maintain the improved facilities.

Each locally managed system has a unique history of resource mobilization. Assistance projects must review that history individually and utilize the experience that exists and assist in strengthening areas in which the irrigators are weak. An area of need found in Nepal in systems requiring improved management capacity was accounting. Enabling the establishment of simple recordkeeping systems open to public scrutiny was important in raising the level of trust which allowed leadership to emerge and rules to be enforced.

IMPLICATIONS FOR MANAGEMENT TRANSFER AND TURNOVER PROGRAMS

Coward and Martin (1986) examined resource mobilization by fanners in selected locally managed irrigation systems in Nepal, the Philippines, and India (Tamil Nadu). They found the level of resources contributed by fanners in these. representative systems to be significantly higher than the fees collected from fanners in most irrigation systems managed by government irrigation agencies in the same countries. Examples of successful resource mobilization by locally managed systems abound and have a common thread — there is proportional equivalence between resources provided and benefits derived from the system. Ostrom (1992) highlights this as one of eight design principles that characterize long-enduring, self-organized, irrigation institutions.

Ensuring that benefits reflect costs identifies another important feature observed in locally managed systems. Control of decisions affecting resource mobilization is placed as directly as possible with those who are to benefit from the action taken. This allows actions considered to be "fair" in terms that reflect local customs and cultural values. This does not imply that all locally derived practices are acceptable and that change should never be imposed as a condition for assistance. However, many local practices have a logic, with historical origins, that makes them acceptable even though they appear to an outsider to be inequitable. Rules imposed to bring "equality" in such a situation will likely be rejected.

The Tallo Kulo System in Chherlung provides an example of apparent inequality. When their own diversion was destroyed by a landslide, the Tallo Kulo irrigators, over a period of several years, negotiated an agreement to use the intake of a small system diverting water just upstream of their own. The terms of the agreement reflect prior water rights and include provision for all maintenance to be done by the Tallo Kulo fanners, Upon inspection, today, it appears that head-end fanners with a small irrigated area are exploiting the rest of the system while Tallo Kulo fanners consider this an acceptable, "fair" arrangement.

In the Chhattis Mauja System, irrigators in each branch canal participate directly in deciding the methods they want to use to operate and maintain the branch and field channels. They also decide directly how they will share responsibility for cash, labor, and material requests from the system and joint-system levels. The quantity, timing and nature of the expenditure for the Chhattis Mauja main canal are controlled indirectly by the irrigators through their election of officials whom they hold accountable for decisions and actions. Local control and accountability are important features that must be built into management transfer and turnover projects.

There is widespread mistrust that fees and materials collected for future use will not be available when needed. Locally managed systems overcome this problem by collecting funds and materials only at the time they are to be used. While this places a limit on the size of improvement projects that can be done at one time, it has been successful in spreading the work over a longer period of time to use resources as they become available. While not all structures can be designed for such an approach, most improvement work could be designed for a more labor-intensive approach and spread over a longer period to allow full user participation.

When resources are mobilized directly in response to needs and used locally, it allows results to be examined and evaluated directly by the contributors. Most irrigation fees collected by government agencies go to the central treasury and are redistributed to meet operation and maintenance costs. However, the timing and quantity of resources often do not coincide with payments made by irrigators or match local needs. When compounded by gross errors in fee assessment relative to delivered irrigation benefits, irrigators resist paying the fees.

For most irrigators involved in turnover and management transfer, the necessity to increase individual expenditure of labor, cash, materials and equipment, leadership, etc., for system operation and maintenance is a negative incentive. This must be overcome to achieve success. Fanners must he convinced that taking control of management and increasing individual cost will bring sufficient returns and are worthwhile. This will only come about as irrigators gain experience. Experience can be enhanced by reorienting assistance activities, especially the construction work, that accompany most management transfer and turnover projects. Instead of using contractors from outside the community supervised by the agency, control of construction should be shifted to the irrigators. This should include setting priorities. preparing and approving designs, and involving the fanners in the actual construction.

The irrigators should be assisted in doing as much of the improvement as possible themselves and in hiring their own contractor for what they cannot do. Completion of work ceremonies should confirm success in taking responsibility for local management rather than attempt to "hand over'' responsibility of work completed by the agency. When they have no voice in making decisions or controlling construction, irrigators resent being "handed over" structures they did not consider to be of high priority and which they observed being built with inferior quality. They take pride in their own accomplishments even while recognizing flaws in their own work.

CHAPTER 7

The Irrigation Organization

TIMELY AND UNIFORM application of the available irrigation supply to their fields is the goal irrigators desire to achieve. Acquiring water from a source, allocating the supply among eligible users, and then physically moving the water from the system intake to the field outlets are major tasks that make field application possible.

A multitude of other supporting activities must take place for sustained operation and maintenance of irrigation systems. The successful operation of most systems requires the systematic, unified effort of many persons. Roles must be defined, leadership appointed, decisions made, accounts kept, communication take place, and the results of activities monitored. The inevitable conflicts that arise must be managed and appropriate discipline applied when free riding (using water without taking responsibility for costs) or shirking takes place.

The organizational structure of locally managed systems with generally well-defined membership, specialized roles, and decentralized, representative decision making help sustain the outcome of the supporting activities enabling successful operation and maintenance. This chapter starts with examples of organizational structures that have emerged to support and control the implementation of tasks. Then it examines a number of critical supporting tasks before reviewing the reasons why irrigators of locally managed systems have found it so important to organize.

ORGANIZATIONAL STRUCTURE

System Membership

Membership in the Raj Kulo System in Argali is limited to cultivators of fields designated to grow rice irrigated by the system. This has been the tradition for at least the last several generations. Owners, tenant fanners, and absentee landlords of the Raj Kulo's rice fields can participate in making decisions and they constitute the system's legitimate authority. Membership has not been allowed to expand in recent years though there is land in the command area that could be converted to rice fields and owners of those fields are keen to become members. Fanners are concerned that their limited supply of irrigation water should not be overextended by adding new fields. Clear definition of the right to use irrigation and the associated ability to regulate membership are important characteristics of many locally managed irrigation systems (Yoder 1986).

In the larger Chhattis Audio System the situation is different. Individual fanner membership is only defined at the branch canal level which is the lowest level in the system. Identification of which fields or fanners are entitled to receive irrigation from their branch is a matter controlled by the village-level organization. Irrigators of the branch determine the irrigation shares they need and maintenance responsibility they can handle. Other branch canals are not concerned if extra fields are irrigated in a given branch as long as the irrigation share used is also the share of maintenance undertaken by irrigators from that branch.

At the system level, the main concern is to mobilize enough labor for canal desilting and emergency repair. When abranch canal increases its number of shares this provides a welcome addition to the labor force. Though the irrigation supply is limited during the dry season from March through May, the supply is generally adequate for rice in the entire command area during the rainy season (Yoder forthcoming).

In the Thambesi Kulo System in Nepal, membership is less clear. Any fanner needing irrigation can divert additional water from the stream provided there is water available and those with higher priority — according to their field location — are satisfied with their supply. It is up to the individual cultivators at the extremity of each rotation block to decide if it is feasible to irrigate with the supply that might reach their fields (Yoder 1986).

Membership in the Subak Gunung in Bali is based on investment in the construction of the canal (Pitana 1991). Membership in the Thulo Kulo in Chherlung, Nepal is also based on investment that includes the initial construction and subsequent improvements. Owning even the smallest fraction of a share entitles the shareholder to one vote in the assembly of irrigators in most hill systems in Nepal.

In Valencia in Spain the service area of each canal was determined in the Middle Ages and has apparently not changed since. To be a member of the canal's general assembly one must own land served by the canal. Renters do not have rights as members. Each member has one vote in the general assembly regardless of the size of landholding. In Alicante, also in Spain, voting members of the general assembly must own at least 1.8 ha of land with the right to use water from the Tibi Reservoir. Landowners with the right to use water but with less land do not have a direct voice in the organization (Maass and Anderson 1978).

