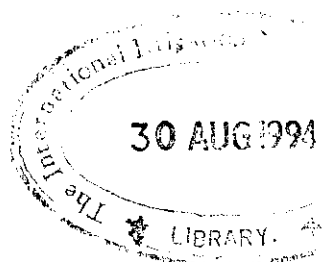


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**Organization and Management  
by Farmers in the  
Chhattis Mauja Irrigation System, Nepal**



**Robert Yoder**

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INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

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*Cover photograph by Daniel Stevens: Farmers desilting the main canal of the Chhattis Mauja Irrigation System.*

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US\$1.00 = NRs 25.10 in 1988

US\$1.00 = NRs 28.10 in 1989

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Though I have drawn upon the information supplied by my colleagues, I alone am responsible for any errors in the interpretation presented in this paper.

**Robert Yoder**

# CHAPTER 1

## Introduction

### PURPOSE

RAPID POPULATION GROWTH has continued in Nepal for the past three decades and is pressing the agriculture system to produce more food. However, economic and environmental considerations have dampened the enthusiasm for constructing new irrigation systems, considered essential by some, for stabilizing and expanding food crops. As a result, assistance to irrigation systems constructed and managed by farmers has received higher priority.

Physical improvements in the irrigation delivery system are usually proposed as the way to expand the area irrigated and to improve the performance of farmer-managed systems. Where area expansion is land constrained, constructing structures to improve control over water acquisition and distribution is viewed as a way to allow more intensive utilization of water and land resources for growing one crop or more each year. The influence that existing institutions will have on the success of such endeavors or the impact that physical improvements might have on vital rules for operation and maintenance are usually ignored.

Farmers struggling to manage their own irrigation welcome and actively seek outside assistance for improving their systems. However, they have a geographic perspective that rests solidly on their own holdings. They seek external assistance to make irrigation delivery reliable and to lower operation and maintenance costs for higher profitability to their own households. They resist losing control over the water resource they have developed if they perceive that their production capacity may be endangered or reduced. Farmers readily approve of assistance for making physical improvements that will conserve water. However, reallocating the saved water to the expanded part of the command area or even to additional crops within the original command area has proven difficult and in many cases impossible.

As part of a larger assessment of the potential for expanding food production by assisting existing farmer-managed irrigation systems, a year-long study was made of one of the larger systems in Nepal. This report concentrates on the current performance of the system by examining the effectiveness of the irrigation delivery system. It also investigates the internal processes of the system to discover how it works and what, if anything, can be done to improve its effectiveness. It addresses the question of gaining farmer acceptance in reallocating irrigation to allow expansion of the area irrigated.

### RESEARCH QUESTIONS

Multiple objectives motivated the study. One was to develop a working relationship with the farmers and to gain a detailed understanding of the organization, institutions, and management practices of a large system so that it could become a training site for farmers from other

locations. Another was to look at the question of what kind of external assistance a large farmer-managed system needs and to examine how assistance should be delivered. The underlying objective, however, was to determine how well such a system is able to meet the goals of its owners and the goals of increasing food production at the national level.

Some of the questions used to guide the preparation of the fieldwork addressed in this report are: 1) Are water rights among systems competing for water in the source established and do they limit access to the irrigation supply? 2) Are there well-defined goals for water distribution within the system and are the goals met? 3) Are cropping decisions constrained by lack of dependable irrigation? 4) To what extent can the area irrigated for each crop be expanded using the existing irrigation supply? 5) Are processes and procedures internal to the system limiting the effectiveness of irrigation delivery? and 6) How does crop yield compare to the national average of irrigated areas?

## **FRAMEWORK FOR ANALYSIS**

Organization of the analysis draws heavily on the goal-oriented performance model defined by Small and Svendsen (1990). The focus is on delivery of irrigation to the agricultural system; not on the agricultural system itself or on the higher-level rural, economic or socioeconomic systems. The approach is to define the goals of the owners of the system and to try and determine how well they are meeting their goals. The extent to which the farmer goals meet national goals is also considered.

Performance is examined from two perspectives. One is the performance of system output, i.e., can irrigation delivery be improved and as a result can more crops be grown? In addition to direct indicators of irrigation system output such as actual irrigation distribution compared to the planned delivery and rice water status, the yield and the cropped area are examined to compare the output of the irrigated agriculture system to that of national and regional goals. Measuring output performance helps determine the magnitude of improvement that one might expect from further investment by the farmers or assistance from the government.

The second perspective is that of the institutions and procedures important to the management of the system, termed "process measures" by Small and Svendsen (1990). These are examined to determine the performance of the system's internal operations and provide information important for two different purposes. First, to identify deficiencies in management that need to be rectified along with physical improvements to achieve system-level goals and national objectives of increased food production. Second, to identify incentives that are operating successfully or that must be activated or modified, to satisfy the farmers' concern for maintaining sustainable production.

## **SELECTION OF A SYSTEM FOR STUDY**

To identify a suitable farmer-managed system for intensive study, a reconnaissance was made of all previously identified systems in Nepal larger than 1,000 hectares (ha). In addition to size, the main criteria for selection were accessibility and perennial irrigation. Systems in the far-western tarai where travel in the monsoon is extremely difficult were not investigated. In the reconnaissance 14 systems were examined and most were eliminated for lack of perennial

irrigation or because they irrigated substantially less area than preliminary information had suggested. From among the systems that met all selection criteria, the Chhattis Mauja System was chosen for study because it is also well located for use as a future training site for farmers.

The Chhattis Mauja Irrigation System was constructed by farmers in the mid 1800s to provide supplemental irrigation for the monsoon rice crop. With the exception of a few hectares of scattered banana plantations and several fish ponds introduced in recent years, rice is grown in the entire command area during the monsoon. In the past few decades the use of the system has intensified. Winter crops are extensively irrigated and all of the available water is used in the dry season to irrigate maize in part of the command area. However, supplemental irrigation of rice in the rainy season, including timely establishment of seedbeds and punctual transplanting, remain as the farmer irrigators' primary purposes in operating the system.

## FIELD METHODS

Research staff were resident in the command area for most of the year of field work. A number of residents of the community, several of them irrigators, were hired as assistants. Informal interviews and daily observation of irrigation related activities were as important as the formal surveys in developing an understanding of the internal system processes. The staff also attended meetings at all levels of the organization and examined village records and system-level records.

Three of the 44 branch canals were selected for detailed study. The sample branches were selected to represent the geographical head, middle, and tail reaches of the system. Discharge diverted into each branch was measured twice daily beginning in late August 1988 and continued until rice transplanting was completed in 1989. Cutthroat flumes were used to measure the discharge in each sample branch canal.

Within each of the three sample branches, numerous plots were selected for observing the field water status. These were located to represent the geographical head, middle, and tail areas of each branch. In addition to the daily water status, gauges installed at a slope of 1:5 were used to record fluctuation in ponded water depth for estimating the seepage and percolation rate in each field plot during the rice season.

Sample crop cuts were made in each of the observation plots. Additional plots near the observation plots were selected for crop cuts to increase the sample size. The weight of the sample, adjusted to 14 percent moisture content, was used to estimate the per hectare yield for each field.

The broadcrested weir used to divide the discharge of the Sorah Mauja System from that of Chhattis Mauja, was used to measure the discharge in the main canal. This structure is located about 1.6 km below the lower of two diversions from the Tinau river. The relationship between water discharge and water level at this structure was derived from a series of discharge measurements made with a current meter. Stage recording was carried out manually twice a day, during most of the period. From November 1988 to August 1989 a datalogger was used to record the depth of water flowing over the weir at ten-minute intervals. Measurement was by means of an ultrasonic sensor installed in a stilling well upstream of the weir.

## ORGANIZATION OF THE FINDINGS

The historical development of the system and the current organization for managing operation and maintenance are explained in Chapter 2. This includes the evolution of rules for allocating irrigation among the shareholders of the system. Allocation of entitlement to irrigation not only defines the boundaries of the system but associates access to water with maintenance responsibility.

Chapter 3 describes the irrigation activities that were observed during field work. Field measurements and observations are used to explain why irrigation rules, especially those related to water allocation among branch canals, have changed. Several instances are described to illustrate decision-making authority and procedures as well as communication patterns.

System-level goals, along with national targets, are described in Chapter 4. The output of the irrigation system for each of the three major cropping seasons is compared to the system goals and national targets. Spatial and temporal distribution of the irrigation supply is the primary output consideration. Irrigation distribution is compared to the allocation established by the organization as the primary measure of performance. Crop yields are also examined as an indirect measure of the system's performance.

Procedures for canal desilting and emergency repair are described in Chapter 5. Effective maintenance is the distinguishing feature of most successful farmer-managed irrigation systems, and the Chhattis Mauja System is no exception. Chapter 6 analyzes the cost of system operation and maintenance. The effective rate of taxation is computed as a means of normalizing the cost of irrigation to the incremental benefit that can be ascribed to irrigation, thus allowing comparison among the branch canals and among irrigation systems regardless of size or type of governance.

The concluding chapter briefly reviews the findings of the performance analysis. It then returns to the questions that directed the study to draw lessons that have general applicability.

## CHAPTER 2

# Descriptive Overview of the Chhattis Mauja System

### SYSTEM CHARACTERISTICS

THE CHHATTIS MAUJA Irrigation System is located in the tarai region of Rupandehi District, in Nepal's western development zone. Figure 2.1 gives the relative location of the Chhattis Mauja System. The tarai is a tract of gently sloping terrain along the Himalayan foothills: the upper edge of the Gangetic Plain. There is more gradient at the head of the system and less toward the tail as one moves away from the hills. The average elevation of the command area is about 150 meters above sea level. The soil is well drained at the head and middle part of the system where the water table is more than three meters below the surface during the rainy season, while in the tail, the water table is near the surface with the low areas having some problem with water logging.

The system was built by farmers over 150 years ago to divert water from the left bank of the Tinau River at the town of Butwal. The Tinau River has an extremely varied discharge with less than three cubic meters per second in the dry season from March through May, while floods reach thousands of cubic meters per second for short durations in the monsoon. The abrupt reduction in gradient as the Tinau River enters the tarai causes it to drop its heavy sediment load resulting in a well-developed alluvial fan.

With a maximum elevation of only 200 m at the foothills, the tarai has a hot climate. Most of the annual rainfall is concentrated in the monsoon period from mid-June through September.

### Historical Development

Settlements such as those inhabited by the family of Gautama Buddha, some 40 km west of the Chhattis Mauja Command Area, existed for periods of time in parts of the northern Gangetic Plain, several millennia ago. However, in recent centuries most of the tarai in Nepal has been sparsely populated and covered by dense tropical jungle.

Of the current settlers, the "Tharus" are the original inhabitants of the tarai. They settled and cleared away the jungle for cultivation in what is now the southern part of the Chhattis Mauja Command Area. The hot, unpleasant climate of this area, the dense jungle with many wild animals, and an endemic malaria discouraged Nepali hill people from settling in the tarai. The Tharu farmers dug the Chhattis Mauja Canal through what was then nearly ten kilometers of jungle to irrigate fields in the area of the present day Thatrihawa, Sagrahawa, Kanpara, and Kumari villages (see Figure 2.2). It is likely that a local ruler encouraged construction of the canal, but it is widely held that the Tharu farmers undertook the actual work and managed its operation until the early 1950s. Residents of the area say that the canal was built during the time of Prime Minister Janga Bahadur (1846-63) under the leadership of Chheda Tharu of Kumari Village. For many years the system was called "Kumari Kulo."



Figure 2.1. Location of the Chhattis Mauja Irrigation System.

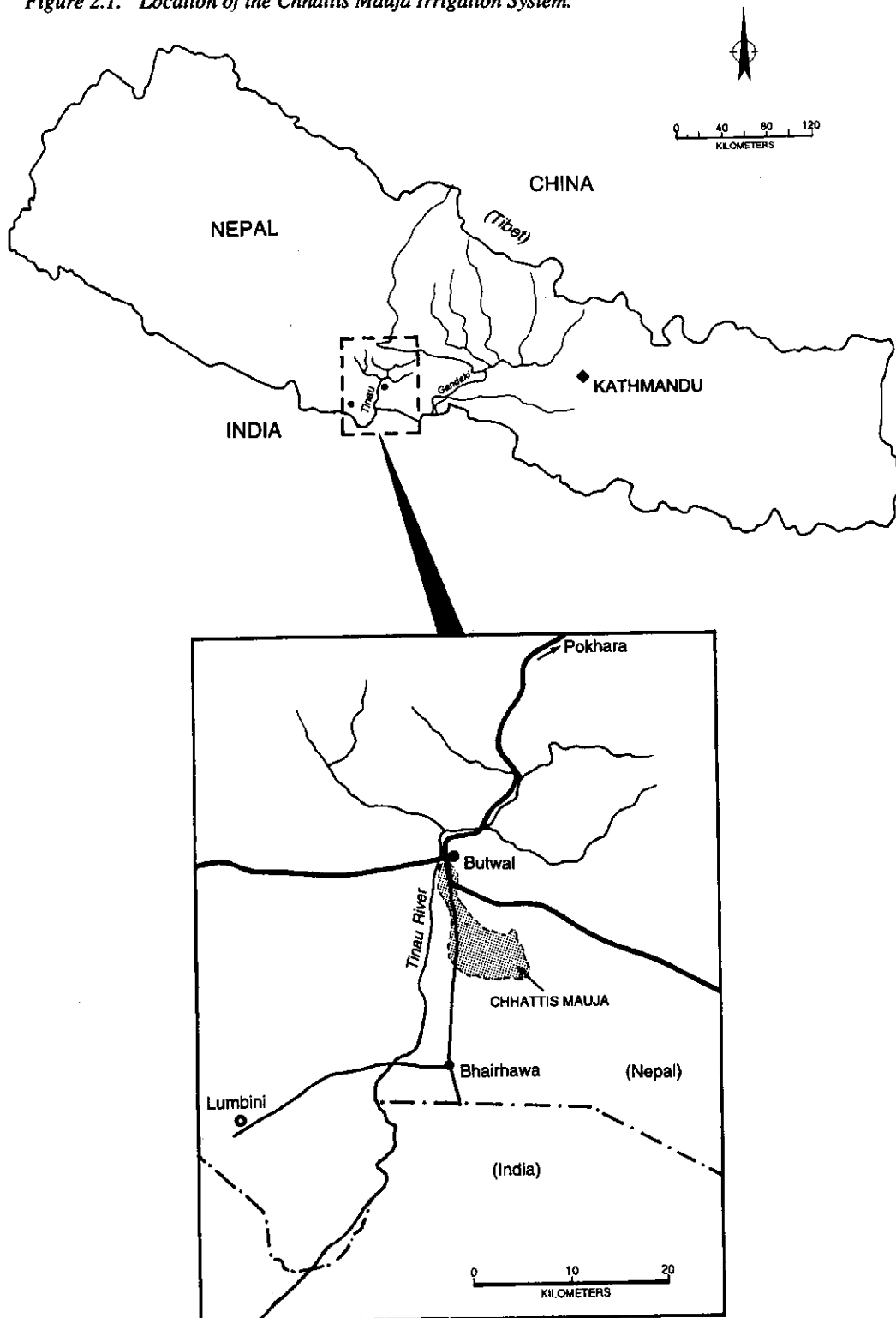
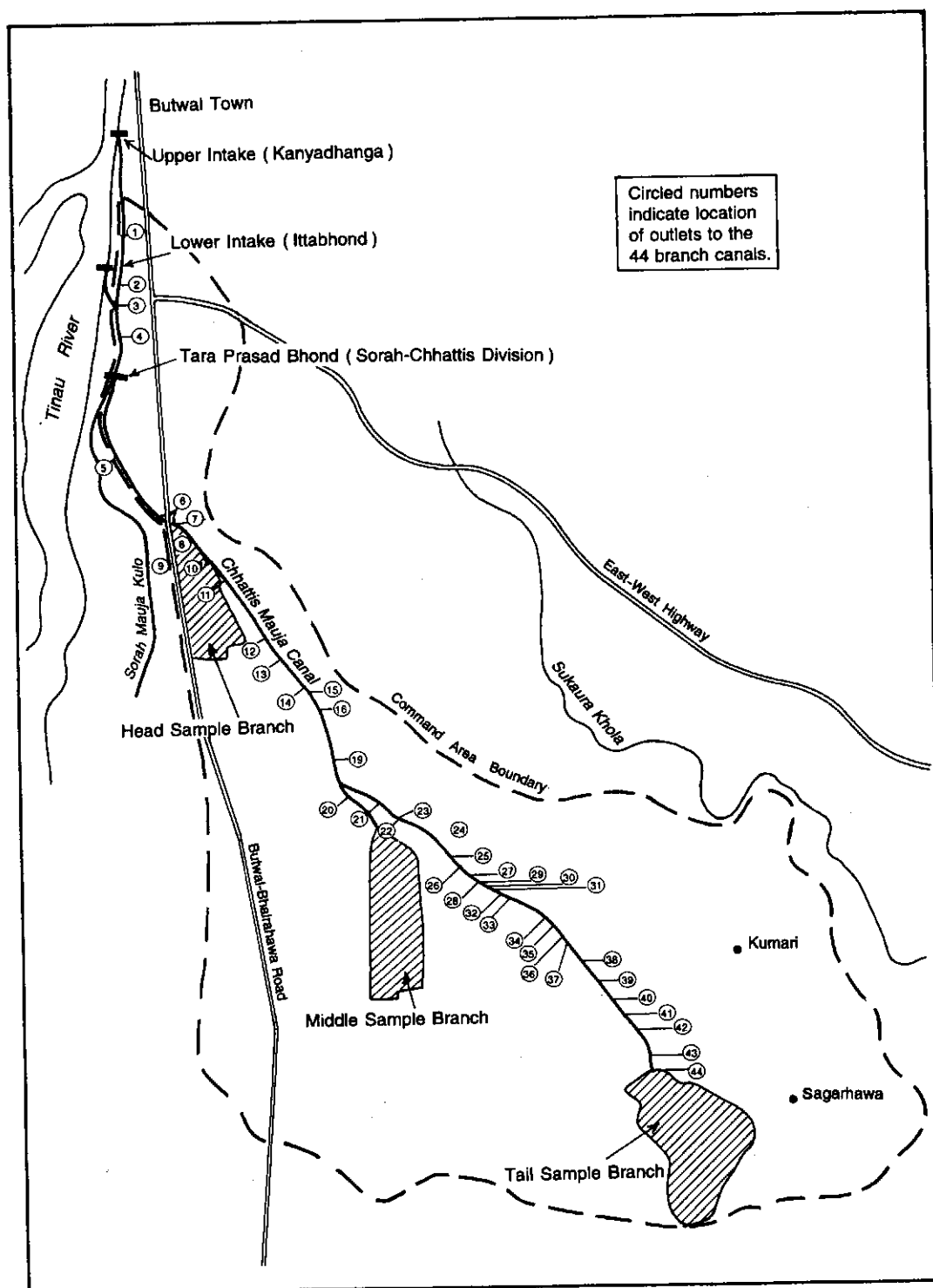