Levels of Organization

Different levels of irrigation operation are established at points in a canal where water is divided into smaller branches. The lowest operational level is established when a canal serves fields. The main canal level conveys the irrigation supply from the source. If fields are irrigated directly from the main canal the system is operating at a single level. Small, fanner-built systems sometimes have only a single level. Most, however, have two or more levels.

The Thulo Kulo System in Cbherlung divides water from the main to seven branch canals which serve the fanners' fields. The first control structure after the diversions in the Chhattis Mauja main canal divides the Sorah and Chhattis Mauja's irrigation supply. Though the

Chhattis Mauja fanners still consider the entire canal from the diversion to the last of the 44 branch canals to be the main canal, in effect the dividing structure has added another level of operation.

Frequently, there are levels of decision making, resource mobilization, communication, and conflict management that constitute organizational levels parallel to the operational levels of the system. The officials elected by a joint assembly of the Sorah and Chhattis Mauja irrigators form a joint committee to operate and maintain the diversions and the first section of the main canal. The general assembly of farmers from all 44 branch canals elect the officials forming an executive committee to operate the main system level of the Chhattis Mauja. A similar committee operates the main system of the Sorah Mauja. Coinciding with the control of irrigation delivery from the main to branch canals. irrigators within each branch canal in the Chhattis Mauja System organize to operate and maintain the branch canal. Although there are additional divisions within most branch canals, where for part of the year smaller groups of farmers form rotation units, the Chhattis Mauja System is considered to have three organizational levels that coincide with operational levels. There is one additional level of organization in the Chhattis Mauja that is mentioned below.

Groupings that coincide with operational levels are the most common organizational structure for irrigation systems. These provide a mechanism for decentralized decision making and control of affairs that concern different groups of irrigators sharing a common distributary canal system. At the lowest organizational level they handle all tasks at their operational level. Generally, there is provision for representation of their interests in operation and maintenance in each organizational level above them. Though this structure is the norm, there are deviations.

The Thulo Kulo in Chherlung uses a general assembly that includes all persons owning an irrigation share to elect officials and to manage operation and maintenance of the main system. Irrigators from each of the seven branch canals arrange to clean their own branch and organize the rotation of irrigation delivery when necessary. However, there is no formal organization at the branch canal level. For the second organizational level, the Thulo Kulo departs from the norm. Instead of using the operational level, i.e., the branch canal operational level, to define their organizing group, they have formed seven maintenance groups where fanners are carefully selected to represent geographical areas of the system. Each group is responsible for maintaining and operating the system one day each week.

The Thulo Kulo irrigators have organized to respond in the best possible manner to their most demanding task maintenance of the diversion and main canal. By including members from all geographical parts of the system they overcome the problem of head enders not responding as diligently to maintenance needs as tail enders. Each day of the week, if the supply is less than desirable. the day's group is responsible for making minor improvements in the canal and diversion. Determination of adequate supply is monitored over the entire command area by members of the group responsible for that day.

In the Chhattis Mauja System there are area-level committees formed that include from three to ten branch canals. The two primary purposes of the area-level committees are to facilitate communication for mobilizing labor and to facilitate irrigation distribution. Rotational irrigation delivery at the branch canal level is at times directed by the area-level committees. There are four organizational levels in the system including the area-level committees, which are not based on an operational level.

Uphoff **(1986)** reports on the analysis of ***50*** irrigation case studies where levels of operation and organization were two of the variables examined. The study showed that there is a tendency for higher levels of organization to operate more formally though informal procedures and consensual norms also exist at the highest levels. The study also showed that direct participation of fanners in collective decision making is more feasible at lower levels. Engaging large numbers of fanners in deliberations is difficult and as a result. representatives from lower levels tend to function as part of the higher-level organizations in a form of indirect participation. Possibly the most important finding was that the difficulty in mobilizing labor increased at the higher levels. Although strong organizations, such as the Chhattis Mauja, can accomplish labor mobilization, in most systems cash — to pay for salaries, materials, and equipment — is more important than labor mobilization at higher levels in the system.

Roles

Locally managed irrigation systems demonstrate a wide variety of specialization. In some cases, farmers participate in virtually all aspects of management and any user may fill any role that exists. At the other end of the spectrum there is a high degree of specialization where certain persons are assigned to very specific tasks (Uphoff **1986).** Special roles evolve for a number of reasons. Dividing labor is more efficient under certain conditions. Some tasks require specialized skills and experience. In other cases irrigators want to avoid difficult or dangerous tasks.

The Thulo Kulo in Chherlung and Subak Gunung in Bali used local specialists in rock cutting and tunneling when constructing and improving the canals. Rock cutting skills used in constructing the Thulo Kulo, as in many other systems in the same region, evolved generations earlier in the small-scale mining industry that once flourished nearby. Irrigators felt comfortable negotiating contracts with skilled persons they hired from nearby villages and in most cases worked side-by-side with them. Members in one system in Gulmi District of Nepal, a system which repeatedly hired local tunnel diggers to improve their canal, eventually became confident of their own skills and now undertake tunneling work themselves (Yoder **1983).**

The Raj Kulo and Thulo Kulo, as do most locally managed systems, have leadership roles for directing operation and maintenance activities. These roles require leadership skills and a thorough knowledge of the rules being used, along with experience with operation and maintenance. Recordkeeping is another important role in both systems. In many locally managed systems, records are kept by the system leader. Another common role in Nepal is monitoring of the diversion and main canal. This is a way to make timely repairs before serious breaching occurs and to provide early detection of other problems that require immediate attention.

The richness of special roles for irrigation management developed around the world is remarkable. Lansing **(1987)** describes the role of temple priests in orchestrating regional irrigation management in the Petanu and OO river basins in Bali, Indonesia. They establish a cropping calendar that helps balance a large and delicate ecosystem. Within the watershed below the volcano where the supreme water temple for the watershed is located, new irrigation systems are only initiated after the approval and blessing of the High Priest.

SUPPORTING ACTIVITIES

Decision Making

The constitution of the Raj Kulo System calls for two meetings a year for conducting routine business. One is just before the rainy season to report on the work completed on canal maintenance and review the status of the accounts. Additional agenda often include modification of rules, such as the rate of fines for being absent from work. The second meeting takes place after the rice harvest to plan repairs and improvements necessary for the canal. Fines, for having missed work, are announced at the meeting and all members are instructed to pay the secretary. At times, business cannot be completed on the first day and the meeting continues for one or more days until all of the agenda has been covered.

Extra meetings are called whenever the. need arises. Usually, this relates to canal improvement activities or financial matters. In 1982, there was a series of intense daily meetings for nearly a week while the Raj Kulo irrigators tried to decide if they should allow irrigation to be allocated to additional fields to expand the system. The proposal was to sell water shares to individuals and invest the income as an endowment for the local high school. Since there was no agreement among the members, the matter was dropped when government support for the high school was announced.

Members are required to attend all regular meetings and must pay a fine equivalent to a day of maintenance labor if they are absent without justification. A quorum of at least 50 percent of the members is required for the organization to make binding decisions. A respected member is usually requested to chair meetings and a second person appointed to take minutes. A list of agenda items is prepared but issues which become necessary are added during discussion. Formal resolutions are drafted and presented by any individual concerned about a particular issue. After an issue is introduced the chairman allows open discussion. Often, time is given for members to break into informal groups for discussion as well. When the chairman feels there has been adequate discussion he asks all in agreement to approve by clapping. If the response is not overwhelming, more discussion is allowed. Only infrequently has there been a call for more formal voting. The secretary for the meeting records all resolutions in a register book. Before the close of the meeting the resolutions are read aloud and the book is passed for all members present to sign.

There is an annual election of canal officials who form a canal committee. If the chairman or secretary is found to be negligent of his duties he can be removed at any time by a two-thirds majority vote. The canal committee is empowered to formulate operating rules in the cases of natural calamity, when there is no possibility of a general meeting being held immediately. These rules must later be approved at a general meeting.

The Chhattis Mauja System also uses annual meetings to form and modify rules and elect officials. Irrigators vote indirectly at these meetings through the representatives appointed from each branch canal. The elected officials, together with one person appointed by each of the nine area-level committees, form an executive committee. The system chairman exercises a great deal of authority in system operation but defers to the full executive committee for all controversial decisions. There is sufficient criticism of maintenance expenditure at the general assembly meetings to cause the executive committee officials to exercise care in the use of their authority. Minutes of meetings give numerous examples where decisions were deferred to a general assembly meeting to avoid criticism. This allows full discussion since all irrigators are free to attend the meetings; however, only the appointed representatives vote.

In the examples reviewed, irrigators find it important to provide all members with an opportunity to meet regularly to discuss problems, approve plans, and determine policies. This allows sharing of information and makes it easier to hold leaders accountable. However, it is difficult for a large body to exercise responsibility. There are committees in addition to an assembly resulting in combining the strengths and compensating for the weaknesses of each mode of decision making.

Uphoff (1986) concluded his discussion of membership and decision making in an irrigation organization with the observation that the structure of decision making and the way members become involved in it are important design features. His studies of local rural organizations other than those that are irrigation-related, confirmed that the best structure is one with an assembly of all members who meet periodically, supplemented by one or more committees. possibly an executive committee, which can exercise more direct and active leadership.

Accounting

Accounting is a tool used for monitoring transactions of cash, labor, skills, and materials — the resources most frequently mobilized. Accounts do not necessarily need to be written but they must be acceptable to those who hold the charter of authority of the system and they are usually systematic. Practices in locally managed systems range from not keeping any accounts to detailed written records requiring verifiable signatures.

In the water-scarce, though easily maintained, Thambesi Kulo System in Nepal, there have never been cash transactions and the irrigators keep no written records. The irrigators meet just prior to planting the rainy season rice crop and work together to clean the canal. They note which families using irrigation are not participating in the work and send someone to visit their maize field to harvest a snack for those working. The group monitors compliance or noncompliance to the request for labor to clean the canal and extracts payment, without a written account, from families that miss work.

In the Thulo Kulo in Chherlung several types of written records are kept. These are recorded in a register book and kept either by the elected system leader or by the secretary.

The most important records are work attendance records. Distinction is made between requests for labor for emergency and routine maintenance since the charge for absenteeism is different. Detailed accounts are also kept of all financial transactions.

The water-powered grain mill that the Thulo Kulo canal organization owns and operates is accounted for separately. For the first six years of operation, the mill was managed directly by the organization. They rotated responsibility for attending the mill and recording income and expenses on a daily basis. Presently. the mill is managed by a single member who has a contract for its operation and pays a fixed annual fee to the canal organization. The contract is awarded through competitive bidding.

In the Thulo Kulo, the written records of individual water share ownership and the basis for irrigation allocation, have several minor discrepancies. These have come about because of sloppy recording of share transactions among members. The adjacent Tallo Kulo with a similar transferable shares arrangement adopted a formal registration of shares, including certificates for individual families that detail their irrigation shares. A water share transaction in the Tallo Kulo requires four separate record entries. Entries must be made on both the seller's and the buyer's certificates. In the system leader's register the shares transacted are deducted from the share account of the seller and added to the account of the buyer. The system leader and the buyer both sign the seller's certificate and the leader and seller sign the buyer's certificate to verify each change (Yoder 1983).

In the Raj Kulo of Palpa it is customary for the system members to call for an audit of the secretary's financial records. At the annual general meeting, a committee composed of irrigators is appointed and commissioned to examine all the records and verify the accuracy of the annual financial report. Care is exercised to select competent persons who represent different group interests among the members. In this way, the person keeping the accounts cannot easily form an alliance and defraud the group. The intent is to dispel any hint of wrongdoing by opening all accounts and records to public scrutiny.

Communication

Successful irrigation operation requires that farmers have information about the current status of the irrigation supply and that they are informed about future prospects. Effective system management requires a two-way flow of information among the operational staff and between the staff and irrigators. Communication is greatly simplified in locally managed systems because the staff are generally irrigators as well. However, the investment made by locally managed irrigation systems in setting up channels of communication highlights the importance irrigators place on an adequate flow of information.

In the 3,500-ha Chhattis Mauja System, 47 of the approximately 100 elected and hired persons holding functional roles in the four main levels of organization are designated as messengers (Yoder forthcoming). Messengers are responsible for the formal flow of information. Decisions at meetings that affect operation or maintenance are communicated via the messengers to the leaders of branch canals and again within branches by other part-time messengers. In some cases, the messenger is required to carry a register book to record the date and time of delivery along with the signature of the person receiving the message. This is a practice that developed after several unfortunate episodes of failed communication resulting in inconvenience to a great number of irrigators.

The three full-time messengers at the joint-system and system levels are provided with bicycles, bags to carry letters, register books, raincoats, and torchlights to he able to carry out their duties day or night. At the branch canal level the messenger's job usually includes informing all irrigators of a call for emergency repairs. A common practice is to ride a bicycle through the village at dusk as farmers arrive home from the fields shouting the message as they go. Most of the 44 branch canal messengers are employed only part of the year.

Farmers generally go to the village-level leader when they have a problem such as water scarcity, or a conflict with labor or irrigation delivery schedules, etc. They are also to contact the village-level leader when they have complaints about main system management. He in turn is then responsible for informing someone in the executive committee. Frequently. farmers bypass all middle levels and communicate their concerns directly to a member of the executive committee. Ultimately, the matter is brought to the attention of the chairman who calls either the manager or the messenger to verify the information and takes corrective action.

In hill systems in Nepal, various methods, from criers to bugle blowers, are used to communicate a call for assembly or emergency work on the irrigation system (Yoder 1986. Gurung 1989). However, most hill systems are small enough to allow easy communication without employing special messengers, provided the irrigators are resident near each other and their irrigated fields. Special arrangements are often made when fanners live on hilltops and their fields are some hours' walk in the valley below.

Staff employed to patrol the Thulo Kulo Canal in Chherlung are responsible for informing the system leader when there is need to take maintenance action. For farmers in the mutual companies of Colorado, the ditchrider is a channel of information flow about system status. While purchasing water in the market, farmers in Alicante depend on ditchriders for information on expected irrigation delivery.

Successful locally managed irrigation systems have recognized the need for effective communication. Though many of the Colorado mutual irrigation companies have few lined canals and use simple gates, their communication system is highly developed. Each irrigator is linked by telephone to his company office and to each other. Rapid, low-cost communication makes it easy to order and monitor irrigation delivery. In most developing countries, reliable telecommunication facilities are not available in rural areas and messages are communicated from person to person. Tea shops and other local gathering points provide important opportunities for sharing information. Individuals are often designated to carry messages and are given well-defined guidelines for accomplishing their missions.

Setting up a communication network is not likely to be the largest problem that will be encountered in management transfer and turnover projects. It may be more difficult to establish an atmosphere of openness for sharing information. Trust and goodwill must be developed for this.

Conflict Management

Conflicts are inevitable in irrigation and some conflicts are never resolved. However, if there is no way of managing minor as well as serious disagreements, disaster is likely to result. Irrigators of locally managed irrigation systems have managed conflict by using a variety of alternative institutions and procedures. When any one combination of methods has appeared to threaten local usage and control, they typically switch to another.