Figure 2.2. The Chhattis Mauja Irrigation System.



About 50 years after construction of the canal, Prime Minister Chandra Shamshere (1901-29) gave Colonel Tej Bahadur Malla a tax-free land grant in appreciation of his service to the government. Colonel Malla's land grant included much of the then cultivated part of the Chhattis Mauja Command Area and he settled in the Kumari Village. Though Colonel Malla controlled much of the land, the Tharu settlers continued cultivation and managed the irrigation system.

The same Prime Minister also granted approximately 1,200 hectares of tax-free land to Ram Mani Acharya Dixit. Dixit's land grant was located partially in what is presently the western part of the Chhattis Mauja Command Area. The area where Mr. Dixit settled is now called Manigram. Another ruler confiscated this land but when Judha Shamshere was Prime Minister (1933-45) he returned it to Ram Mani Dixit. In the period between 1935-45, the Dixit family brought in many contract laborers from the hills and from along the Indian border to clear the forest for cultivation and settlement. They opened an outlet from the Chhattis Mauja Main Canal in 1947 to irrigate the land in the Manigram area. Within a few years management of the system was taken over by the Manis and the settlers they had encouraged.

The expanding population in the hills where all good agricultural land was already under cultivation, and the successful malaria control efforts in the tarai in the 1950s, encouraged rapid migration into the Chhattis Mauja Command Area (see Table 2.1). Most settlers who moved into the area after 1950 were from the hills. Many acquired land by encroachment; clearing a jungle plot for a residence and for subsistent cultivation. Land clearing was done entirely by hand with family labor which limited each family to a small holding. Since the canal was first built to deliver water to fields near the southern boundary of the jungle, the new settlement gradually expanded the command area from the south to the north. Development of the Chhattis Mauja Command Area is unusual in the way expansion of irrigated area proceeded from the tail toward the head of the system.

*Table 2.1. Settlement pattern of a sample of 106 families in three branch canals of the Chhattis Mauja Irrigation System.*

Period	Head		Middle		Tail		Total	
	H	T	H	T	H	T	H	T
Before 1950	0	0	0	0	0	12	0	12
1951-1960	6	0	2	5	0	0	8	5
1961-1970	6	0	19	1	6	0	31	1
1971-1980	14	0	10	2	12	0	36	2
1981-	1	0	5	1	4	0	10	1
	27	0	36	9	22	12	85	21

Notes: H = Settlers that migrated from the hills.

T = Settlers of the tarai and India (includes some persons originally from the hills).

People of the newly settled areas were able to acquire irrigation water by paying a one-time fee to the Tharu canal leaders for permission to open an outlet to their villages. Much controversy surrounded this expansion and there were frequent disputes over operation and

maintenance of the canal. The area settled by Colonel Malla was dominated by Tharus, while the area opened by the Dixit family was primarily inhabited by hill people. Thus two major factions developed roughly along the geographical lines of the two land grants given many years earlier.

As a result of the conflict over water distribution between the two factions, Dibbyaswori Malla, the wife of Colonel Tej Bahadur Malla of Kumari Village, with the help of farmers from the villages of the eastern and southern parts of the system, realigned the main canal from Jogikuti to Kumari Village via Chaprahatti in 1957. The new canal alignment made illegal access more difficult and allowed easier division of the water among the then existing 30 villages of the eastern and southern parts of the command area and the six villages of the Manigram area in the west.

By 1958 the Tharu builders who had managed the system for the first 100 years were completely dominated by the hill settlers, and a three-tiered organization came into existence. The rules and roles for operation and maintenance evolved along the lines familiar to the immigrants from the hills where many had previous experience with irrigation management. A constitution that was first written in the 1950s underwent major revisions in 1979 and the rules being used were formalized. The full text of the constitution, including all amendments made up to 1989, is given in Appendix 1.

### **Merger with the Sorah Mauja System**

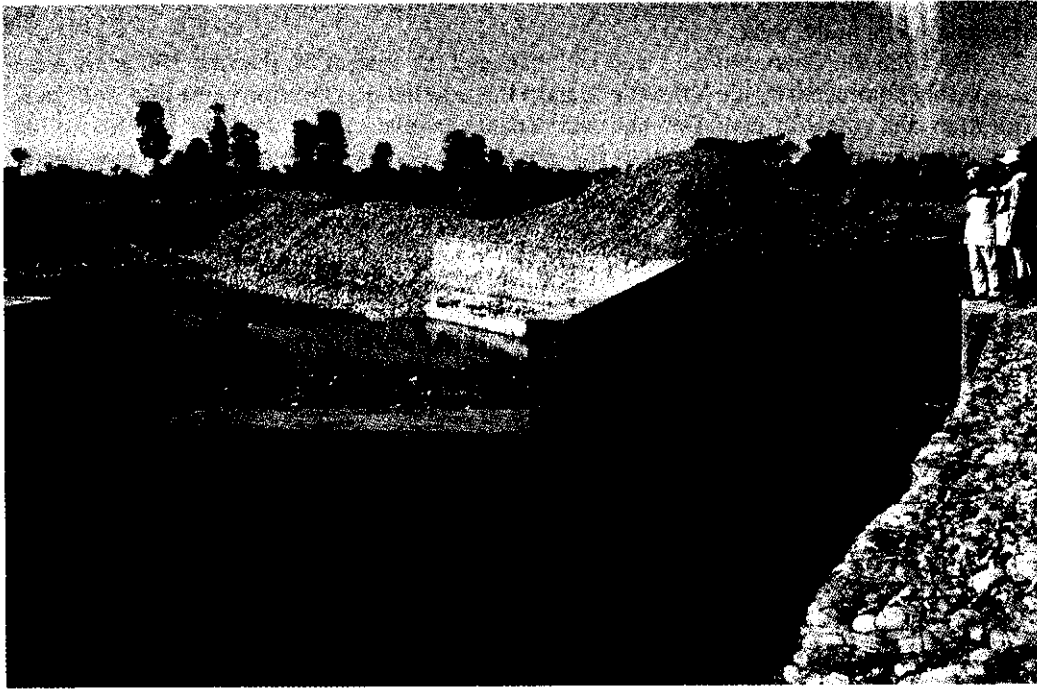
In total, five canals compete for water from the Tinau River at Butwal. Three take water to the right bank of the main river channel. On the left bank, the Sorah Mauja System irrigates the area between the Chhattis Mauja and the Tinau River. Its intake was located just downstream of the Chhattis Mauja Ittabhond Diversion. The construction of a major diversion intended for a large new irrigation system on the right bank of the Tinau closed the Sorah Mauja Diversion in 1959. The Sorah Mauja's continued operation required agreement and cooperation with the Chhattis Mauja. Mediation by government officials resulted in the construction of an additional diversion upstream of the existing Chhattis Mauja Diversion at a place called Kanyadhunga. A short canal links the new diversion to the existing Chhattis Mauja Canal at Ittabhond (see Figure 2.2 above). To manage the river diversions and joint segment of their canals, a committee with representation from the two systems was formed.

The Sorah Mauja and Chhattis Mauja systems work jointly to divert water from the Tinau River. About two kilometers below the lower river diversion at a place called Tara Prasad Bhond (named after the zonal commissioner who helped them reach a settlement), the water in the jointly operated canal is divided into the former separate canals. The government-mediated agreement stipulates that the Sorah Mauja System is entitled to 40 percent of the combined canal discharge at the point of division. The Chhattis Mauja Constitution states that, of the water flowing in the canal at Tara Prasad Bond, 10 parts out of 16 (i.e., 62.5%) belong to the Chhattis Mauja System. A proportional dividing structure (see Figure 2.3) has been constructed to divide the water between the two canals. The structure has a 4.55 m opening for the Sorah Mauja Canal and a 6.67 m opening for the Chhattis Mauja Canal. Assuming uniform hydraulic conditions, this gives 40.6 percent to the Sorah Mauja and 59.4 percent to the Chhattis Mauja systems.

In the course of land settlement, a number of outlets were opened from the main canal near the river diversion and upstream of the Sorah-Chhattis Dividing Structure. These outlets were highly controversial and were authorized only after intervention by government officials. In 1989 these four branch canals were entitled to 12.6 percent (22 out of 175 units of irrigation allocation) of the total discharge from the two diversions into the combined Sorah and Chhattis Mauja canals. Though the uppermost outlet was initiated to provide drinking and bathing

water to a new settlement near Butwal Town, the water is now used almost exclusively for irrigation of land with an extremely high infiltration rate on the toe of the Tinau River's alluvial fan. As will be examined later, it is reported that these outlets benefit from their privileged position by taking a great deal of extra water.

*Figure 2.3. Structure to divide water between the Chhattis Mauja (left) and the Sorah Mauja irrigation systems.*



By 1980 all of the jungle that the original Chhattis Mauja Canal passed through had been cleared and settled. Access to water had been acquired from the Chhattis System and some level of irrigation is taking place on all of this land. Since the upper reach of the command area is a coarse alluvial deposit, infiltration rates are high, requiring higher rates of application for irrigation than in the lower reach. As will be shown in a later chapter, water demand for the system outstrips the supply in dry periods of the year.

Fortunately, the tail part of the system has access to groundwater. The Department of Irrigation initiated a project in the mid-1970s to develop a reliable deep aquifer. This has offered a new source of irrigation supply for a number of villages previously served by the tail end of the Chhattis Mauja System. Some of these villages have dropped out of the system entirely and others have reduced their entitlement to water in order to decrease their obligations to provide labor and cash for maintenance and operation, but still retain membership in the system.

## Present Status

The introductory paragraphs indicated the dynamic nature of system expansion. The following describe in more detail the system characteristics at the time of observation and data collection from June 1988 through August 1989. This description must be seen as a "snapshot" of the system at the time of field observation. Change continues as farmers struggle to adjust irrigation input to their agriculture strategy in the context of a rapidly changing labor and market environment.

*Physical Characteristics.* Diversion of water into the canal is accomplished by two temporary stone/brush structures on the alluvial fan at the town of Butwal. Since the fan is continually reshaped by floods the temporary wing walls must frequently be modified and maintained. In 1988, the wing wall extended nearly 800 m up the river bed at the upper intake, to intersect with the main water channel and divert it to the left bank of the river. A similar situation exists at the lower intake.

As the town of Butwal grows, much of the surrounding area and hills are being cleared for settlement, heavy animal grazing has reduced brush growth, and trees are being harvested for fuelwood. Access to forest products and brush essential for maintaining the diversions has become difficult and expensive. Stone-filled wire cage (gabion) structures are increasingly used to substitute for brush and wood giving slightly more permanence to the diversion structures.

In addition to destructive forces from floods, the intake and canal suffer from massive bed load and silt deposits diverted from the river together with the water. To help reduce damage from floods and to reduce bed material entering the canal, the Department of Irrigation provided assistance in constructing a gate to control flow into the canal through the lower intake at Ittabhond and a gate for flushing the intake canal. The upper diversion at Kanyadhunga is unregulated and joins the Ittabhond Diversion just below its regulating gate.

The system's main canal is 11 kilometers (km) long and presently serves an area extending fourteen kilometers into the tarai from the lower intake. Figure 2.2 above gives the general layout of the intakes, main canal, and outlet locations. In total, 54 village units are using water from the system. This is accomplished through 44 outlets and branch canals from the main canal. The gross command area is about 3,500 ha serving over 2,500 households with a total population of approximately 20,000. An average household in the command area has 8 members and an irrigated landholding averaging about 1.0 ha in the head reach of the system to 1.6 ha in the tail. The adjacent Sorah Mauja System irrigating the area between the Chhattis Mauja System and the Tinau River, has a command area of about 1,500 ha.

Most of the 44 outlets from the main canal are temporary structures with only wooden posts driven into the canal bed to define and control the opening width. In recent years about one-third of the branch canals have installed masonry or gabion structures to control water entry into their branch. Only a few of the outlets have gates which are generally operated in either fully open or closed positions rather than as a means for variable adjustment of the discharge.

Natural drainage channels remove excess water from the command area. Much of the drainage water is reused by villages in the tail of the system. Infiltration is high in the upper reach of the system due to coarser material in the alluvial deposit. The depth to the water table even in the monsoon season remains several meters below the surface in the upper command area and water logging is not a problem. However, in the lower reach of the system, the topography is slightly undulating and the land is classified by the farmers as "lowland" (fields that easily become waterlogged) and "upland" (well drained ridges elevated up to 0.5-1.0 m

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above lowland). Winter crops such as wheat or gram generally are not grown in the "lowland" fields because they remain too wet for timely land preparation.