Most conflicts involve two parties. Any party or institution not involved in the substance of the conflict but that enters it in order to help resolve it is called a third party. Maass and Anderson (1978) provide a useful description of different modes of conflict management. A conflict can be resolved by avoidance by one of the parties, coercion by one of the parties, or negotiation involving both parties. Avoidance occurs when one party takes no action even though its interests were violated. The tactic is to cause the other party to make amends. By coercion one party imposes the outcome on the other, typically by a threat or the use of force until the other party concedes. In negotiation, both parties seek a mutually acceptable settlement without the intervention of a third party. Negotiation is more likely to succeed between allies than between adversaries.

All of these methods are used by locally managed systems. Ujjwal Pradhan (1988) describes a series of conflicts among three communities over access to irrigation in the Tallo Kulo in Chherlung. The initial conflict was between only two communities and negotiation resulted in an agreement between them that was acceptable. Afterward, a third community was successful in attracting funds from the government to assist in extending the canal to its fields. The canal extension was completed before an agreement was reached on allocating the irrigation supply among tbe three communities and the new irrigators insisted that the government should intervene and arbitrate the dispute. However, the first communities resisted. arguing that they had made considerable prior investment. They further insisted that since all parties would need to work together to manage the canal they should negotiate the agreement without third-party interference. It took numerous meetings over a five-year period for a settlement to be reached hut working arrangements are now satisfactory to all parties.

Ditchriders often discover infractions by fanners but use avoidance to manage the problem. In the Chherlung Thulo Kulo, for example, when the person hired to patrol the canal finds an illegal outlet as a poorly disguised crab hole, he may choose not to confront the farmer directly and instead close the hole in a manner that makes it clear that he recognized that water was being stolen. If the problem persists he may make a reference about an increasing problem with people stealing water to a group of farmers when the offender is present. Usually, without confrontation, he can get farmers to stop stealing water. However, if necessary, he can call on the full organization to take action and will then recount all the occasions when he had to plug the holes made by the farmer. The organization's rules state that a fine must be. paid and that if the problem continues, the sanction will increase with ultimate refusal by the organization to give the offender water. Graduated sanctions for illegally taking water are common in many systems (Ostrom 1992).

There are many examples where irrigators in systems with diversions in proximity on the same stream dispute the available supply. In many cases, coercion is used. The farmers of the lower system break the diversion of the upper system to release water downstream. Sometimes the problem persists year after year. In other cases, resolution is sought in courts of law with varying success in different countries. A case in Bali mentioned by Bellekens (1992) negotiated a settlement after a new concrete weir was constructed. They converted the flush gate into a proportional divider to deliver the agreed upon fraction of the river flow to the lower system.

Early (1990) reports that conflict management occurs at numerous levels within the mutual companies in Colorado. The ditchrider interfaces with the fanners and may intervene when two fanners have problems that relate to the supply they receive at the same time. In many cases, the ditcbrider prefers to err on the high side in water delivery to eliminate a perceived shortage rather than involve company management because it would indicate he has not managed to take care of a problem on his own. Discussion of water supply and allocation at the regular monthly meetings can head off or directly address many of the conflicts that would arise otherwise.

Institutions in locally managed systems evolve in response to conflicts. It is a slow process but one that generally reflects the cultural values and norms of the community. Programs for assisting locally managed systems should put greater effort into identifying and understanding these institutions and utilize the mechanism they provide for conflict management.

REASONS FOR IRRIGATORS TO ORGANIZE

Hill Systems in Nepal

Locally managed irrigation systems exhibit a diversity of organizational structures and varying degrees of formality of structure. Martin and Yoder (1988) examined eight systems in the hills of Nepal to determine the most likely cause or purpose for irrigators to organize themselves and the reason for variation in their organizational structure. The indicators they used to rank the level and formality of the organizational structure included: designated roles, meetings, number of different written records, and sanctions.

One hypothesis tested was that the management organization of systems with a scarce water supply would be more structured than that of systems in which the water supply was relatively abundant. Downing (1974) refers to this as the "excess scarcity hypothesis." The hypothesis is "scarce water equals more conflicts equals more social control.'' It was concluded that the established water rights, not the organizational structure, enabled irrigators to limit access to the irrigation supply. While the organizational structure enabled enforcement of the water rights, factors other than water scarcity were more influential in determining the nature of the structure in this hill environment.

Another hypothesis investigated was that the relationship of management intensity and formal organizational structure to the relative water supply is described by an inverted U-shaped function. At the extremes where water is either very scarce or extremely abundant.

increased management effort through a stronger organization is either unproductive or unnecessary. The maximum returns to, and thus incentives for. organized group activity are in cases of intermediate water supply levels. This type of community response function was suggested by Uphoff, Wickramasinghe and Wijayaratna (1981) in analyzing incentives for fanners' participation in irrigation system management. Results of the study in Nepal showed reasonable correlation in systems where water was scarce but not in those where water was abundant or at an intermediate level.

Martin and Yoder also examined the argument that systems irrigating only a small part of the command area with a relatively high irrigation supply would need to have a strong organization to be able to restrict access to the water. A high degree of formal organizational structure would be necessary to keep irrigators from expanding the area they irrigate or from selling water to their neighbors. This hypothesis was also rejected. Strong institutions of water rights, open access for irrigation except for the rice season, and the fact that the relatively abundant supply is only a recent phenomenon were reasons given. The well-developed organizational structure enabled the formation and implementation of access rules but as noted above, other factors tended to be more important in shaping the nature of the organizational structure in this particular environment.

Size, especially the number of members, would Seem to be an important variable explaining the level of organizational structure. Organizational theory suggests that, in general, an organization with a large number of members will be more formally structured than one with fewer members. While this may contribute to the level of formal organizational structure, it did not explain much of the variation in formality observed among the systems studied.

Implicit in the hypothesis that the degree of organizational structure is inversely correlated with the water supply is the assumption that the organization is structured primarily for distribution of water. This may be true of fanner organizations within large irrigation systems which are jointly managed by an irrigation agency and fanner organizations. The agency may carry out all activities, including maintenance, required to deliver water to a certain level within the system where it becomes the responsibility of the water users' organization to distribute it among the fields.

In locally managed surface systems diverting water from streams, activities other than irrigation distribution often determine the organizational structure. Martin and Yoder (1988) concluded that mobilization of labor for maintenance, a dominant activity in the hill environment of Nepal, was most influential. The greater the amount of labor mobilized to maintain the headworks and main canal to capture and convey water to the command area, the more highly structured and formal was the organization. This was found to be true irrespective of the amount of irrigation supply available. In the environment of streams with high floods in the rainy season and unstable hill slopes, organization to maintain the system for water acquisition — getting the water to the command area — is more important than distribution of the irrigation supply among the users. As mentioned below, strong organization for irrigation acquisition also has a positive influence on distribution.

The amounts of labor per hectare and labor per member were examined as possible scale variables to correlate with the organizational structure. Neither predicted the level of formal organizational structure nor the total labor requirement in the eight sample systems, although both gave better rankings than the other variables tested (Martin and Yoder 1988).

Analysis of Resource Mobilization and Organizational Structure

If members of an irrigation organization must invest a significant amount of labor, and sometimes cash, in order to acquire water, they want to be sure that each one who benefits contributes his fair share. Hence, organizations that mobilize a large amount of resources tend to keep written attendance records, enforce sanctions for missing work, and audit accounts. The organizations' rules and minutes of meetings tend to focus on the issues surrounding the mobilization of resources, e.g., how much labor and cash members must contribute, the tines for not attending to work, and circumstances under which one is excused from work. The main functions of the elected officers are to organize and supervise the maintenance work on the system, keep accurate records of members' contributions, and enforce sanctions for failing to contribute as required. This is the case in the Raj Kulo in Argali and the Thulo Kulo of Chherlung where the canals are from two to six kilometers long, requiring many man-days of labor for maintenance prior to and during the important rice growing period in the monsoon season.