In an average year, rainfall contributes about thirty percent more than irrigation to the total water supply available in the Chhattis Mauja area. While the average annual rainfall is about 1,700 mm in the Bhairawa/Butwal region, the measured available irrigation supply from August 1988 through July 1989 was about 1,160 mm. However, this comparison assumes that the irrigation supply available to the system is uniformly distributed over the entire area and that none was lost by infiltration in the canal bed. As will be seen in Chapter 4, the entire command area is not irrigated during the winter and spring seasons, making some additional water available for areas that are irrigated.

*Socioeconomic Setting.* The Tharu people who built the first canal are now a minority in the system. The Tharus own about 25 percent of the land in the tail area and none in the head of the system. A few settlers were of Indian origin but the majority came from hill districts north of the command area and are of mixed ethnic and caste groups. A large number of the hill settlers are retired from service in either the British or Indian Army and are receiving military pensions.

Just over half of the 170 farms sampled are less than one hectare in size. While two-thirds of the farms in the head branch are less than one hectare in size, nearly two-thirds of the farms in the tail branch are larger than one hectare. Only two of the households in the three sample branches have holdings of more than five hectares.

While agriculture is the main occupation of the 101 farmers interviewed, many hold other jobs that earn them additional incomes. Almost 95 percent of the farmers in the head branch, 60 percent of the farmers in the middle branch and 50 percent of the farmers in the tail reported incomes from nonagricultural work. None of the head-branch farmers reported renting in land but 14 percent said they rented out land. In the middle and tail branches about 10 percent of the farmers surveyed indicated that they rented in land and 5 percent reported that they rented out land.

In the head and middle branches, about 30 percent of the farmers reported that they hire labor to supplement family labor during periods of peak agricultural activity. Only 10 percent of the tail branch farmers reported hiring labor. Most small farmers hire labor on a daily wage basis but some of the larger farmers have made contracts with regard to labor on a seasonal or annual basis. They provide fixed amounts of rice and other food commodities, and may even provide housing and land for a kitchen garden. Exchange labor is practiced by most households.

Farmers in the Chhattis Mauja Command Area have good market access. An all-weather road runs south through the command area and Nepal's major east-west highway also crosses it. The town of Butwal where the system's intake is located and Bhairawa, a town near the Indian border, are the two major market areas. Both of these towns have grain and food processing industries, banking and governmental offices, businesses marketing agricultural inputs, and numerous private grain traders. In both towns there are *haat bazaar* (produce markets) twice a week where farmers can direct market goods if they wish. Butwal has become the largest center of small-scale industry in Nepal, providing considerable employment opportunities.

*Agricultural Practices.* Until a three-year period of drought in the early 1960s caused a nearly complete crop failure, a single crop of rice was grown in most of the then cultivated command area. The drought encouraged diversification in order to increase food production and minimize risks. Cultivation practices shifted to include wheat, maize, mustard, lentils, linseed and peas. Many farmers plant mango, papaya, lemon, jackfruit, litchi and guava trees near

their houses. However, fruit and vegetables are primarily grown for home consumption. Recently several farmers have experimented with commercial banana plantations.

Monsoon rice is still the most important crop. Most farmers grow early maturing varieties on part of their land. This helps to minimize the risk of losing all of their crop if a drought develops toward the end of the growing season. It also allows better household labor utilization with a somewhat staggered harvest and early land preparation for winter crops. Though traditional varieties such as Mansuli are relatively low yielding compared to management responsive early maturing varieties, they are preferred for their fine grain quality and high straw yield.

Seedbed preparation starts in late May while the available irrigation supply is at its lowest, but with the expectation that monsoon rains will increase the irrigation supply by mid June to make transplanting possible. Transplanting takes place during June and July. Harvesting of early maturing rice begins in mid September and is completed by mid October. The traditional varieties are harvested in October and November.

Wheat is the most important winter crop. It is normally sown in late November or December and harvested in March or April. Usually some area is also planted to other winter crops such as lentils and mustard for home consumption. Low wheat prices and higher market demand for lentils has resulted in increased area being used for this low water demand crop in recent years.

In a year of average rainfall, there is not enough moisture to grow maize during the dry season from March through June without supplemental irrigation. This has largely restricted dry season cultivation to the upper part of the system where irrigation is available even in the dry period. In water restricted conditions, maize is the preferred dry season or spring crop.

## ORGANIZATION AND IRRIGATION RELATED INSTITUTIONS

### Allocation of Rights and Obligations among Branch Canals: the Kulara System

Water allocation is a fundamental institution of the Chhattis Mauja System. It determines system boundaries, establishes right of access to a specific portion of the available water in the system, and defines the level of responsibility for system maintenance and contribution to main system improvements.

A basic characteristic of the management system is the use of the *kulara* unit, which is explained in this section. This unit expresses a certain share, assigned to a member village, and it refers simultaneously to that village's share of rights and of obligations. Water rights and voting rights are in proportion to the number of *kulara* held by the village; but so also are the obligations to provide labor and cash for the upkeep of the system. This ingenious balancing of obligations and entitlements restrains villages from seeking excessive shares. The total number of *kulara* is not fixed, and the executive committee controls the numbers held by villages according to rules and procedures described below.

For the purpose of this study the system boundaries declared by the Chhattis Mauja Executive Committee are used. While management of the system has partially shifted to the joint Sorah/Chhattis Executive Committee, it is clear that the Chhattis Mauja members still view their system boundaries to extend from the diversion structures on the Tinau River and include all 44 branch canals diverting water from the canal, as it existed prior to the Sorah Mauja gaining access to the diversion structures. Their view is that both intakes from the Tinau River and the segment of main canal, now used jointly by the Sorah and Chhattis systems, are inseparable parts of the Chhattis Mauja Irrigation System. They say that they have historically

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controlled the diversion structure and now, because of outside intervention, also allow the Sorah Mauja System to transport their water through the Chhattis Mauja Canal.

The Sorah Mauja's portion of the irrigation delivery was fixed in a settlement mediated by the local government. Its portion of the irrigation supply diverted from the Tinau River, is removed from the main canal at Tara Prasad Bhond (see Figure 2.2). All discussion of irrigation allocation in this text refers to the irrigation supply controlled by the Chhattis Mauja Executive Committee. This includes the irrigation supply of the 44 branch canals, four of which are above the Tara Prasad Bhond Sorah/Chhattis Divider. As discussed below, the total kulara irrigation allocation from the system changes over time. In 1989, there were 22 kulara of irrigation allocation from the Chhattis Mauja System to the four branch canals above the Sorah/Chhattis Divider. Below that divider, there were 153 kulara in the Chhattis Mauja System, making a total of 175 kulara in the canals represented in the Chhattis Mauja Organization. Water allocations to the Sorah Mauja play no part in these kulara shares within the Chhattis Mauja System.

A village wishing to join the Chhattis Mauja System and open a branch canal must apply to the executive committee for approval. If it is approved they must pay a fee of NRs 500. The same rule applies to villages wanting to shift their inlet upstream on the main canal. However, shifting the inlet downstream only requires approval and not payment of the fee.

A village that receives the right to open a branch canal outlet from the main canal is considered a member of the system. Hence, from the main canal or system-level perspective, determination of branch canals and their respective quantified entitlement to water defines the system boundary. Membership at that level refers to villages served by branch canals rather than individual farmers. The system-level organization is not concerned with the physical boundary of the irrigated area. At the branch-canal level the village organizations deal with individual farmers and the physical boundary to which water is delivered. Most village-level organizations keep a list of households and their landholding to assist in determining rights and obligations within the branch, but these lists are not passed on to higher levels of organization in the system.

It is unknown how water was allocated to branch canals when the system was first constructed. Since 1945 there have been many changes in the number of villages accessing water from the system with resulting changes in the physical layout of the canal system and the organizational structure. Therefore, it seems reasonable to accept the farmers' undocumented reports that the rules for allocating water have also changed.

Persons associated with the system for many years claim that for a period of time water was allocated in proportion to land ownership. System leaders suggest that allocation based on land area took place in the late 1940s during the time when many new branches were opened and system management was reorganized. Each branch canal was entitled to receive water in the same ratio as the area irrigated by the branch to the total command area. Since labor mobilization for maintenance is one of the organization's most important tasks, requirements for mobilizing labor from each branch canal for main canal maintenance were set proportional to the land area irrigated, i.e., in the same ratio as water allocation.

It was reported that until sometime in the 1950s, each branch canal was responsible to send one person for canal maintenance, for each day that maintenance work continued, for each 17 ha of area it irrigated. The term used for a person-day of labor for canal maintenance was *kulara*. Since the share of water a branch canal is entitled to receive is the same as the resource mobilization requirement, water allocation is now also referred to as "so many kulara of water." The word *kulara* is used interchangeably to refer to water entitlement and resource mobilization obligation.

Voting rights for all important system management and improvement decisions are based upon water allocation. Each branch canal is entitled to as many votes as it has kulara

of water rights and resource mobilization obligations. During the 1988 rice season, the total number of kulara for the 44 branch canals was 177. Therefore, a branch canal with five kulara was entitled to  $5/177$  of the water in the main canal, responsible to supply  $5/177$  of the resources mobilized from the irrigators for maintenance and improvements, and had 5 of the total 177 votes in all important decisions.

Since 1945, as the jungle was cleared and new land brought under irrigated cultivation in the upper reaches of the system where the seepage and percolation losses are high, there has been considerable adjustment in the water allocation. There is no longer a direct relationship between the land area irrigated and the water allocation for each branch canal. Villagers from each branch can decide if they need more or less water and apply to the executive committee to change their allocation. In effect, the basis for water allocation has changed from shares proportional to land area to a share based on water demand and ability to provide resources to the system.

The rule in use states that a branch canal desiring to increase its water allocation must apply to the executive committee. They must also clear all of their accounts due under the existing kulara allotment. If the request is approved they must pay a fee of NRs 500/kulara for each additional kulara of water. An automatic consequence of increasing the water allocation is the responsibility to provide additional maintenance labor and cash resources in proportion to their total number of kulara. A branch canal that wishes to reduce its water allocation must only give notice to the executive committee.

In addition to the changes in irrigation allocation requested by some villages, others in the tail area have dropped out of the system entirely. This is primarily because irrigation is available to them from a government sponsored tubewell program. The government project overlaps with a number of villages in the tail of the system that previously depended entirely on the Chhattis Mauja System for irrigation.

The total number of kulara of irrigation allocation in the system has reduced from more than 183 in 1980 to 175 in 1989. In 1989, Haraiya Bazaar withdrew from the Chhattis Mauja Irrigation System. According to the Haraiya Bazaar village leader, the farmers withdrew because the Chhattis Mauja Canal could not supply them with water for winter crops. Their irrigation allocation of one kulara was not sufficient for the rice crop and they did not want to increase their maintenance expense by adding additional kulara. Also because there is lowlying land in the middle of their branch, it has always been difficult to move water from the main canal in this area. Since they now have access to irrigation from the government's tubewell project, they have decided to drop their entitlement to the Chhattis Mauja water.

### Levels of Organization

Final authority for decisions concerning the Chhattis Mauja System is vested with the general assembly. All irrigators are members of the general assembly and are welcomed and encouraged to attend the general assembly meetings and participate in the discussions. However, each branch canal can designate only one voting member for each kulara water allocation that they control. Only the designated kulara representatives are eligible to vote. The Chhattis Mauja Constitution (see Appendix 1) specifies that a general assembly meeting be held twice a year.

Since designation of kulara representatives for proportional representation is time consuming and inconvenient for many irrigators, provision for another general-level decision-making meeting has been made in the constitution. This is simply called a general meeting and is composed of all the village leaders (54 during 1988) and executive committee members.

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A well-defined organization with four functional tiers has evolved to control operation and carry out maintenance of the system. At the lowest level, groups are formed to include all irrigators of a branch canal. All but ten of the forty-four branch canals serve a single village; so most of the lower-level organizations are village based and usually referred to as village-level organizations with *village-level committees* responsible to lead in managing their affairs. The command area is divided into nine areas each comprising of three to ten branch canals for the second level of organization. An *area-level committee* is the responsible body at the second level. At the third level there is a twelve member *executive committee* which manages operation and maintenance of the Chhattis Mauja Main Canal. The highest level is a *joint committee* of the Sorah and Chhattis Mauja systems. The joint committee was formed to oversee maintenance of the intakes and canal shared by the two systems and to govern the division of water between them.

Two additional bodies need to be mentioned but will not enter into the description and analysis that follows. The first of these is a *Tinau River Committee* which was organized in 1956 to resolve disputes over access to water in the river at Butwal. It had representation from each of the five right- and left-bank farmer systems using water from the river. After allocating fixed proportions of water to each system this committee's activities decreased and it has not met during the past decade.

During most of the year, including the monsoon, many of the branch canals must practice rotational water delivery within their branch. *Rotational units* are formed below the village-level committees in some branches to coordinate water rotation among the farmers receiving water at one time within the branch. Formation and control of these groups is entirely the responsibility of the farmers within each branch.

**Village-Level Committees.** The village-level committee manages all of the irrigation activities within the branch canal. These include: 1) Allocating the water they are entitled to receive from the main canal among irrigators in the branch, 2) Monitoring water distribution in the main canal and within the branch, 4) Managing conflicts, 3) Planning and carrying out maintenance within the branch, 5) Assessing fines to irrigators within the branch, and 6) Appointing branch canal representatives to the higher levels of organization. This includes appointment of representatives to vote in the general assembly.

The village-level committee is also responsible for mobilizing labor for main system maintenance as directed by main system officials and for linking management of the main system with the branch canal. Except for activities that involve other branches or the main system, it functions as an autonomous unit.

The structure of a village-level organization differs from one branch to another. In all cases there is a leader called *mukhtiyar*. The term mukhtiyar traditionally refers to the village leader responsible for managing all village affairs from hosting visitors to maintaining roads and other infrastructure. The Chhattis Mauja Organization recognizes the village mukhtiyar as the official functionary of the village-level irrigation organization. Some mukhtiyars are elected for fixed terms and are only responsible for irrigation activities. In other villages they are appointed by the villagers and continue to serve as long as they are willing and perform their duties acceptably. In a few branch canals the village-level organization consist of only the mukhtiyar. Generally, all irrigators using water from the branch canal meet to elect officials for a committee with the mukhtiyar performing the duties of chairman. A secretary is usually appointed to keep records. In most cases the appointment is for a one-year term.

Most village committees appoint a village-level messenger. Without telephone or other public means of communication, the messenger is essential for prompt communication between the irrigators and main system officials. He is directed by the mukhtiyar and in many

cases becomes the mukhtiyar's assistant for monitoring all irrigation tasks, and keeping records.

The village mukhtiyar's main responsibilities are to: 1) Keep a record of all persons absent from village irrigation work assignments, 2) Collect fines for absence from regular maintenance work, 3) Coordinate the establishment of a water rotation schedule within the branch canal during periods of water scarcity, 4) Designate each farmer's turn to contribute labor to main canal maintenance, and 5) Preside over village-level irrigation meetings. Other members on the village committee advise the mukhtiyar on water management issues.

Duties and remuneration of village-level committee officials vary a great deal among branch canals. Roles and payment of officials in the three branches monitored intensively are described to illustrate this diversity. When the irrigators in the head branch agreed that the mukhtiyar in their branch be selected by the area-level committee as their representative to the executive committee, they also concluded that the messenger could perform the mukhtiyar's duties in their branch. The messenger was paid in kind at the rate of 10.7 kg/ha of rice for the monsoon crop, and 10.1 kg/ha of wheat for the winter crop. Using Farmgate financial prices, this was the equivalent of a total annual payment of about NRs 3,750 to the messenger from the 50 ha branch. The messenger is responsible for collecting the grain from each farmer at the end of each crop season.

In the middle branch with 70 ha of irrigated land, the mukhtiyar received NRs 900 for his annual allowances. In addition, he was given 12 pairs of flashlight batteries for the year. The batteries were needed for work at night. The messenger was paid at an annual rate of NRs 700 plus 12 pairs of batteries. In total, including the batteries, about US\$75 was paid to the branch-level officials for the year. In the middle branch, payments were made from funds collected as fines and charges related to main system maintenance and operation. In 1988, the total income of the middle branch-level organization was NRs 8,578 and the total expenditures including payment to the staff amounted to NRs 4,788.

In the tail branch there is no organized committee. The mukhtiyar implements all irrigation management activities. If he needs assistance he gathers the farmers together for discussion and direction. Instead of sending the mukhtiyar to serve on the area committee as is the custom in most branches, the tail has selected another person. Therefore, this village system functions with two officials: the mukhtiyar and a member of the area committee. The mukhtiyar is exempted from labor contributions for main system maintenance but he receives no other compensation.

*Area-Level Committees.* The area-level committee is the link between the executive committee and the village-level committees. It is composed of the village or branch canal mukhtiyars with several exceptions as noted in the tail sample branch above. One of the members is selected to serve as the area-level committee chairman for one year and during that period he is the area-level representative to the executive committee. The area-level committee is responsible to assist in resolving village-level conflicts regarding irrigation management and provide supervision for improvement of irrigation channels in the area. It is the chairman's responsibility to supervise work in his area during main canal desilting. The chairman is exempt from physical work during main canal desilting as remuneration for his service on the executive committee.

*Executive Committee.* The executive committee consists of twelve members. The chairman, vice-chairman, and secretary, are elected by ballot for two-year terms by voting members (kulara representatives) of the general assembly. The nine area-level representatives bring geographical representation to the executive committee and are directly responsible to their constituency. The executive committee meets at the request of the chairman to make decisions

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regarding operation and maintenance of the system and to assist in communicating the decisions to the mukhtiyar of each village.

The executive committee chairman presides at all the general assembly meetings, general meetings, and the executive committee meetings. Village- and area-level conflicts are referred to him for resolution. The constitution authorizes the chairman to perform administrative duties such as writing checks jointly with the secretary and supervising the other executive committee members. However, his most important leadership task is to manage the day-to-day operation and maintenance of the main canal and to initiate long-term improvements in the system. At critical irrigation periods he is busy listening to complaints and giving directives. The chairman receives NRs 700 per year plus a per diem when he travels away from Butwal on irrigation business. He is exempt from physically working on the maintenance of the system. The vice-chairman fills in when the chairman is unable to perform his duties or is away, but he is not paid for his services.

The secretary records minutes of all meetings and is responsible for maintaining the records. He also keeps the accounts and gives a report of the accounts at the general assembly meeting. As with the vice-chairman, the chairman calls upon the secretary to assist with directing irrigation activities. The secretary is paid NRs 500 per year for his services.

The executive committee has provisions to employ two *meth mukhtiyars* (main system leaders) to supervise day-to-day operation and maintenance of the main system. When one *meth mukhtiyar* retired in 1988 the remaining one requested to be assigned all the duties normally divided between the two. His most important task is to supervise the maintenance work. This involves assigning work to village work groups proportional to their *kulara* entitlement, and monitoring that the work is satisfactorily completed. The *meth mukhtiyar* measures and records incomplete work when quantity assignments are given and notes absenteeism when daily labor has been requested. His records are used by the secretary to compute fines to village-level committees when obligations are not fulfilled. The *meth mukhtiyar* is responsible to notify the village *mukhtiyar* when fines have been assessed. He is also responsible to adjust the outlet openings as directed by the chairman to ensure proportional water delivery. The *meth mukhtiyar* is paid NRs 5,000 per year for his services.

The executive committee employs two messengers<sup>1</sup> to assist the *meth mukhtiyar*. A large part of their work is communication with village *mukhtiyars* and the area-level committee chairman. They also run errands for the *meth mukhtiyar* and the executive committee officials. A bicycle has been made available to each of the messengers to facilitate movement. Each branch canal is responsible to contribute NRs 55/*kulara* to pay for the messengers. Until 1988, all but the branch canals below Sorah-Chhattis Division paid the messengers in kind.

*Sorah-Chhattis Joint Committee.* The predecessor organization to the Government of Nepal's present Department of Irrigation constructed a new irrigation system on the Tinau River with foreign assistance in the 1960s. The command area for the new system was entirely on the right bank of the river and extended into India. Unfortunately, due to heavy siltation and shifting of the river course, this system was never fully operational and was subsequently abandoned. Construction of the permanent diversion weir for this new system blocked the Sorah Mauja Diversion. After the Sorah Mauja Diversion from the Tinau River was closed the Chhattis Mauja organization was forced to allow the Sorah Mauja System to divert

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<sup>1</sup> They are called *sipahi* which literally translates to "guard." Since presently, their primary function is to communicate messages, they are given that designation in the text.

additional water into the Chhattis Mauja Canal and then remove its share by diverting it back into the old Sorah Mauja Canal. To manage the diversions and canal segment delivering water to the two systems, a Sorah-Chhattis Joint Committee was formed. It is presently composed of 11 members. The chairman, vice-chairman, and secretary of the joint committee are elected in a combined general meeting where all the mukhtiyars (54 from the Chhattis Mauja and 33 from the Sorah Mauja) represent the irrigators. This gives representation of nearly the ratio of water sharing prescribed by the government-supervised agreement, i.e., 40 percent for the Sorah Mauja and 60 percent for the Chhattis Mauja. The chairman of both the Chhattis and Sorah Mauja systems is an ex-officio member of the joint committee. At present, three additional voting members have been appointed by the Chhattis Mauja and one by the Sorah Mauja organizations, and two persons have been selected on an ad hoc basis to serve as advisors to the committee without vote.

The joint committee has jurisdiction over all decisions related to system improvement above the point where the two systems divide at Tara Prasad Bhond. It is responsible to see that the water distribution and mobilization of resources from the two systems for operation, maintenance, and improvements are made according to the agreed upon 40 and 60 percent basis. Its mandate includes resolving conflicts between the two systems regarding water and resource mobilization. The joint committee is also responsible to punish anyone damaging the canal or structures above the canal division point with a maximum fine of NRs 5,000, but it cannot intervene in irrigation activities of either the Sorah or Chhattis Mauja systems below the division weir at Tara Prasad Bhond.

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## CHAPTER 3

# Management of Operations

### INTRODUCTION

THIS CHAPTER DESCRIBES operation of the irrigation system as reported and observed in 1988 and 1989. It deals with the performance of the internal operation of the system. Small and Svendsen (1990) call this process performance as distinguished from the water delivery output function of the system. Analysis and evaluation of the internal processes, though they are vital to the delivery of irrigation, do not tell one how well or poorly the system performed its water delivery task. However, from investigation of the internal process comes an understanding of the evolution of the system's institutions and the dynamics of change that affect system sustainability.

The first section of this chapter is a detailed description of irrigation activities conducted throughout the year. The second part uses field measurements and observations to explain why several irrigation practices and rules have been modified. The next two sections examine decision-making authority and give examples illustrating the ability, and in one case the inability, of the Chhattis Mauja Organization to cope with problems of system operation. In the final section the elaborate communication network is described.

Much of the information used in discussing the internal operations is descriptive and anecdotal. Problems discussed by the farmers in meetings or observed in the field are included to illustrate the nature of the steps taken to cope with them.

### Sample Branch Canals

As described earlier (page 3), the analysis in this study of the inputs and outputs of the Chhattis Mauja System has been based on extrapolation from data gathered by an intensive survey of the activities in three branch canals during the period August 1988 to August 1989. These three sample branches (out of the total of 44 branch canals in the system) were selected to represent respectively the head, middle and tail portions of the system.

The general features of the three sample branches selected for intensive study are summarized in Table 3.1.

In subsequent chapters, data about labor inputs, cash costs, crop outputs and so on are aggregated up to provide system-wide estimates, from the information gained in these three branches. The procedure for estimating the system aggregates was not uniform. Items have been estimated on a "per hectare," "per village," "per canal," or "per kulara" basis, according to judgement of which factors seemed more significant in determining the values of a particular data item.

*Table 3.1. Summary features of the sample village branch canals.*

Features	Head Sample	Middle Sample	Tail Sample
Village name	Sardar Nagar	Char Number	Makrahar
No. of households	45	69	56
Distance from lower intake to the branch inlet (km)	4.9	8.8	11.0
Distance from main canal outlet to the starting point of the command area (km)	0.2	0.7	2.3
Command area (ha)	50	70	92
Water allocation and labor responsibility for the main system (kulara)	5	4	2
Land area per water allocation (ha/kulara)	10	17.5	46
Average landholding (ha/household)	1.11	1.01	1.64

## MANAGEMENT OF AGRICULTURE AND IRRIGATION EVENTS IN 1988/89

### Crop Calendar

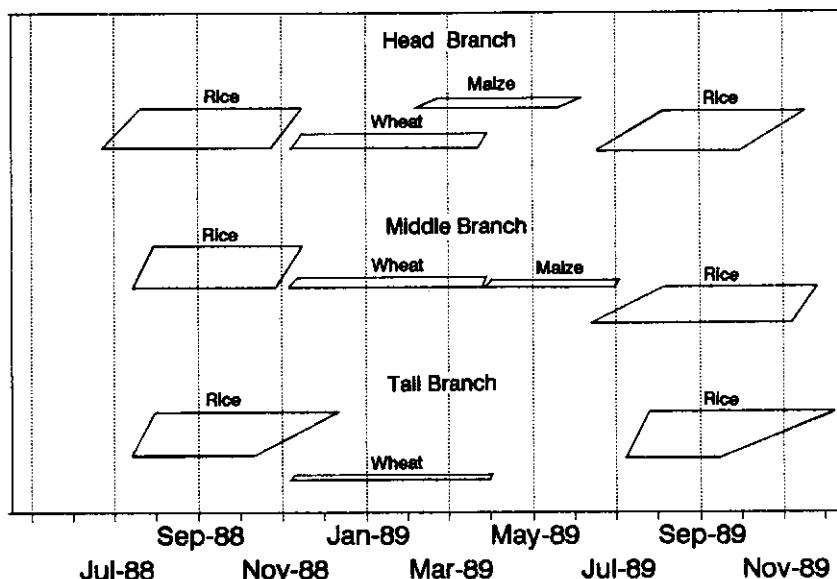
Figure 3.1 shows the timing of planting and harvesting of the major crops in the three sample branch canals. Variation in timing from one year to the next are primarily the result of differences in rainfall or irrigation availability.

### Irrigation in the 1988 Rice Season

From July through mid-September the rainfall was above average. This allowed continuous irrigation delivery from the main to each branch canal throughout the rice season. In some years irrigation delivery is by rotation to one or several branches at a time if the supply is too low for continuous delivery to all branches. By mid-September when rainfall and the irrigation supply were both reduced, some of the early rice was already mature and no longer required irrigation. This reduced the area in the tail branches that required water, making it easier for the meager supply reaching them to satisfy the demand.



**Figure 3.1.** Crop calendar for 1988/89 in the head, middle, and tail sample branch canals of the Chhattis Mauja System.



Harvesting of early rice began in mid-September and the entire process of harvesting was completed in the system by early December. Irrigation application was discontinued by the end of October in most of the command area.

### **Irrigation in the 1988/89 Wheat Season**

Wheat, lentils and mustard are the most important winter crops in the Chhattis Mauja Command Area. Lentils do not require irrigation, and mustard is generally not irrigated more than once, if at all. Wheat is the only major winter crop dependent on irrigation for reliable production.

Farmers sow wheat as soon after harvesting rice as possible. Sowing later than early December results in a significant reduction in yield. In the head end of the system where the soils are well drained, availability of labor and bullocks are the major constraints to timely sowing. In the tail branches lower-elevation fields cannot be sown to wheat because they do not dry out in time. By planting an early rice variety in fields in the tail branches that are slightly elevated, sufficient drying takes place by November so that plowing and sowing of wheat is possible.

Irrigation delivery is seldom a constraint for sowing winter wheat. In a year with normal rainfall throughout the rainy season, there is sufficient residual moisture for seed germination after sowing. The first irrigation for wheat usually takes place about three weeks after sowing. Generally that is followed by a second irrigation as heading starts, and a third just before maturity.

Rainfall in early 1989 reduced the need for irrigation to one or two applications in the head and middle, and one in the tail. Some fields in the tail suffered yield reduction because of flooding due to rainfall soon after wheat emergence. Water was flowing continuously in the main canal during the entire winter period. Farmers were able to divert water to their fields

at any time they wished without consulting village or main canal leaders or other farmers. Drainage water was also used for irrigating wheat in some of the tail branches.

In drought years, the water is rotated from the main canal to one or more branches at a time. To initiate rotation the chairman and meth mukhtiyar evaluate how much water is available at the Sorah-Chhattis Division Structure. Then in consultation with all the mukhtiyars requesting water they establish a rotation schedule among the branch canals. It is seldom necessary to use rotational distribution until late January or early February. It is farmers from the tail branches who generally request the chairman to initiate rotation when the supply in the canal drops to a point when it is difficult to irrigate all the wheat they sowed.

In the 1988/89 winter season, wheat was grown on about 35 percent of the land area in the head sample branch, 24 percent in the middle, and 12 percent in the tail. Farmers said that household food requirements, possible water scarcity, high cost of cultivating wheat including the need for irrigation, and the low market price for wheat were the main reasons for not sowing wheat on more of their land. While irrigation was not a constraint for growing wheat in 1988/89, the lack of sufficient irrigation in some years drastically reduced wheat yield. The threat of water scarcity is a factor as farmers decide how much wheat to sow. In the next chapter water availability for expanded wheat cultivation is discussed further.

### **Irrigation in the 1989 Maize Season**

One reason for irrigating wheat as it matures is to prepare the land for planting maize. The residual moisture makes plowing conditions ideal and assists in germination. Without prior irrigation, farmers must soak the land after harvesting wheat before plowing and preparing the land for maize.

The months from March through May are usually dry and hot. Premonsoon thunderstorms start as early as April but cover only limited areas and cannot be relied upon for spring crops. Without irrigation, crops other than lentils are not grown in the dry season. Discharge in the Tinau River is also at its lowest during this season, often dropping to less than 3 m<sup>3</sup>/s to be shared among the five irrigation systems with diversions near Butwal.

To initiate irrigation, the chairman and meth mukhtiyar together with mukhtiyars from many of the branch canals evaluate water availability at the intake and decide on the type of rotation. Usually, early in the season a number of branch canals are given water simultaneously. Initially the kulara water allocation to each branch canal is used to compute the duration to each group, and water is roughly proportioned among the branches receiving water at the same time. In recent years it has been the practice to start rotation from the tail branches one year and the head branches the next.

Often, before all branch canals have received irrigation, the water supply diminishes to a point when it is necessary to shift rotation to a single branch at a time. As the supply reduces further and most of it infiltrates into the canal bed before reaching the lower branch canal inlets, the duration of delivery is decided only after water arrives at the inlet. The main canal messenger and meth mukhtiyar are the primary main system functionaries responsible for managing the rotation. Though the chairman is often approached with appeals and will give instructions to the meth mukhtiyar, he and the executive committee are less involved in day-to-day management during the dry season rotation than during the rice season. This corroborates the chairman's statement that managing the system is much easier when the irrigation supply is low and rotation from one branch canal to the next is being practiced. He was contrasting this with adjusting branch canal discharge under continuous flow conditions when water is scarce.

Branch canal mukhtiyars frequently appeal for a few hours extra delivery if they have not been able to service all the crops in their branch, or if they are dependent on canal water

for domestic purposes and have holding ponds to fill. The extra delivery is given before the start of the next rotation. Some farmers complained that success in getting extra water delivery depends more on the relationship between the village mukhtiyar and the main canal messenger or the meth mukhtiyar than on genuine need. However, no one suggested that flexibility in assigning extra time should be abolished.