On the other hand, the Thambesi Kulo has a main canal that is less than 200 meters long and can be cleaned in one day with only a few members working. This has resulted in an organization that has little concern with keeping an accurate record of members' contributions or for enforcing proportional contribution by all members. The Thambesi Kulo organization does not keep records of members' attendance at work, imposes minimal sanctions for being absent, maintains no written rules nor minutes of meetings, and keeps no accounts. The organization has no elected officers or designated functionaries.

The irrigation organizations in the Raj Kulo and the Thulo Kulo have, in recent years, assessed cash contributions per irrigation share to make improvements to their intakes and main canals. Keeping account of the contributions and expenditures also requires a more formal organizational structure. The Thambesi Kulo organization has never raised any cash from its members.

System Performance

There is a relationship between the need to mobilize resources to acquire water and the effectiveness of the distribution of water. Lewis (1971) compared two systems in the hills of Ilocos Norte in the Philippines. One required a great deal of maintenance (40 to 60 work days per member annually). Fines for absence from work were enforced and repeat offenders were denied water. In the year Lewis observed the system, there were few absences, all fines were paid, and the members were satisfied that they were receiving the water to which they were entitled. In the other system, much less maintenance labor was required, some members regularly failed to appear for contribution of labor, and fines against them were often impossible to collect (Lewis 1971). Members in the tail area of this system complained of inequitable distribution; several who often did not receive irrigation dropped out of the organization.

Similar results were seen in the systems studied in Nepal. In systems requiring mobilization of large amounts of labor for maintenance. the distribution of water coincided more with the irrigation allocation than in systems requiring little effort in water acquisition. In the Thulo Kulo and Raj Kulo, irrigation distribution matched the irrigation allocation remarkably well and waterstress whenitoccurredwasnotattributed to inappropriate irrigation delivery (Yoder 1986).

The organizations in Argali and Chherlung required the resources of all the members to acquire the water. The fanners at the head of the system could not take all the water and deny the tail-end farmers their share because they were dependent on the assistance of all fanners in maintaining the system. This interdependence among the fanners in systems requiring a high level of resource mobilization is a key factor affecting the equitable and efficient operation of the system. Where few resources are needed to keep the irrigation supply flowing, the farmers at the head end can do the work by themselves and are less concerned with keeping the tail-end farmers satisfied.

Effective organization is more difficult to maintain in a system where irrigation distribution rather than water acquisition is the primary activity. Fanners in a system all face the same incentives for water acquisition but not for distribution. When water is scarce the fanners at the head end have an incentive to break the rules and take more than their allotted share. However, if they are dependent on the tail-end farmers for assistance with irrigation acquisition, it is easier for the organization to enforce equitable irrigation distribution.

IMPLICATIONS FOR ASSISTING LOCALLY MANAGED SYSTEMS

In the preceding chapters it was proposed that assistance to locally managed systems should be channeled through their existing organizations. If an organization is strong there are few obstacles. If it is weak it was proposed that the assistance activity should be used to strengthen the institutions essential for continued operation and maintenance. This implies two assumptions: first that there is a way to determine the viability of the organization and second that methods exist for enabling weak organizations to take increased responsibility.

Identifying the Existing Rules and Organizational Structure

Evaluation of an irrigation organization is complicated by the enormous diversity possible in the formulation of institutions. As seen in the examples from Valencia and Alicante, in two irrigation communities in Eastern Spain in a similar physical setting and with the same sociocultural experience, the institutions and organizational framework are very different. A useful approach for determining how irrigators organize and what rules they use to conduct their business is to first determine the irrigation-related activities carried out each season of the year and then to formulate questions that elicit how the irrigators accomplish those activities.

Reyes and Borlagdan (1981) prepared an interview guide for their work with communal irrigation systems in the Philippines. It provides a good outline of many basic questions regarding the operation of irrigation systems. Rapid rural appraisal procedures have been used in many countries to explore organizational issues. Yoder and Martin (1985) prepared a question guide for investigating irrigation systems in Nepal that have been used for rapid appraisal of systems. A more recent innovation, used primarily to explore rain-fed agriculture but which could be adapted for use in irrigation projects, is participatory rural appraisal (PRA). PRA is a process of enabling a group, like an irrigator's organization, to provide information on a selected topic (Chambers 1992). The topic could be the operation of the group's irrigation system. Villagers are encouraged to use any media that are comfortable — usually locally available items such as grain, stones, baskets, the entire floor of a court yard, etc., rather than paper and pencil — to create models, illustrated lists, or any other aids that help them communicate the information about the topic.

Strengthening Weak Organizations

Change in an organization. in the rules used and how business is done, must usually come from within to be sustainable. An assistance project can help a group identify its underlying problems and make suggestions for overcoming them but the will to implement change must come from the group. Incentives must be sufficient to attract participation of all involved. These can be social, economic, or simply convenience but the reason for change must provide enough benefit to make it worth the effort and cost.

Farmer-to-farmer training visits have proven beneficial in initiating changes in organization and operational rules (N. Pradhan and Yoder 1989). Groups of farmers from a system receiving improvements were taken on a tour to other locally managed irrigation systems. Farmers from the systems being visited were proud to show visitors their system and explain how it was operated and maintained. A facilitator asked questions when necessary to encourage an exchange that also identified the rules being used and how sanctions were applied.

By visiting a number of irrigation systems that had used different approaches to overcome problems similar to those faced by the visitors in their own system. discussion was stimulated about available options. Farmers exchanging information with other farmers is an effective training mode because of their similar backgrounds and interests. The necessary level of trust can be reached quickly and extended discussions take place that reveal weaknesses as well as strengths of the organizations visited.

IMPLICATIONS FOR MANAGEMENT TRANSFER AND TURNOVER

Membership is important in most locally managed systems because it identities the legitimate body of decision makers and its source of authority. In the Raj Kulo of Nepal this was evident in an irrigation meeting which took place the day following a local government election. Opponents in the bitterly contested election, who were both members of the system, stated publicly that the issues of the irrigation meeting had nothing to do with politics. The authority for the decisions they were about to make regarding irrigation came from those assembled, not from the government. Since the operation of the irrigation system concerned all of their livelihoods they were putting aside politics and working together to maintain the system (Yoder 1983).

The Thambesi Kulo, without a well-defined membership, is in an interesting and revealing category of locally managed systems. Acquiring and delivering irrigation is easy and controlled by those with fields in the most advantageous geographical location. Decisions are not made collectively so there is little need for a structure or rules for decision making. This is analogous to the lower levels of most agency-managed systems where the agency supplies irrigation to the headgate of the unit. Farmers with fields near the headgate have first access to the irrigation supply. There is often little interdependence among the farmers receiving water from the common headgate. They do not need to work together to acquire water from the source or to maintain the main canal. Fanners in disadvantaged locations relative to the headgate have little means for influencing irrigation distribution. Membership and organization for decision making have less meaning in such a situation.

This has serious implications for management transfer efforts where the agency continues to maintain the acquisition and main canal facilities. While this certainly does not mean that all management transfer projects will fail to stimulate stronger user organization, it does mean that a major unifying factor found in locally managed systems is lacking and something else must be substituted in its place.

Locally managed systems that are given assistance and systems that are turned over must continue maintenance and water acquisition activities. An organizational structure can be built around the needs of these activities. Ways must be explored for giving irrigators responsibility for activities that require them to depend on each other in systems where management transfer takes place. As noted by Coward and Uphoff (1986) this is not likely to happen unless farmers are also given a voice in activities of acquiring, allocating, and distributing the irrigation supply.

CHAPTER 8

Summary and Implications for Assistance, Turnover and Management Transfer Programs

IRRIGATORS FACE A set of physical conditions that bring uncertainty to their task of delivering water to individual fields in a timely fashion. Unregulated stream flows are highly variable both seasonally and from year to year. The simple fact that water flows makes its status, at a particular location and paint in time, dependent on what has happened upstream — in the watershed, along the canal, or elsewhere in the groundwater basin. Uncertainty brings a level of insecurity that influences relations among a group of irrigators.

A powerful conclusion that emerges from the examination of selected locally managed irrigation systems is the extent to which irrigators have controlled their own destiny as farmers. They have accomplished this in the face of uncertainty and insecurity. Local control bas enabled irrigators to act collectively in establishing rules and procedures for acquiring and distributing a limited and highly variable irrigation supply among themselves. The institutions they created have been tailored by trial and error to meet their needs. In the competition for use of the water resources, they have successfully managed conflicts arising within and among groups. They have been successful in paying for operation and maintenance that accompany independence in system governance. They have sustained, even improved, systems by supplying labor, materials, cash and knowledge when needed.

However, descriptions of Locally managed systems available in the literature are generally not representative of all systems in an area. They have been selected for study because of features that stand out — a perennial water supply, successful maintenance activities, or a unique irrigation distribution procedure — rather than by random sampling of all systems. Studies tend to choose systems that represent above-average performance of the characteristics being investigated. This is valuable in identifying viable management options and models to emulate, and helps establish the upper boundary of local management potential but should not be construed as the norm.

For many different reasons — loss of effective leadership, change in economic environment, or occurrence of natural calamities — some systems have lost the ability to sustain their performance. Others are still struggling to achieve successful and sustained operation. These are the ones that assistance programs need to identify. The final section of this chapter discusses possible strategies for identifying and supporting systems that can benefit most from assistance. The following section reviews some of the characteristics that emerge from the study of successful locally managed systems.

CHARACTERISTICS OF SUCCESSFUL LOCALLY MANAGED SYSTEMS

If longevity is a reliable indicator of success, many locally managed systems are highly successful. A more precise measure of system performance would be to compare the irrigation delivery with the irrigator's expectations as identified in their allocation rules. Few studies have made systematic irrigation delivery measurements in locally managed systems. Most studies dwell on and give high marks to the performance of process measures. These are measures relating to the system's internal operations and procedures. They deal with irrigation allocation, resource mobilization, and the many supporting activities that transform the inputs of water, management, labor, and physical facilities, into the system's many intermediate and final outputs (Small and Svendsen 1992). The following paragraphs summarize some of the observations and impressions made from examining how locally managed systems accomplish their many tasks. Local control is the dominant influence in the success of these activities.

Interrelationship between Construction and Management

An important consequence of irrigators being responsible for the construction and improvement process is the contribution of this exercise to building institutions. In the process of meeting to discuss and plan the construction, irrigators also define the structure of their organization, learn to make decisions as a group, define roles, handle conflicts, and establish procedures for keeping records. Leaders who demonstrate that they are capable and trustworthy during construction are often assigned leadership positions in managing the operation and maintenance activities. Possibly most important, rules are developed for mobilizing contributions from members. The key element to the success in continuing to mobilize labor and other resources for maintenance is the perception that responsibility for the contributions is divided equitably among all who share the benefits of the system.

Ownership and Membership

Ownership of the hydraulic and physical property develops for those who construct the system and subsequently maintain it. This gives them a socially recognized right to receive water from the system and a recognized responsibility to help with its operation and maintenance. After construction of both the Subak Gunung and Tulo Kulo systems irrigation shares were allocated only to the persons who had contributed to their construction. Now both systems allow others to become members by purchasing shares, thus compensating directly and indirectly those who invested labor for constructing the system.

System membership is generally defined by the irrigation allocation rules. Where the allocation is proportional sharing, irrespective of the basis for sharing, it generally defines system membership. Where the allocation is based on rules relating to location of fields or by priority of who first accessed the source, membership is less defined. Membership determines who has the authority to create and confirm the rules and procedures that shape the system.

Security of the Irrigation Supply

The limits to which irrigation can be delivered are generally spelled out by the irrigation allocation rules. Irrigation allocation by shares requires membership rules or other criteria to limit growth and provide security of access to the water. When location of land or "first in time" allocation rules are used, system expansion is automatically limited. This gives security to those who have the first right to use water. Those who join the system later only receive water after those with the first rights take all they need.

The right to continue using the source of water, as well as the knowledge that the system cannot be expanded without consideration for irrigation adequacy, are important factors in determining future participation and investment in the system. The Thulo Kulo members agreed to allow a 25 percent increase in the area irrigated after determining that the income from the sale of shares was sufficient to increase the canal capacity, thus ensuring adequate delivery. The Siran Tar Kulo example illustrates the difficulty when water rights are not secure. Many individuals who had contributed to the original construction of the canal did not receive irrigation and refused to participate in further investment in the system.

Strong Organization

Organizational structures are determined by many factors. In Nepal, it was found that the greater the amount of labor necessary to maintain the system the more highly structured and formal was the organization. In Valencia, a strong irrigation organization is required to distribute irrigation during periods of severe drought when the allocation is shifted from proportional shares according to landownership to a crop-priority basis. In Alicante, the water market automatically adjusts for drought conditions but a strong organization is necessary for operating the water market.

Having full authority vested with the system members makes it possible for the organization to modify its rules and adapt its procedures to changing conditions. This gives them the opportunity to test specific solutions to problems and tailor their institutions, over time, to best meet their needs in ways that match local conditions and resources.

Representation

A common characteristic of almost all locally managed systems is that virtually all imgators have a voice in making decisions. In smaller systems, decisions are often made in a general meeting of all members. In the Raj Kulo, a general meeting is treated like a day of routine maintenance and all members are required to attend. A fine must be paid by all who are absent. The attendance rule ensures that decisions have strong member support thus reducing complaints and conflict. Larger systems use representatives to vote on important issues. The lowest organizational levels in the Chhattis Mauja collectively appoint their representatives to the general assembly meeting. Only the appointed representatives vote for the officers of the executive committee.

Monitoring

Irrigators in most locally managed irrigation systems know exactly how much of the available irrigation supply they are to receive and the timing of the expected delivery if it is not on a continuous basis. The ability of individual farmers to monitor the compliance of irrigation delivery to their entitlement is an important factor in the success of these systems. At the field canal level irrigators monitor the distribution individually. At higher levels they may take turns checking that the planned irrigation supply is being delivered from the main canal through the network into the field channel. Fixed pmportional dividing structures are preferred by many irrigators when conditions are favorable for their use because it is easy to monitor irrigation delivery in such a network.

Monitoring resource contributions of each member is done in most systems. Attendance records of mandatory work sessions and accounts of cash transactions are generally the responsibility of appointed or elected officials. However, these records are generally open for public inspection at all times. Equitable sharing of the operation and maintenance cost, as well as the benefits reduces conflicts and raises the level of trust and cooperation.

Resource Mobilization

An outstanding characteristic of successful locally managed systems is the ability to contribute labor and other essential resources to keep systems maintained and operating. The emphasis is on making structures functional and durable but at the lowest possible cost. Coward and Martin (1986) reported that the value of resources mobilized in a number of locally managed systems in Nepal, the Philippines, and India (Tamil Nadu) were all substantially higher than the fees collected from farmers in most irrigation systems managed by government irrigation agencies in the same countries.