Irrigation distribution within the branch canal is managed entirely by the farmers of each branch. In most cases the entire flow in the branch canal is rotated from one farmer to the next. The within-branch rotation schedule is prepared after the water arrives at the first field and the main canal messenger and meth mukhtiyar decide on the duration of delivery to the branch.

In 1989, maize was planted in 34 percent of the land in the head sample branch and 15 percent of the area in the middle sample branch. No maize was planted in the tail sample branch. The reasons given by farmers in the tail for not planting maize were: 1) Uncertainty of water availability for planting and subsequent irrigation; 2) Not having a tradition of growing or eating maize; 3) Open grazing being allowed for cattle during the period so that it would be difficult to protect maize fields; 4) The soil in the tail being unsuitable for maize (meaning, the lowland is difficult to plow); and 5) Maize not being a profitable crop given the high cost of cultivation.

In the head branches where early maize planting was possible, many farmers intended their maize to be harvested as green ears for roasting. A profitable market is available for green ears. A farmer estimated that 100 average size ears of maize would yield about 8 kg of dry grain worth NRs 28 at the market price. However, if the same 100 ears were marketed green, they would be worth NRs 40. This calculation assumes that the maize would be marketed at the early season price. Later in the season the price for green ears usually drops to about the dry grain price.

If maize is harvested as early as green ears, the stalk can be used for fodder which is in short supply during the dry season. Removing the crop early also allows greater flexibility in land preparation for the rice crop.

Dry season cropping carries a great deal of risk. In the 1989 season the, irrigation supply available during April and early May was not sufficient to sustain the maize crop. Some of the maize planted early did not yield green ears and was harvested for fodder. The maize planted late benefitted from unusually good rains in May and June.

### **Rice Seedbeds and Transplanting in 1989**

Rice is the most important crop for farmers in the Chhattis Mauja System. Seedbed preparation in late May overlaps with the maize crop. Transplanting begins in some fields before the last maize crop is harvested in others. Because of its importance, irrigation for rice-growing activities takes precedence over those for maize.

Frequent rainfall from mid May through mid June in 1989 made this an unusual season. While irrigation still needed to be coordinated and rotation was practiced, seedbed preparation and transplanting in all three sample branches were completed a week earlier than in the previous years.

Typically, the first seedbeds are prepared in the head of the system during the second week of June. Transplanting starts three weeks later or as soon as water is available for land preparation. If there has been no rain for some months, the available water supply will be low and distribution from the main canal will be on a rotation basis. Farmers from the tail sample branch indicated that they usually do not receive water for seedbeds until the end of June or the first week of July. In both 1988 and 1989, they received water from the canal in the third

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week of June. In 1989, the demand for the water was low because rainfall alone was sufficient for seedbeds in the lower-elevation plots.

Farmers in the head branches began transplanting as soon as the seedlings were ready and they could get enough water for land preparation. Unless there is enough rainfall to increase the discharge in the river and main canal, transplanting proceeds very slowly. Irrigation must usually be distributed by rotation for transplanting. Farmers indicated that rotation for seedbeds always starts from the head of the system but that for transplanting they alternate, starting at the tail one year and the head the next. Until rainfall increases the discharge in the river, it is often necessary to rotate the water one branch canal at a time.

### Main Canal Water Distribution Procedure for Rice

The chairman and other members of the executive committee explained the rules and practices for water distribution as follows:

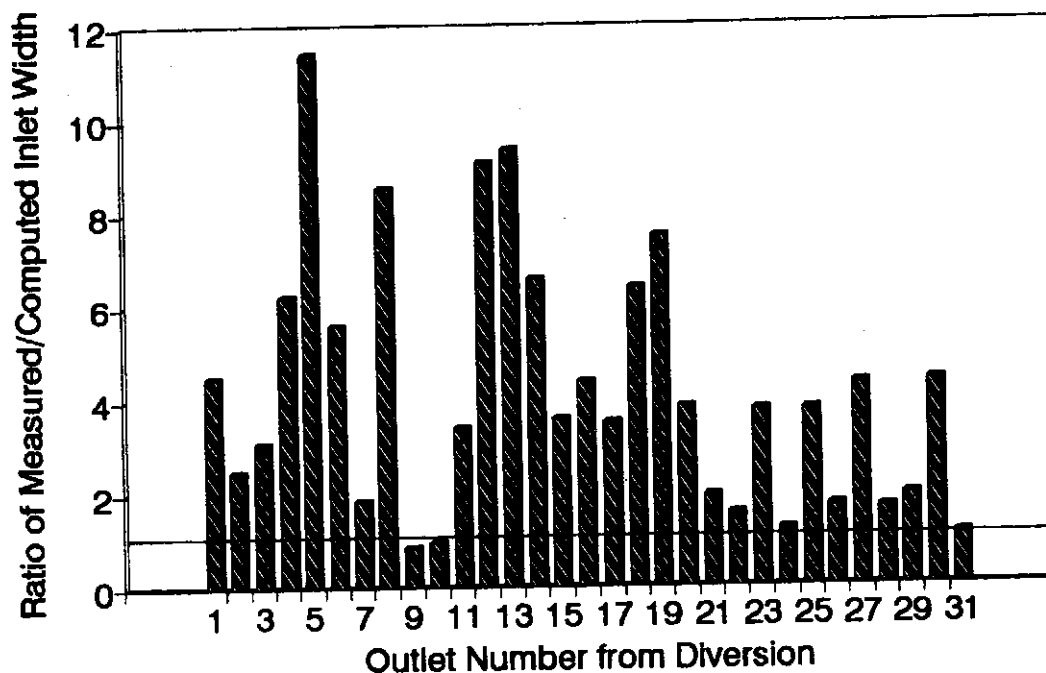
*For the monsoon rice season, with the exception of severe drought when we use timed rotation among branch canals similar to what we do in the winter for wheat and in the spring for maize, we have continuous flow into each branch canal outlet. We measure the total width of water flowing at the location of the outlet, i.e., the main canal width plus the branch canal outlet width. Then we adjust the width of the branch canal outlet so that the ratio of the outlet width to the total is the same as that of the ratio of the kulara (water allocation units) served by the outlet and the total number of kulara of the main canal and outlet at that location.*

The executive committee claimed to have records of computations they made for determining the opening size of branch canals. They found an example that showed calculations made before installing a masonry proportioning structure in 1982 and said similar calculations had been made for all thirteen outlets recently improved with masonry or wire gabion material. The computations were checked and support the procedure they described; the size of the proposed outlet opening was proportional to the kulara entitlement of the branch canal. It seemed that the system managers had initiated a procedure for implementing the water allocation rules.

**Measurement and Observation of Branch Outlet Openings.** Thirteen of the branch outlets have structures made of masonry or stone-filled wire crates to provide permanent, reliable, delivery of water from the main into the branch canal. The remainder of the 44 outlets use wooden posts, stones, and branches to define and control the opening width. Figure 3.2 compares the proportionality of the first 31 outlet openings to the kulara entitlement. The width of the measured opening is divided by the width as computed according to the proportionality rules stated by the executive committee. This ratio compares the actual inlet opening to the opening size computed according to the procedures indicated by the system managers. With two exceptions, every opening width exceeds the authorized entitlement.

The measured openings do not conform with the stated rules and practices and in a number of cases are more than seven times the expected width. The magnitude of the deviation is surprising given that in nearby hill systems with similar rules the error was only a few percent. Hill system irrigators receive water through proportioning structures typically assembled to check the dimensions and alignment on an annual basis (Yoder 1986). This practice was not observed in the Chhattis Mauja System. Measurement or construction error could not possibly account for the discrepancy either since there are many examples of accurate farmer-built structures in the Chhattis Mauja community.

Figure 3.2. Ratio of measured width of the branch canal openings to the width computed by procedures suggested by the executive committee.



Obviously the rule in use for continuous water distribution is quite different from the rule the executive committee members said was used to compute and adjust outlet openings. They seem to have recognized that if constructed according to the computed dimensions, proportional water distribution would not be achieved by side intake structures common in the system. Even recently built structures using masonry or gabion crates do not have check structures to regulate the main canal water level or a means to stabilize the canal bed. This is primarily because the canal bed has eroded to a width of 10 m in many locations and even up to 20 m at one inlet. The cost of building a structure to regulate the main canal bed elevation is more than the amount most villagers using a branch would want to invest.

The exceptions are outlets 9 and 10 (see Figure 3.2) built on a common sill that continues across the main canal. The structure has done a good job of stabilizing the canal bed level and width. It provides an equal head of water to both the main canal and inlet openings. This is the opening for which the executive committee was able to provide the record of computing the opening size. The reason that the openings are smaller than allowed is that the total number of kulara has decreased in the system since the structure was built. The benefit of increasing the openings slightly to match the new entitlement has not been considered worth the cost of modifying the masonry structure.

**Adjustment of Branch Inlet Openings.** It appears that proportional division using the computed outlet opening size is the starting point for dividing the available water. Other factors including farmer satisfaction are also considered. When rainfall is abundant the head branches divert as much water as they need with the excess entering the drainage system. In the tail branches where the infiltration rate is much lower, rainfall, water diverted from drainage channels, and

whatever small amount of water delivered by the main canal are usually sufficient to keep water ponded in the fields. It is easier for farmers in the tail to divert water from the drainage channels than to notify the chairman and apply the continual pressure necessary to get their share of water delivered.

When the water supply drops, less water enters the drains and farmers from the lower branch canals press the chairman to take action. The first alternative is usually to try and increase the supply from the river by repairing the diversions. When that does not suffice, the chairman instructs the meth mukhtiyar and the messenger to adjust the branch canal inlets for more equitable water delivery.

The meth mukhtiyar and the messenger start at the head of the system and adjust the flow into each branch outlet. The branch canal mukhtiyar and farmers from that branch are required to be in attendance and assist with this process. One person is instructed to stand in the branch canal about 10 m down the canal to observe the discharge. The meth mukhtiyar is assisted by farmers from the branch canal in adjusting the flow by placing stones and brush to further close or open the inlet. Upon completion of the adjustment, the mukhtiyar of the respective branch must sign the following statement:

*I am satisfied with the share of water adjusted by the meth mukhtiyar and messenger in my presence at the main canal outlet. I will be responsible for any disturbance in the main or branch canal carried out to change the flow in the branch. If we disturb the flow we agree to receive punishment according to the rules of the Chhattis Mauja executive committee and will pay the fines accordingly.*

Before such an adjustment was made by the meth mukhtiyar there was no consideration for water theft from the main canal. Requiring each branch canal mukhtiyar to sign a statement signaled that monitoring will start. It also established that adjustment had been made and that they had reached agreement that the discharge into the branch was acceptable. The signed statement provides evidence that the chairman and meth mukhtiyar are doing their task properly and gives the chairman a stronger position in the event of there being charges of water theft. During the 1988 rice season there were no reports of illegal water diversion.

Due to siltation in the main and branch canals, the amount of water entering a branch is continually changing. However, it is up to the farmers of each branch to check and inform the chairman if they feel maintenance action is needed near their intake or that they are not getting sufficient water. The effectiveness of this process is reviewed together with an analysis of water distribution from the main to the branch canals in the next chapter.

### **Irrigation Management Pattern in the Sample Branches**

Each village is free to set its operational goals and formulate irrigation plans within its branch command area. People migrated from the hills at different times and from various locations bringing different concepts of irrigation management. Consequently, the resource mobilization and water allocation principles applied in separate branch canals differ among villages.

Farmers in both the head and middle sample branches indicated that water was not a serious constraint for the rice crop in 1988 or for transplanting rice in 1989. They reported that a shortage of labor and bullocks at transplanting time caused several days, sometimes weeks, delay beyond the optimum time for transplanting.

**Head Sample Branch.** A messenger appointed by the branch canal committee looks after much of the day-to-day work and communicates important information to all the farmers. He is responsible to distribute the list of irrigation turns which is prepared after a village-level

meeting establishes the duration of rotation and method. He also reports problems such as water theft. The fine is up to NRs 100 for stealing water within the branch.

The farmers in the head branch indicated that during rice seedbed preparation and transplanting they generally receive water from the main canal on a rotational basis. Their turn is often combined with two or more other branches. In 1989, however, rainfall was above average both in the Tinau Catchment Area and in the command area. Water was available from the main canal on a continuous basis. This enabled them to complete all seedbed sowing in the branch about a week earlier than normal. Generally, the seedbeds must be irrigated repeatedly but because of recurrent rainfall in 1989 they only irrigated the seedbeds twice.

During the entire rice season in 1988, even when water was abundant, irrigation distribution within the branch was done by rotation. For transplanting rice the command area was divided into two rotation units, with one unit in the top and the other in the bottom half of the branch command area. Each unit received water for a 24-hour period in their turn. Persons ready to transplant used water during the day and fields already transplanted were irrigated at night. Rice transplanting was completed by the end of July in 1989, about a week earlier than usual.

During the rice growing season irrigation allocation within the branch is on the basis of area irrigated by each individual household. This is also the basis for contributing labor and cash for branch canal and main system maintenance. For the first week after transplanting in 1988 each 0.67 ha was entitled to receive water for 1.5 hours. One full irrigation cycle took 4.5 days. For the last three weeks of September the rotation time was increased to 2 hours for each 0.67 ha and the rotation took 9 days.

Whenever the rotation cycle needs to be changed a village-level meeting is called. The messenger prepares the rotation list according to the decision made at the meeting. Each farmer's name, land area, and time allocation is on the list. This list is passed from one farmer to the next. According to their rule, the irrigation list must be handed over to the next farmer at least one hour before his turn is to start. Failure to pass it on in time results in a NRs 100 fine. All family members including school boys knew the time of their turn and were ready to take over the water the instant they were allowed to do so. The rotation worked smoothly without conflict during the entire season.

Wheat was planted in about 35 percent of the head sample branch in the 1988-89 winter season. The rest of the area was planted to mustard, lentils, and in some fields a mixture of mustard and lentils were planted. Most of the planting was complete by the month of November. The wheat harvest was complete by early April.

*Middle Sample Branch.* In this branch, the mukhtiyar and the messenger are elected for a one-year term each. They are responsible for looking after all irrigation activities. A meeting is held once a year where all beneficiaries participate to formulate rules and hold the election. Individual water allocation is based on the size of landholding and carries with it a proportional responsibility for resource mobilization.

To simplify water distribution the beneficiaries are divided into three groups so that the total water allocation to each group is about equal. It is the responsibility of the group getting the water to check the main canal outlet to be certain that their branch is receiving its share. During the rice season in 1988 irrigation was rotated among the groups every 24 hours. Within the group the water is roughly proportioned to each farmer's field according to his water allocation, using earth and stones to adjust the discharge through the field inlet. Either the mukhtiyar or the messenger supervises the distribution of water to each farmer within the group to ensure that all get water according to their share. In this branch, when water is in short supply each farmer must first check with the mukhtiyar before applying water to his field.

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The water supply in the main canal decreased in the month of September 1988. By the middle of the month the rotation schedule was changed and the full branch canal discharge delivered from one farmer's field to the next. This allowed precise timing of each irrigation turn in proportion to the area irrigated by each household.

The middle sample branch has a low-gradient branch canal. Siltation is a serious problem near the intake. In each irrigation cycle, four or five farmers accompanied the mukhtiyar to the intake to desilt the canal and increase the discharge. Because their fields are on slightly higher ground, the middle branch canal does not have access to drainage water from other upstream branches as do most other branch canals in the lower half of the system.

*Tail Sample Branch.* The mukhtiyar of this branch is responsible for all irrigation activities as there is no messenger. Compared to the other two sample branches the tail branch farmers did little to organize their irrigation activities. If there were decisions to make they all preferred to meet and provide input.