Communication

There is generally an open atmosphere for sharing information in locally managed systems. This is essential for the level of cooperation necessary for effective system operation and maintenance. Most meetings are open to all members, not only to receive input but also to facilitate communication. In larger systems and where members do not all live in proximity, persons are often hired as messengers to deliver instructions reliably and on time. The temporary nature of structures and often difficult terrain make many systems vulnerable to failure. Effective monitoring and rapid communication enable timely response to emergencies.

Accountability

Most employees and appointed officials of locally managed systems are also irrigators and long-term members of the community. There is social pressure upon them to do their work honestly. Terms of officials are kept short, generally not more than one or two years, so that persons who do not perform well can be removed at the end of their normal term without being disgraced. In many systems, officials are reappointed many times if their work is satisfactory. Most systems can terminate officials immediately for fraudulent behavior. Local control over the appointment of officials makes it easy to hold them accountable for their actions.

Accounts and Records

Many small systems do not keep written accounts. If shirking and free riding take place all members are generally aware of them and can take collective action. In larger systems, especially where considerable resources are used for maintenance each year, written accounts are kept. Labor attendance and financial accounts are the most common records kept. The accounts are typically checked by an audit committee appointed by the members and reports are given to the members at meetings. Having the records and accounts available for inspection by all members is an important characteristic that builds trust.

Conflict and Sanctions

Successful locally managed systems generally have rules to control shirking and free riding. If water is taken out of turn or from an illegal outlet, graduated sanctions are applied that take into account the extent and damage caused by the infraction. Verbal warnings at meetings called specifically to deal with an infraction and other forms of public disclosure put strong social pressure on members living in proximity to each other. The nature of the conflict determines options for managing it. Most conflicts among members are handled internally. However, it is not unusual for authorities from the local government to be asked to intervene in disputes among systems.

IMPLICATIONS AND STRATEGIES FOR TURNOVER AND MANAGEMENT TRANSFER

Understanding the characteristics of successful systems is important in outlining what systems that are turned over to the local management will need to look like. While the same characteristics are important for agency systems where management transfer is to take place, the form they take may be somewhat different than in locally managed systems.

Turnover Programs

Farmer-to-farmer training visits are an effective method of introducing irrigators to the new tasks that they will need to perform when the system is turned over to them. During these visits fanners are often surprised at the amount of work required for effective maintenance but excited about the power they sense in a well-organized group (N. Pradhan 1987). Observing differences in agricultural practices among systems is another important part of the training visits. The desire to increase production to the level they had witnessed in systems they visited was identified as one of the major incentives for changing management practices in systems assisted in Nepal (WECS/IIMI 1990).

Reviewing and establishing irrigation allocation rules should be a central issue in the initial discussion of turnover and should involve all potential irrigators. Different options should be discussed and if possible observed in other systems. The implication of different rules must be clear to all irrigators. If the allocation rules give secure access to irrigation they will provide an incentive for increased cooperation. The rules will define the boundaries of the irrigated area and membership in the organization. Depending on the type of rules chosen and the water resources available, some farmers may need to be excluded from membership. Setting broad guidelines and allowing the irrigators themselves to come to a decision on allocation will improve the acceptability of the rules.

Formulating a major rule like irrigation allocation forces the irrigators to deal with the process of making rules. They will need to decide how to discuss issues, prepare a motion, choose a voting method, and how to deal with other seemingly minor but essential procedures. Discussing and setting procedures for all the irrigation tasks is a long intense process. Using trained irrigation organizers to facilitate this process is essential,

Turnover as a process of creating a new locally managed system will benefit from using construction activities as an exercise to build institutions. If the irrigators construct the improvements that are a part of the turnover process it will help create group identity. Requiring some level of contribution from the irrigators will increase their ownership in the physical and hydraulic property. The basis for contribution needs to be decided and a mechanism for monitoring compliance established. Consequences for shirking responsibility and a means of enforcement all need to be put into place. Establishing effective patterns of group interaction during the construction/improvement phase will make enforcement during operation and maintenance easier. If the construction process can establish interdependence among irrigators from all parts of the system, it will contribute to establishing a need for equity in system operation. With appropriate support to facilitate the process and the provision of essential incentives for the irrigators, turnover can be a viable way to create new locally managed systems.

Management Transfer Programs

Irrigation management transfer as a method for improving system management has a number of positive options. Because the management interface between the agency and the irrigators is shifted, both the agency staff and the irrigators must modify at least some of their practices. This provides an opportunity for change. Establishment of a new organizational structure and modification of the charter of authority are two changes that should have high priority.

In agency-managed systems, the charter of authority in most cases is entirely with the agency. Decisions regarding irrigation allocation or resource mobilization are generally taken by the agency and dictated to the irrigators. As a strategy to increase irrigator participation in system management, management transfer should transfer some authority to the irrigators and give them a voice in all the affairs of the system. A shared charter of authority with the agency holding veto power would be one possibility.

In larger locally managed irrigation systems, there are usually multitiered organizations with an executive committee at the top level. Officials at all levels are accountable to the irrigators either through direct election or by representation. A system involved in management transfer could set up a similar organization. A hierarchical structure or a federation of organizations could be established with an executive committee at the main canal level. The executive committee could be composed of representatives from all branch canal organizations and from the agency.

Such a structure would establish a mechanism for information sharing, often lacking in agency-managed systems. Through the representative members there would be an effective channel for communication with all irrigators. Opening the system's accounts to the executive committee would allow the irrigators to perform a monitoring role in the resource mobilization activity. Sharing authority to accompany their increased responsibility will be an incentive for irrigators to actively participate in system management. A voice in making decisions in operating and maintaining the main system is an incentive generally lacking in agency-managed systems.

STRATEGIES FOR IMPROVING LOCALLY MANAGED SYSTEMS

Examination of locally managed imgation systems in the field is an interesting exercise. Differences between systems that function well and those that are having difficulty in delivering water are not always readily apparent. If it is a season when water is not available they may look identical — neglected and rundown. The structures may be of a similar design and built from the same materials, yet during at least part of the year one may be much more effective than the other in delivering irrigation. Differences in the less-visible components of the system, the rules and procedures, are possibly the only reason for differences in performance.

Knowledge about the characteristics of successful locally managed systems is useful in the process of identifying possible reasons for differences in performance among systems. First, it helps in formulating appropriate questions to probe how different essential tasks, such as resource mobilization or irrigation allocation, are accomplished. Second, this knowledge is necessary to make a comparative analysis. If distinctions can be made among systems related to their level of performance, assistance can be targeted more effectively

Assistance Programs

For the development of a responsible national policy and for the operation of effective support services at the field level, information is needed about systems operating at all levels of performance. A starting point is to catalog all the systems in a region by identifying their location and size. Included should be information that indicates the performance of each system relative to its available land and water resources. This makes it possible to analyze the need and potential benefits from assistance.

Diagnosing the reason as to why assistance is needed requires a higher level of information. This must probe beyond the symptoms of broken structures to determine the underlying problems. Poor organization, ineffective rules and procedures, conflict among the irrigators, or conflict with competitors for the same source of water are a few of the possible problems. A successful assistance plan must enable the irrigators to address these problems as well as to improve deficient physical works.

The level of assistance is another factor that should be carefully considered. While the construction component of assistance is valuable for strengthening local management, massive improvements are counterproductive if they eliminate interdependence that routine and emergency maintenance needs demand among the irrigators. Minor improvements can be cost-effective and can stimulate the formation of stronger institutions (WECS/IIMI 1990).

Inventory of all systems. The project that assisted the Siran Tar Kulo System in Nepal identified systems by conducting an inventory of the entire project area (WECS/IIMI 1990). Rivers and streams were systematically investigated to discover all diversion structures. Irrigators from each system accompanied the inventory team to the source and estimated seasonal water availability in excess of what was already diverted. Together they walked along the main canal and discussed operation and maintenance problems. This provided some information about operating rules and procedures for maintenance. The irrigators also estimated the area irrigated and explained the limitations to expanding it.