Rainfall in 1988 was sufficient for land preparation without irrigation. Farmers with low fields had to wait for water to drain before they could transplant. Farmers reported that usually they had to wait for water from the irrigation system to transplant rice. They complained that water was distributed to the head branches first and that they were always the last to transplant. Not alternating the rotation schedule so that they can have first access every other year was the only major weakness in main system management that they identified.

The tail sample branch does not have fixed rules for water distribution. The farmers met informally several days after completing rice transplantation and established an irrigation rotation schedule. Households were divided into 14 groups of four each. Each group was entitled to use all the water in the canal for a 12-hour period. Within each group water was divided roughly according to landholding. Water was not sufficient at their outlet in the main canal to complete the first irrigation turn. They requested the meth mukhtiyar to adjust the flow and then resumed the rotation when water was again available a few days later.

The inlet of the tail branch is near the end of the main canal 11 km from the intake. In addition, the branch canal is 2.3 km long from the outlet to the first fields. Several other tail area branch canals have intakes near the sample branch but with their command area nearer the main canal. The tail sample branch farmers accused those from the other branches of frequently stealing their water. However, the mukhtiyar did not make a formal report to the system chairman because he was accused by the other branch canals of having taken water illegally at night from the main canal, a more serious offense.

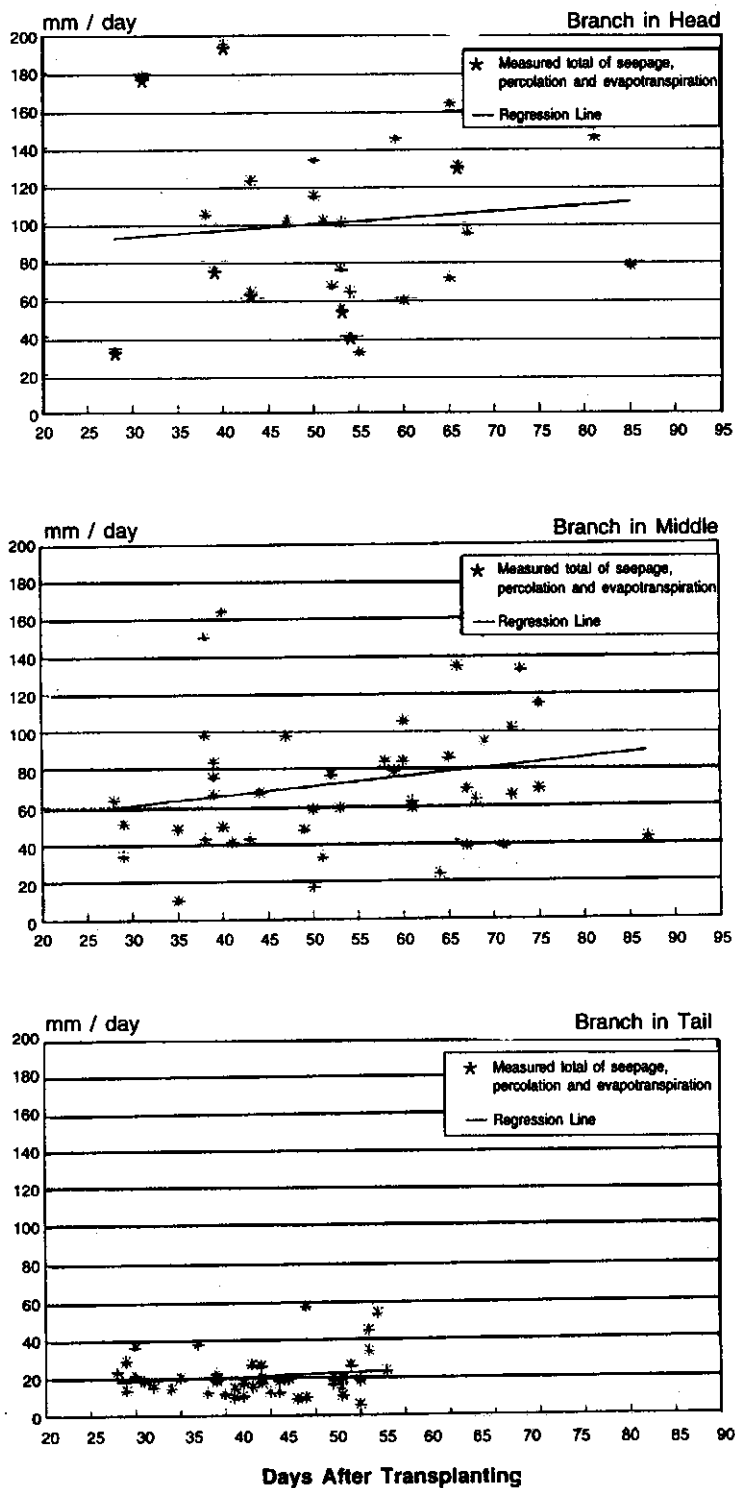
Nearly 40 percent of the tail branch canal area was planted to early maturing rice. By the time water delivery became difficult in late September irrigation was no longer necessary for the early varieties, making the meager supply sufficient for the remainder of the fields.

## **HYDROLOGIC CHARACTERISTICS SHAPING OPERATIONAL RULES**

Several factors that have influenced the operational rules in use but are not immediately apparent through observation, were identified during the period of field study. These include differences in the seepage and percolation rate, depth to the water table, and access to the reuse of drainage water from head end branches by some of the tail branch canals.



Figure 3.3. Seepage and percolation plus evapotranspiration rates measured during the 1988 rice season in the Chhattis Mauja head, middle, and tail sample branch canals.



### Seepage and Percolation Rates

Figure 3.3 indicates the seepage and percolation plus evapotranspiration rate as measured in different field plots of the three sample branch canals. As noted in other studies of seepage and percolation in Nepal (Adhikari 1987; Yoder 1986), there is a tendency for the rate to increase over the growing season. However, of major interest here is the relative magnitude of the rates. The regression lines for the sample data indicate that the combined loss from seepage, percolation, and evapotranspiration was on average about 100 mm/day for the head branch, 70 mm/day for the middle branch, and 20 mm/day for the tail branch.

With losses of 70 mm/day, more than 8 l/s/ha of continuous water application would be required to maintain ponded water in the field. With such rapid infiltration, farmers found they needed higher field application rates than available through continuous distribution to all fields even when the irrigation supply was adequate. Within-branch rotation is practiced for all irrigation distribution in the head sample branch. This allows individual plots to be flooded quickly to ensure that the entire field is covered. Lower percolation losses between periods of water application reduces the amount of water used to grow rice.

The surface soil texture is slightly more coarse in the head and middle branches than in the tail. Soil textural analysis of three plots in each branch where seepage and percolation rates were monitored gave a range of clay content from 9 to 23 percent, but all samples fell in to the silt soil texture class. The lack of deep plowing and soil puddling and the depth to the water table rather than the soil texture, control the seepage and percolation rate. Labor and animals for land preparation are in short supply. Animal traction is generally of low quality and the implements used do not allow deep plowing. As a result the puddled layer of soil often averages 75-100 mm and is seldom as much as 150 mm.

### Level of Groundwater Table

The water table in the command area was monitored by observing the water elevation in dug wells. In the head branch there were no dug wells since the water table is too deep. The uppermost branch canals were opened at the insistence of the local government to supply water to communities that did not have access to groundwater. Since that time, a piped drinking water system has been installed in parts of the upper command area. Part of the drinking water system is linked to the Butwal town system and other parts to a deep tubewell drinking water project established with assistance from the government. However, some of the upper and middle command area is still dependent on the canal for the domestic water supply.

In the tail branch the water table was observed in a location where land elevation was slightly higher than in the nearby fields, and the water table came to 0.15 m below the surface by the end of the rainy season. Groundwater was making some contribution to sustaining rice plant growth in this area, especially by the end of September when irrigation delivery was discontinued to the tail. With the water table so near the surface in the tail branch, percolation losses were greatly reduced compared to fields in the head of the system.

### Reuse of Drainage Water

The head and middle part of the system have well-established surface drains. Some areas in the middle and most of the tail branches of the system can access and reuse water that has collected in drains from the head reach area. In some parts of the tail small masonry dams were constructed to divert and use drainage water for irrigation.

The Chhattis Mauja Constitution declares that all drainage water flowing through the command area is under the control of the organization because it either originates directly

from excess irrigation spilling into drains or from springs that flow because irrigation and rainfall have infiltrated in to the upper reaches of the system. The constitution states that only farmers from villages that have contributed labor for maintenance of the main system are entitled to use drainage water for irrigation. If conflicts occur over the use of drainage water, the executive committee has authority to arbitrate and if necessary make the final decision.

### **Implications for Operational Rules**

Because of lower infiltration rates and the contribution of groundwater to plant growth, much less water is required in the tail of the system for growing rice than in the head end. Except during a drought, it appears that this more than offsets the water delivery losses in the canal during the rainy season. In addition some fields have easy access to water diverted from drains. As a result of these factors the villages in the tail of the system were interested in decreasing their water allocation in order to reduce their maintenance responsibility and operating cost. Farmers in the head and to some extent in the middle branches found that irrigation allocation on the basis of land area was not sufficient for timely irrigation. As a result the organization changed its rules regarding irrigation allocation. Allocation on the basis of land area introduced by the new organization established in the 1950s was changed to a demand basis where each village or branch canal could propose the level of allocation it desired.

As noted in Chapter 2, an application must be made to the executive committee if a branch canal desires to increase its water allocation. As with the opening of a new branch canal, the executive committee usually defers decisions concerning water allocation to a meeting where there is representation from each branch canal to discuss the implications. This can be either a general meeting or a general assembly meeting. The referral reflects an important aspect of the water allocation principle. A change in kulara allocated to a branch affects all the irrigators by changing the total number of kulara, and hence, the denominator in the ratio used to calculate the water entitlement and resource delivery obligation of each branch. This is in contrast to irrigation systems where the number of shares is fixed and changes in water allocation must be made by trading shares. For example, in the Chherlung Thulo Kulo in Palpa District of Nepal, shares of water increased in one branch must be reduced in another branch so that only the branches participating in the allocation transfer are affected (Martin and Yoder 1987).

Farmers indicated that the following factors are important in determining the number of kulara water allocation necessary for a branch canal:

- \* The type of land irrigated (upland which is well drained, or lowland with drainage problems);
  - \* The seepage and percolation rate;
  - \* The availability of labor and the ease with which the farmers in the village are able to contribute labor for main system O&M;
  - \* The proximity to the main canal and travel time to the river diversion for maintenance;
  - \* The water availability at the branch canal intake point during normal flow periods; and
-

- \* The opportunity to use drainage water either from within the branch or from other branches.

Table 3.2 illustrates the change in water allocation that has taken place in recent years in a few villages. In each case, branches in the head increased and those in the tail decreased their allocation.

*Table 3.2. Sample of recent branch canal changes in water allocation (kulara).*

Village	Relative Location in System	Original Allocation	Allocation in 1988
Sardar Nagar	Head	4	5
Kapil Mohoda	Head	2	3
Chiniya Bahadu Mohoda	Middle	1	2
Madrani	Tail	6	4
Haraiya	Tail	3	2
Sakhuwi	Tail	3	2
Budhabare	Tail	3	2
Tuktuke	Tail	3	2
Mauwari	Tail	4	3
Darshan Tole	Tail	2	1
Semra	Tail	2	1
Kumari	Tail	10	8
<b>Total</b>		<b>43</b>	<b>35</b>

The data in Table 3.2 may not represent all the changes in water allocations that have actually taken place. These items are derived from searches of executive committee records and from field discussions. They are believed to show the trend of recent changes, but may not be comprehensive in detail. It should be noted that, during the period covered by Table 3.2, water demand in the tail areas was affected by the inception of the groundwater development project there. This development caused some communities in the tail reaches of the Chhattis Mauja System to change from dependence on the canal system, to use of the new well resources.

The village of Haraiya, mentioned in Table 3.2, is different from the village of Haraiya Bazar which (as was discussed on page 15) withdrew entirely from the Chhattis Mauja System in 1989, because of their preference for the new groundwater supplies.

Flexibility in determining irrigation allocation allows movement toward improved performance. The analysis in Chapter 6 shows that there is now a better balance between the benefits received from irrigation and the payment of the cost of system operation and maintenance than in the past. Changing the irrigation allocation has allowed closer matching of entitlement to irrigation and the need for irrigation, and because of the maintenance responsibility attached, it has encouraged efficient use of the available water resource.

## DECISION-MAKING AUTHORITY

Authority for decision making in the Chhattis Mauja System is highly decentralized. At each level there is a mechanism for representation by persons affected by the decision.

### Joint System Level

A joint general assembly composed of all 54 village-level mukhtiyars from the Chhattis Mauja and 33 village-level mukhtiyars from the Sorah Mauja is the highest level decision-making body of the joint system. It elects the joint executive committee and meets periodically to make other decisions relating to the operation and maintenance of the diversions and the first 1.6 km of canal used by both systems. The joint executive committee is charged with enforcing the rules and implementing decisions made by the joint general assembly but does not have authority to formulate new rules and regulations.

The frequency of joint general assembly meetings varies from year to year. Table 3.3 shows that in 1984/85, when construction on the division weir at Tara Prasad Bhond was under way, the joint committee met often to resolve problems. In 1988/89, the frequency of joint committee meetings was high due to the start of system improvements at the lower intake.

*Table 3.3. Frequency of meetings of the Chhattis Mauja System and the joint meetings of the Sorah and Chhattis Mauja systems.*

Year	Joint Meeting		Executive Committee	General Assembly	General Meeting	Village-Level <sup>a</sup> Meeting		
	Executive	General				Head	Middle	Tail
1982/83	*	*	12	1	2	*	*	*
1983/84	*	*	12	1	1	2	1	1
1984/85	7	1	8	1	3	5	1	1
1985/86	6	5	11	1	1	6	12	1
1986/87	3	2	11	1	4	3	2	1
1987/88	6	1	7	1	5	7	3	1
1888/ August 89	5	1	3	1	1	4	2	2

<sup>a</sup> Branch sample canal villages.

\* Not available.

### Main System Level

The Chhattis Mauja Constitution defines two types of meetings for system-level decision making by representation. The highest level decision-making body is the general assembly. It is composed of one representative for each kulara water allocation and resource mobilization obligation from each branch canal. The representatives must be assigned by the village committee and must be registered in the minutes of meetings in which they vote. Two-thirds of the representatives must be present for a quorum.

All water users of the system are welcome to attend and participate in the discussion at meetings but only the persons assigned for each branch canal can vote. This formalizes

representation in decision making according to the water allocation and resource mobilization responsibility. Election of the chairman, vice-chairman, and secretary is the most important function of the general assembly meeting. The secretary generally gives an oral report about the status of the financial accounts that includes a list of income and expenditure. Any other issue placed on the agenda can also be discussed at this meeting.

The general meeting is the second type of meeting. It is composed of the executive committee members and a representative from each village. Two-thirds of the 65 members must be present to form a quorum. A general meeting can be called whenever there is need to discuss and decide an issue that involves more than one branch canal. Usually knowledgeable and influential irrigators are invited to attend in addition to the village representatives.

The constitution states that there are to be two general assembly meetings and four general meetings each year. Table 3.3 shows that in the past seven years there has only been one general assembly meeting each year. In order to send representatives to a general assembly meeting, a village-level meeting must first be held to select representatives according to their kulara entitlement. This is inconvenient and time-consuming. It is easier to call a general meeting. Because branches in the head of the system have increased their kulara irrigation allocation and branches in the tail reduced theirs, a general meeting gives a voting advantage to the tail end of the system relative to a general assembly meeting.

It is the Chhattis Mauja chairman's job to implement operation and maintenance activities of the system by supervising the meth mukhtiyar and the messengers. He operates within a well-defined set of rules spelled out in the constitution (Appendix 1). He is authorized to spend up to NRs 1,000 and to take action to resolve conflicts.

During the rainy season, the chairman and the meth mukhtiyar are busy either solving water distribution problems when water is in short supply or supervising emergency maintenance when there is heavy rainfall and water is abundant. Often action for maintenance must be taken immediately to limit further damage or save time and expenses. If delaying by a day to call an executive committee meeting to make a decision is judged by the chairman to be harmful he will consult with the meth mukhtiyar and together decide on the course of action to be taken immediately.

When a decision concerns the majority of the irrigators, such as for resource mobilization in situations other than emergencies, or could be considered controversial by other irrigators, the chairman calls an executive committee meeting for consultation. In general, activities that involve the majority of irrigators and that need to be planned ahead are first discussed in an executive committee meeting. Geographical representation by the area committee representatives helps balance the discussion and facilitates communication to all irrigators.

### **Village Level**

Except for conflicts over irrigation matters they cannot settle by themselves, all authority over irrigation activities at the branch level are delegated to the irrigators in each respective branch. Each village can decide for itself how to organize and carry out its irrigation activities and fulfill obligations for main system operation and maintenance. At the village level, entitlement to irrigation and responsibility for irrigation costs are usually either shared equally among households or on the basis of landholding size.

Most villages have between 50 to 100 households living in close proximity. If a village meeting is held to discuss irrigation issues most farmers attend it. In some villages there are five or more meetings a year. In others they meet only once or twice to discuss the budget or to decide on how to cope with a water shortage.

## DECISION MAKING AND OUTCOME EXAMPLES

### The Joint System

During the 1988 General Assembly Meeting, the chairman reported that the new masonry structure to divide the main canal water between the Sorah and Chhattis systems at Tara Prasad Bhond was now complete and asked if the farmers had seen it since it was completed (Appendix 2). The chairman had been observed checking the structure the previous day. With only a few hundred liters per second discharge, he systematically measured the depth of flow over the sill at various points on each side of the Sorah and Chhattis Dividing Structure. He reported that the difference in sill elevation was not more than "half a millimeter" and that there should no longer be disputes about division of water between the two systems.

He was interrupted by a farmer who said: "Yes! I have seen what has been built. All of the water will go toward the Sorah Mauja and all the sand toward the Chhattis Mauja." He was angry that the upstream approach curved slightly and had not been straightened during construction. Though this farmer had no formal training, his observations of how the canal transported bed material matched hydraulic theory. The chairman acknowledged the problem and indicated that it had already been discussed with the joint committee chairman. They had agreed to observe the water division and install a deflector wall upstream if necessary to adjust the flow properly.

The chairman monitored the situation as the discharge increased in the canal during the rainy season. He concluded, as the farmer had suggested, that when the discharge was more than 1-2 m<sup>3</sup>/s the curved approach channel did disturb proper flow division. The joint committee chairman agreed and together they convinced the Sorah Mauja Executive Committee to allow the Chhattis Mauja farmers to construct a deflector about 25 m upstream of the dividing structure. After its construction no further complaints were lodged about the flow division in the Chhattis Mauja Organization.

### Free Riders

The joint committee was formed when the Sorah Mauja joined the Chhattis Mauja in 1965. It was to be a mechanism for better cooperation in operating and maintaining the jointly used diversions and the first few kilometers of main canal. For a number of years it remained inactive and the executive committee of the Chhattis Mauja System controlled most day-to-day operation and maintenance duties with village-level organizations from both systems providing labor, cash, and material resources. With the opening of four branch canals above Tara Prasad Bhond, where the main canal is divided between the Sorah and Chhattis systems, a conflict developed over operation and maintenance of the jointly operated part of the system.

Many settlers of the area now comprising the four upper branches are retired from the Gurkha Regiment of the British Army. They receive pensions and are relatively well-to-do. They gained influence with the local government and through it put pressure on the regional government to do something about water availability for their area. Since the area from the southern edge of Butwal for several kilometers into the tarai has coarse soil with a deep inaccessible water table, it is not possible to construct wells with local resources and household water supply was a serious problem for much of the year. The government intervened and forced the Chhattis Mauja to allow the upper branch canals to be opened ostensibly for domestic water supply.

Earlier, farmers from the Chhattis Mauja System had reluctantly accepted sharing their irrigation facilities with the Sorah Mauja at the insistence of the regional government. They have achieved a satisfactory workable arrangement for sharing water and operation and

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maintenance costs. More intrusive for them has been the government's support for opening the four upper branch canals. Rather than restricting use to household purposes these branches irrigate crops all year on soils that have extremely high infiltration rates.

In 1983, the farmers from the four newest branch canals above the Sorah-Chhattis Dividing Weir challenged the Chhattis Mauja Executive Committee's authority. They claimed that only the joint committee should have jurisdiction over the diversion and the jointly operated canal up to Tara Prasad Bond and resented attempts by the Chhattis Mauja Organization to assert authority over them. They declared that they would only participate in operation and maintenance activities that involved the jointly operated facilities. To press their claim they formed the Kalika Irrigation Reform Committee.

To counter the threat of a new organizational structure, both the Sorah and Chhattis Mauja executive committees encouraged the joint committee to take responsibility for activities that involved external resources for improvement of the diversion structures and canal above Tara Prasad Bhond and to be active in desilting and maintenance of that part of the system. The joint committee mukhtiyar and the messenger now play a major role in the emergency maintenance of the diversions by requesting labor and materials from the two executive committees and keeping records of contribution by each branch canal.

The four upper branch canals are considered a part of the Chhattis Mauja Organization with water allocation rights and labor responsibility of 22 kulara. They exercised their right to vote in the 1989 election of executive committee members. There has never been agreement by the general assembly that these four branch canals should be exempt from participation in main canal desilting and emergency repairs and most Chhattis Mauja members feel they should participate in the same way as the remainder of the branch canals. However, in 1988 they did not contribute to canal desilting since the main canal above their outlets did not need cleaning.

In the 1988 General Assembly Meeting, the audited account statement included income generated by charging each branch canal NRs 600/kulara. However, because the money was intended for the Sorah-Chhattis Dividing Structure the four upper branch canals refused to contribute as they do not use that section of the canal. An example from the executive committee meeting in August 1988 illustrates that it is the general practice for all branch canals to assist with the main system regardless of where the problem is located. In this case, a village in the tail of the system appealed to the executive committee for assistance in repairing a diversion dam which they used to divert water from a drainage channel. A recent flood had damaged it and they did not have enough labor available to make the repairs in time to finish transplanting their rice. The executive committee instructed 13 villages in the tail of the system to assist in the repairs and exempted them from an equivalent amount of emergency work on the main canal diversion later in the year.

In the General Assembly Meeting in 1989 a list was presented enumerating each village's shortage in contributing labor for emergency maintenance. The four villages of the four upper branches were the only ones not listed. The Chhattis Mauja farmers have not found a way to enforce their rules in the case of the four upper branch canals and a discrepancy continues to exist between the state rules and the rules as practiced for this part of the system.

This is a conflict that has not been resolved and is a source of major irritation to the Chhattis Mauja farmers in the lower part of the system. They view the farmers of the four upper branches as free riders who take far more than their share of the water without doing their share of the maintenance. They continually accuse the four upper branches of not cooperating in sending labor at the appointed time and for breaking the rule that only allows adult men to work on the canal. In the hotly contested election of executive committee members in 1989, the 22 kulara vote representing the four upper branches were openly



recruited by the past chairman. There were strong accusations of collusion between the chairman and the irrigators of the four upper branch canals for their mutual benefit.

From the perspective of farmers in the Chhattis Mauja, their general assembly has the final authority over management of all operation and maintenance activities of the main system. They argue that they built the system and have invested a great deal on its maintenance over the years and consider themselves the owners. They define the boundary of the main system to include the diversion structures on the Tinau River, the jointly operated canal, and the lower canal network delivering water to the branch canal outlets. The village-level organization takes control at the branch canal outlet. The joint committee is seen as a mechanism of cooperation to gain resources to assist in running the system and not as a hierarchical authority.

This view is not shared by the Sorah Mauja, the villagers of the four upper branch canals, nor has it been shared in the past by members of the regional government. They would like to see the joint committee take more control in managing the joint part of the system. The Sorah and Chhattis Mauja have worked through a long and bitter struggle over joining intakes and dividing the irrigation supply between them. They both gained by having access to two instead of one diversion and together can mobilize a much larger work force for emergency repairs. However, the relationship with the four upper branch canals remains strained because the government was able to pressurize the Chhattis Mauja into allowing the branch canals to be opened before a solution on sharing water and operating costs satisfactory to all parties was negotiated.

### **Rule Regarding Illegal Water Use from Main Canal**

In the 1988 General Assembly Meeting (Appendix 2), there was discussion about the fine for illegal use of water from the main canal. The rule stated that the punishment for stealing water would be a fine varying from NRs 250 to NRs 5,000 depending upon the amount of water stolen or damage done to the outlet and the frequency of the offence. Both the level of the fine and enforcement of the rule were criticized by farmers.

Farmers from the tail area wanted the fine increased because such a low rate did not deter head end farmers from stealing water. The benefit from the water stolen was greater than the cost of the fine. The argument for keeping a relatively low rate was that experience showed that nominal fines could be collected. Collection established a record that made more severe punishment for repeated offenses possible. A list of offenders in the past year was read together with the amount of their fines as an example. Since a low rate was in the interest of head end farmers who were in a majority at the meeting, a resolution was passed giving a nominal increase in the variable rate for the first offense.

Some farmers wanted a fixed rate for each occurrence of water theft. They did not want the chairman to have an opportunity to show favoritism. The chairman made a strong argument for a variable rate. He felt that by negotiating a fine it made collection easier and helped establish the record necessary if frequent and serious offenses occurred.

Farmers from the tail of the system seemed satisfied with having made their point and accepted the decisions without further discussion. Compared to the investment in maintaining the system, fines for water theft are not an important source of revenue. However, the social pressure as evident in the discussion at the meeting indicated that the rule was an important institution.

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### System-Level Accounts

In the 1988 General Assembly Meeting, the secretary presented an audit report. The report was prepared by a committee appointed by the executive committee. The audit committee had verified the bank balance, bills, and payments and prepared a balance sheet. Time was given for questions and one farmer asked about the sources of income. The secretary listed each including NRs 93,600 raised by charging NRs 600/kulara to each branch canal. The report was accepted without further challenge indicating that the 350 irrigators attending the meeting had confidence in the report prepared by their fellow farmers. The secretary then presented the current balance sheet. He concluded his presentation by saying that the accounts would again be audited and reported at the next meeting. The only question was regarding interest on the current balance.

At the 1989 General Assembly Meeting, a current balance of NRs 26,000 was reported. When the chairman was proposed for re-election, a farmer objected. He said that he had just gone to the bank and checked the account balance and found only NRs 8,000. He wanted to have clarification before proceeding with the election. The former chairman was clearly embarrassed and readily admitted that he was holding NRs 3,000 and that the secretary and treasurer had the remainder. His excuse was that they were holding the money to pay current bills. He was reminded that the rules state that any cash on hand was to be deposited in the bank immediately in order to earn interest. A further rule stated that the treasurer should not keep more than NRs 2,000 in cash to pay bills. A farmer who had previously served as the Sorah-Chhattis joint committee chairman reminded the group how they had in a similar circumstance required the offender to pay interest on the money not deposited.

The chairman sent a person immediately to deposit the money in the bank which took half an hour. They waited for the money to be deposited before proceeding with election preparation. Having accounts available for scrutiny by all irrigators has proven to be effective in reducing financial irregularities.

### Salary Review for the Meth Mukhtiyar

The Chhattis Mauja generally has two persons working as meth mukhtiyar. When one retired in 1988 the other asked to be given responsibility for both jobs since he needed an extra income. This was agreed to but a few months later the meth mukhtiyar asked the chairman for an increase in his salary. The chairman brought the matter to an executive meeting. The meth mukhtiyar presented his case and the members discussed among themselves. Finally the chairman proposed to increase the salary and the secretary seconded the motion. However, the vice-chairman opposed the idea. While he personally agreed that the meth mukhtiyar should be paid more for the work he was doing, he pointed out that the salary was approved in a general assembly meeting not many months earlier. If they now change the salary, even though it is in their power to do so, how will they respond if the increase is challenged in the next general assembly meeting? They finally agreed that a general meeting should be called and the decision made there.

When the issue was raised at the next general meeting a farmer immediately questioned why this was brought to the general meeting. He felt this should only be dealt with at the general assembly meeting. Others supported him, indicating they did not want to take responsibility for changing a salary that had been discussed and approved by the general assembly only a few months earlier. "What will the general body of irrigators think?" was the response of another farmer. The chairman had no alternative but to accept the advice he was given and deferred the issue to the next general assembly meeting.

### **Fine for Absent Workers**

Labor, knowledge, local materials, and cash are all necessary inputs from the farmers for operating and maintaining the system. As the local economy changes, the relative availability of cash and labor is altered. In the 1988 General Assembly Meeting, the chairman indicated that many preferred to be absent from emergency maintenance work and pay the fine. However, the NRs 15 fine was not enough to hire other workers. He proposed that the rate be increased. One farmer was concerned that raising the rate for working on maintenance would mean that labor working in agriculture would also demand more. The rate was increased to NRs 20, about half the market rate for labor doing heavy manual work in the town of Butwal.

This relatively small adjustment of a seemingly minor issue required the approval of the highest policymaking body of the Chhattis Mauja System. While this type of decision making is not efficient, there is certainty that the majority of irrigators would support the outcome. This makes implementation highly effective. As the secretary said in the same meeting when the amount charged for stealing water from the main canal was being discussed: "In formulating any regulations we must consider whether we can enforce the rule....Setting rules won't do anything unless they are strictly enforced...."

## **COMMUNICATION**

The joint-system messenger's main task is to guard the two diversions from the river. During low flow periods he monitors to see that other systems using water from the river do not reduce the share being diverted into the Sorah-Chhattis System. During floods he monitors damage and reports to the joint-system chairman if labor and material need to be sent to do repairs.

When the intake structures are damaged, the joint committee messenger informs the joint committee mukhtiyar who calls the meth mukhtiyars from Sorah Mauja and Chhattis Mauja to advise them of the date of damage and the number of laborers needed to accomplish the repairs. The system-level messengers are then responsible for informing all the village-level mukhtiyars concerned.

The Chhattis Mauja has two messengers, one for the upper half and one for the lower half of the system. The messengers and the meth mukhtiyar are provided with a bicycle, bag to carry letters, an attendance book, a raincoat, and a torchlight to be able to carry out their duties day or night.

During the rainy season, the meth mukhtiyar and messenger prepare a schedule to gather materials for emergency maintenance. Based on experience, they ask the farmers to stockpile stones and brush to be used when emergency repairs are necessary. At the completion of work each day the meth mukhtiyar records how many persons reported for work from each village and announces the date and time for future work by each village if it is already planned. The farmers who reported for work on that day advise the rest of the farmers in their village of the date and time they should report for the next activity.

Decisions made at the general assembly and general meetings need no further communication since there are representatives from all parts of the system present. The information flow from executive meetings was intended to be through the area member mukhtiyars. However, since they have no staff to assist them this was not always effective and the main system messengers are now requested to inform village mukhtiyars about decisions that concern them.

Most messages require action by the irrigators and if not properly communicated can cause difficulties. One farmer complained at a general meeting that their village had not been

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informed about a schedule change for maintenance work at the intake. They had gone at the regular time but no one else was present for work so they returned home. However, later they learned that the meth mukhtiyar had recorded that they were absent from work. The meth mukhtiyar was asked to explain the situation. He said he had sent a message with the village mukhtiyar's daughter but she did not pass on the information. The mukhtiyar was reprimanded for not having used the messenger to transmit the message and instructed to remove the absent entry from the record book. When a message is delivered the messenger is required to have his log book signed by the person receiving the message as proof that it was delivered.