The inventory identified several hundred systems in the 200 km^2 project area. Over one hundred were in the range of size and canal length that the project considered candidates for assistance. The final selection of systems to be given assistance was based on the potential for expanding the irrigated area. This intensive but simple field exercise enabled the examination of multiple criteria for ranking prospective systems for assistance.

With limited resources for assisting systems, a procedure such as the inventory is useful both to develop an appropriate plan at the national level and to select systems eligible for assistance at the project level. Since the field work for collecting the information is labor-intensive, it must be designed carefully to be manageable. Only data relating to the criteria considered important for policy and field-level decision making should be collected for all systems. For determining the type of assistance and implementation approach, much more detailed information is necessary.

Investigation of the need for institutional change. Most irrigation agencies have well-defined procedures for developing new irrigation systems in locations where irrigation did not previously exist. Without existing irrigation institutions to worry about, the procedures are purely technical. As agency emphasis shifts to providing assistance and support services to existing systems some of the procedures need to be revised. One is the method of collecting and analyzing information about existing institutions to determine if they need to be modified.

A useful starting premise is that if collective action for irrigation is taking place, some level of organization exists. Each organization must have some level of rules and procedures for operating and maintaining its system. These may be rudimentary and never discussed or they may be highly developed as the examples in preceding chapters have indicated. In addition to evaluating the physical works of the system in determining assistance needs, the management side must be examined to identify changes that may be necessary. A number of agencies and organizations have established methods for doing this.

The National Irrigation Administration (NIA) in the Philippines was one of the first agencies to accommodate participation of irrigators by making major adjustments in its implementation procedures for assisting locally managed imgation systems. The first step in their assistance procedure involves a technical and economic assessment by NIA technical staff. If this shows that a system is a feasible candidate for assistance, socio-organizational data are collected by an irrigation organizer and a socio-technical profile of the system is prepared. Socio-organizational information is collected by using a question guide. The guide was initially developed by researchers for the purpose of preparing irrigation case studies. It was modified to use as a tool for gaining an understanding about the irrigators' organization and the rules used to accomplish operation and maintenance (Reyes 1987).

The Aga Khan Rural Support Programme in northern Pakistan is another example where the approach is to strengthen existing local institutions for irrigation development. This is done by holding a series of dialogues with a majority of village residents in each village participating in an irrigation system. This allows the irrigators to define their goals and discuss how they have established "fair" patterns for sharing responsibility and benefits of irrigation. Through this process of discussion, equity rules can be challenged by villagers and the underlying, often historical, reasons for water rights and resource mobilization rules can be confirmed (Hussein et al. 1986).

Normally in project preparation, data are collected in the field and taken to the office for analysis. Decisions are then made without participation of the people who supplied the data and without the additional input they could give to fill missing gaps in information. Participatory rural appraisal (PRA) is a different approach for generating information about existing rules and relationships and could be used in determining assistance needs in locally managed systems. **PRA** requires that members of the assistance team go to the irrigators as students and facilitators rather than as collectors of data. The goal of the **PRA** approach is to enable the irrigators to do their own investigation, cany out the analysis, share their knowledge through presentations, and to own the outcome.

Visual sharing is an important part of the **PRA** approach. To learn how to share their information, something familiar is used, such as the weaving of a rice-straw mat. The irrigators are encouraged to demonstrate their skills and knowledge and explain the detail of each step in weaving the mat. Eventually, they are asked to do the same for each task that they perform with the irrigation system. Another medium is to have irrigators prepare a skit to dramatize an event such as irrigation delivery and the conflict involved. These activities allow sharing of rules and relationships and feelings that are normally suppressed or missed by formal interviews. Enabling irrigators to share their spacial relationships by drawing a map or by building a scale model of their imgation system is another important tool of **PRA**. Maps can be drawn on the ground and illustrated with sticks, stones, cigarette packages, seeds, etc. Elaborate models can be constructed using mounds of earth dug and shaped to approximate the topography. Groups and individuals add to and modify the model, debating what to include, checking and correcting each other, and determining what is most important. The information is visible and public, and is added to, owned and verified by the imgators (Chambers 1992).

Construction* and institution *building. Examples from locally managed systems indicate that building effective institutions is a slow iterative process. While outside agents such as imgation organizers can facilitate the process, they cannot provide a blueprint that is likely to be adopted. Groups choose remarkably different rules and procedures to accomplish the same task even when they face the same local conditions. A self-governing group that is part of the process of developing its rules is more likely to have its members abide by them.

Activities that require a group to grapple with making collective decisions and canying out actions that require disciplined behavior are important in the process of institution building. Construction activities provide this experience and are ideal because they mirror many of the actions required for successful system maintenance. In improving locally managed systems, construction activities should be used as a mechanism for building institutions. Instead of bringing in agency staff or a contractor hired by the agency to do the construction, the irrigators should be required to either do the work themselves or hire a contractor if technical expertise beyond their capacity is required. The irrigators will remain the primary actors in their system if the agency staff concentrates on facilitating rather than executing the construction activities.

Based on the detailed information from investigating the institutional needs, a strategy must be planned for enabling the irrigators to proceed with construction. The diversity in degree of institutional development among locally managed systems requires that the strategy be tailored to each system. In a case such as the Raj Kulo or Subak Gunung. where strong organizations exist that already have well-enforced rules for labor mobilization, accounting, etc., very little input may be necessary. Assuming that no changes in procedures are mandated by the project, it may be sufficient to review the project's conditions of quality control and accounting to check that all members agree to the improvement activity under those conditions.

However, if the improvement project carries with it a stipulation that the membership rules be changed to allow the system to expand, additional agreement would be necessary. In the Raj Kulo, for example, where membership is defined by ownership of fields entitled to use the Eanal to irrigate rice. it would be necessary to determine that the members agree to allow inclusion of additional fields. All qualifying conditions should be discussed and the details put into writing. Discussion and agreement would also be necessary to determine how irrigation will be allocated to the new fields. This may require changes in the distribution facilities and rules for mobilizing resources for maintenance. The owners of the new fields should be a part of all negotiations to determine if they agree to carry their share of maintenance responsibility and if they agree to all other conditions. By encouraging the irrigators to examine each task essential for operation and maintenance. they can modify the rules to accommodate all changes brought by the project before starting construction.

For systems with few rules and little experience in making collective decisions, the strategy is more complex. If holding meetings and making collective decisions constitute a new experience for the irrigators, the facilitator's role becomes crucial but remains one of helping the irrigators take the lead. The objective is to use the construction activity as a rallying point for irrigators to address issues that they know are critical for continued operation and maintenance.

The facilitator can describe multiple ways of accomplishing each task and the merits and disadvantages of each. However. such abstract discussion is often difficult for the irrigators to grasp and apply to their own situation. Arranging tours so that the irrigators can observe other similar systems and can discuss these issues firsthand with other fanners is more effective. The inventory and other field studies can help identify systems with different sets of characteristics. Systems selected to visit should illustrate differing approaches used to solve problems or carry out activities that must be dealt with by the system receiving assistance.

Another option for fanner-to-fanner training is to hire a team of irrigators as consultants to the system being assisted. The consultants should be from a number of different systems where effective institutions are in place. As consultants, their job is to observe the irrigation system and discuss with the irrigators the work that needs to be accomplished. The objective is for them to explain how they accomplish similar activities in their own systems.

Suggesting that the irrigators take responsibility for construction requires them to enter into activities that enhance their management capacity. It also gives them opportunity to influence the design selection and construction methods. Disagreement over design and construction may lead to mistakes but inigators who have taken ownership in their work and been responsible for decisions will modify and rebuild deficiencies with minimum criticism.

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