At the branch canal level each village decides on the procedures they want to use to share information and record work done. The middle sample branch has a typical procedure. When advised of the date for emergency maintenance the village-level mukhtiyar prepares a list of all irrigators and schedules the rotation of work for each farmer. He must inform each farmer of his turn to contribute labor 12 hours before that farmer's turn is due. At the end of the working day all the farmers gather at the work site and attendance is taken. While the meth mukhtiyar is only interested in the number of persons who reported for work from each village and calculates fines only on a village basis, the village-level mukhtiyar needs to know who reported for work to access fines to individuals.

When there is a problem of water scarcity, if a farmer has a conflict with an assigned schedule, or when there is failure in receiving information in time, the farmer goes directly to the village mukhtiyar. Farmers also approach the mukhtiyar when they have complaints about main system management. It is then the responsibility of the mukhtiyar to inform someone in the executive committee. Usually they contact the chairman directly. The chairman then calls on either the meth mukhtiyar or the messenger to verify the information and take corrective action.

## CHAPTER 4

# Analysis of Irrigation and Agricultural System Outputs

### GOALS OF CHHATTIS MAUJA IRRIGATION SYSTEM

BECAUSE THE CHHATTIS MAUJA Irrigation System is owned and operated by the farmers, it is assumed that the rules they have formulated and the actions of the elected managers embody the goals of the irrigators. Output performance at the system-level is evaluated against the goals inferred from a year of closely monitoring the irrigators' activities. This included attending meetings, formal and informal interviews, review of records and the constitution, and observing operation and maintenance activities.

Since the irrigators actively seek external assistance and the national government is interested in improving food security by expanding the irrigated area, performance of the system is also evaluated against national goals for irrigated agriculture and irrigation development. These goals are derived from development plans.

#### System-Level Goals

The farmer irrigators of the Chhattis Mauja System are willing to invest their labor and cash to maintain the system because they expect reliable irrigation delivery in adequate quantities to supplement rainfall for growing rice. Timely preparation of seedbeds and transplanting requires irrigation before the rainy season starts. It is only in the past three decades that irrigation of crops in the winter and spring has become important. Irrigators, particularly in the head end of the system, have adjusted their farming strategy to use all of the system's share of the water available in the river for crop production in the dry season.

The irrigators regularly invest their own resources to make improvements in the system to increase reliability and long-term sustainability. They recognize that investment in maintenance and improvements can only be sustained if there is assurance that the benefits of irrigation will be uniformly shared among themselves in proportion to investment. Water allocation rules that mandate this were formulated.

Since the change in government in the early 1950s, the irrigators have pursued opportunities for attracting assistance from outside the system. They have had moderate success. Pursuit of outside assistance continues to be the goal of the organization.

Managers of day-to-day operation and maintenance of the main system are primarily concerned with reducing complaints and conflicts. The prestige and power of elected management positions is balanced by accountability to the electorate. Providing irrigation delivery that satisfies the farmers is an important management goal. This must be balanced against the inevitable disagreements that arise over low irrigation supply, expensive system improvements, and continuing maintenance expenses.

At the system level the goals of Chhattis Mauja can be summarized as:

1. Delivery of irrigation for preparing rice seedbeds before reliable monsoon rains begin;
2. Timely irrigation for land preparation and rice transplanting;
3. Reliable supplemental irrigation for the rainy season rice crop;
4. Proportional sharing of all available water resources in the winter and spring for irrigated nonrice crops;
5. Appropriate maintenance and physical improvement for sustainability of the system;
6. Proportional equivalence between the irrigators' costs and benefits; and
7. Farmer satisfaction with irrigation delivery.

### National-Level Goals

The Irrigation Master Plan (DOI 1990), prepared by the Department of Irrigation, recommends goals for irrigation development and targets to be achieved. A policy established in 1985 set a target for nearly doubling the national production of food by the year 2000. Translated into irrigation development activities, this suggests that the net command area receiving assistance from DOI must increase nearly three-fold. An overarching goal at the national level is to maximize the irrigated area.

In addition to dramatically expanding the irrigated area, the new policy proposes to increase yields of existing irrigated agriculture. Table 4.1 summarizes the average present yields and future targets for the main irrigated crops in the tarai region where the Chhattis Mauja is located. The targets are largely based on the expectation that improved varieties will do even better in the next decade and that some constraints of all inputs, including irrigation, will be removed. While there is evidence that cropping intensity could be increased in many irrigation systems with improved irrigation management and modified market incentives, this option has not been included in the national plans. Cropping intensity will be examined in the Chhattis Mauja System to determine if land and water resources could be used more effectively.

*Table 4.1. Current production and future target yields of irrigated agriculture in the tarai region in the proximity of the Chhattis Mauja (t/ha).*

	Monsoon Rice	Wheat	Maize	Mustard	Lentil
Present level	2.5	2.2	1.8	0.7	1.0
Future target	3.8	2.8	2.6	1.0	1.5

Source: Master Plan Cycle 2.

## SYSTEM-LEVEL WATER DISTRIBUTION

Irrigation delivery measurements began in mid-August 1988, about a month after the majority of rice had been transplanted and continued for one year. Measurements were recorded in the main canal at the Sorah-Chhattis Dividing Structure at Tara Prasad Bhond. Discharge in three sample branch canals was measured near their inlets from the main canal. Figure 4.1 shows the results of the four daily discharge measurements. While flow in the main canal averaged less than  $0.5 \text{ m}^3/\text{s}$  during the dry season, the only period that the main canal was without water was during days of cleaning in March.

Water allocated to the sample branch canals is 5, 4, and 2 kulara entitlement in the head, middle, and tail branches respectively. Thus the trend of decreasing water availability from head to tail is to be expected. However, except during a period in July 1989, the tail branch was clearly receiving less than its share of the water. Several possibilities exist for this situation. Two obvious ones are that headenders are taking more than their share of the water. Another is that seepage and percolation losses from the canal make it impractical to try and deliver water to the tail for part of the year.

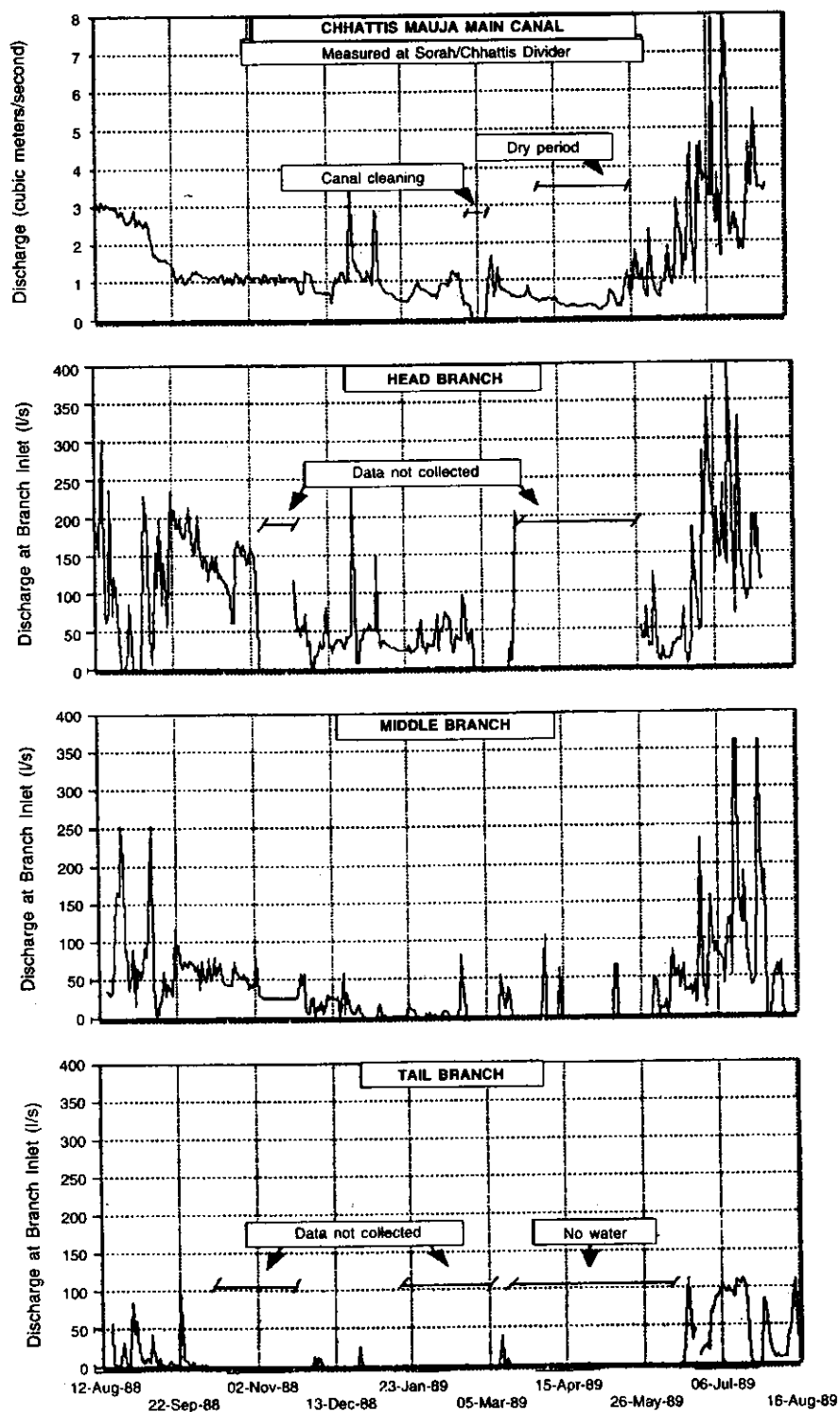
Measurement of canal losses during low flow periods were made in a companion study of the Sorah Mauja System (Stevens 1991). His measurements were made in the 2.8 km section of the Sorah Mauja Main Canal just below the Sorah-Chhattis Division Structure. That section of canal is 3 to 10 m wide, similar to the Chhattis Mauja. The canal is unlined in silty soil as in the case of the Chhattis Mauja Canal. The water table as monitored in five wells near this reach of the canal was more than 8 m below the canal bed during the dry season. Stevens found that with a discharge of 300 l/s the losses were about 70 l/s/km. Assuming uniform losses for the entire length of canal, this implies that more than 600 l/s are required at the inlet of the Chhattis Main Canal in order to deliver water to the tail branches of the system.

The dry season discharge in the Chhattis Mauja Main Canal averaged about 500 l/s but there was a period from late April through early May when it dropped to about 300 l/s. This was a period without rainfall and the temperature rising above  $40^\circ\text{C}$ . Crops without access to irrigation could not survive this period. The implications of seepage losses from the main canal will be examined together with the irrigation delivery for each of the three irrigation seasons in the next sections.

Although devastating drought sometimes develops in August or September, the most consistent water shortage for rice irrigation in the Chhattis Mauja reported by the farmers is during May and June when they are establishing seedbeds and into July when land preparation and transplanting should be completed. Data collection was divided over parts of two rice crop seasons: irrigation delivery and yield in 1988 and land preparation and transplanting in 1989. Since initiation of seedbeds and timely transplanting can have a major impact on crop yield, analysis of irrigation delivery for seedbeds and transplanting monitored in the 1989 season cannot be used in the analysis of the 1988 rice crop. To clearly separate the two seasons, analyses of the distinct irrigation seasons are given in chronological order.

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Figure 4.1. Daily average discharge in the Chhattis Mauja Main Canal and three sample branch canals.





## MONSOON RICE SEASON

### Water Distribution Compared to Water Allocation

Each branch canal of the Chhattis Mauja System has negotiated the number of kulara water entitlement and resource mobilization responsibility that they want. The stated water distribution rule is proportional division of the flow of water into each branch canal. The delivery performance ratio (DPR) has been computed for each branch to indicate the success that the Chhattis Mauja managers had in delivering the irrigation water as compared to the allocation plan.

The DPR is the ratio of the actual to the planned irrigation delivery. When the dimensionless DPR is less than one it indicates that the branch canal did not receive its planned portion of water. If it is two, for example, it received twice the planned irrigation delivery. The "actual" delivery was measured in each sample branch canal. The planned delivery for each branch was assumed to be the ratio of the number of kulara in the respective branch to that of the entire system multiplied by the discharge in the main canal, as measured at the Sorah-Chhattis Mauja division point.

$$DPR = \frac{\text{Discharge in Branch Canal}}{\text{Discharge in Main Canal} \times (\text{Kulara in Branch} / \text{Kulara in System})}$$

Irrigation delivery in the Chhattis Mauja System, as with most farmer-managed irrigation systems, is not derived from crop water requirements. Rather it is based on proportional sharing of the available water supply. When irrigation delivery is not adequate, the system managers must try to increase the water being diverted into the system from the Tinau River. In periods of drought this is limited in theory to the 62.5 percent portion of the river discharge allocated to the Chhattis and Sorah Mauja systems.

Figure 4.2 shows the DPR for the three sample branch canals during the 1988 monsoon rice season. The head and middle sample branches on average received far more than the planned share of water and the tail sample branch received less. Based upon this indicator alone one would conclude that the performance of the irrigation delivery system was not equitable during the growing season for rice. Before discussing possible causes for the apparent poor performance of the irrigation delivery system, several other indicators need to be examined.

### Rice Yield

Rice yield in the three sample branches was estimated by harvesting and weighing samples. The results are shown in Table 4.2. The estimated mean yield of the twenty-two rice crop-cut samples was 3.7 t/ha with a standard deviation of 0.9 t/ha. This is well above the 2.5 t/ha average yield for irrigated monsoon rice presently found in the surrounding area and compares favorably with the target yield of 3.8 t/ha proposed for the future.

Figure 4.2. Delivery performance ratio of three Chhattis Mauja sample branches in the 1988 rice season.

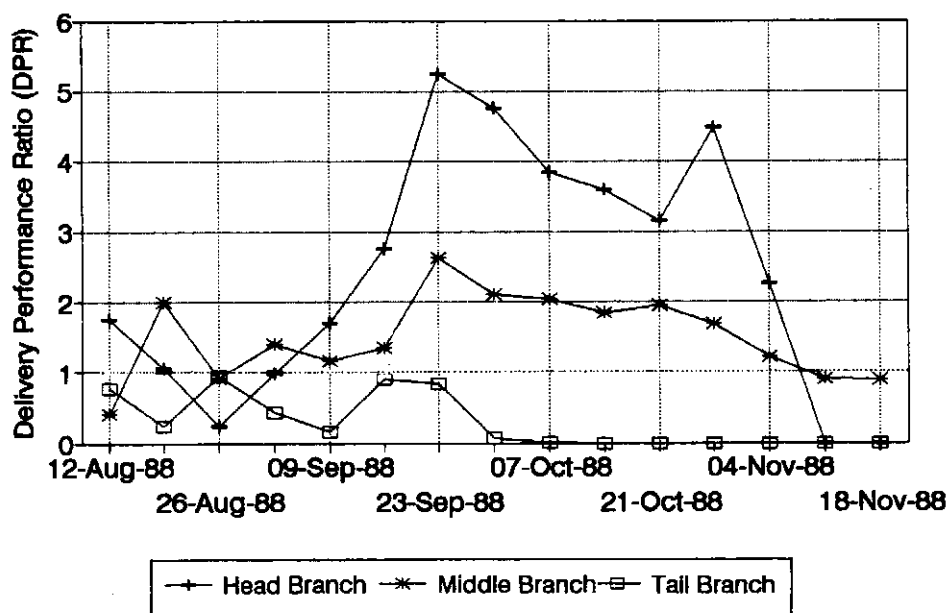


Table 4.2. Crop yield estimates and area cultivated in three Chhattis Mauja sample branches in 1988/89.

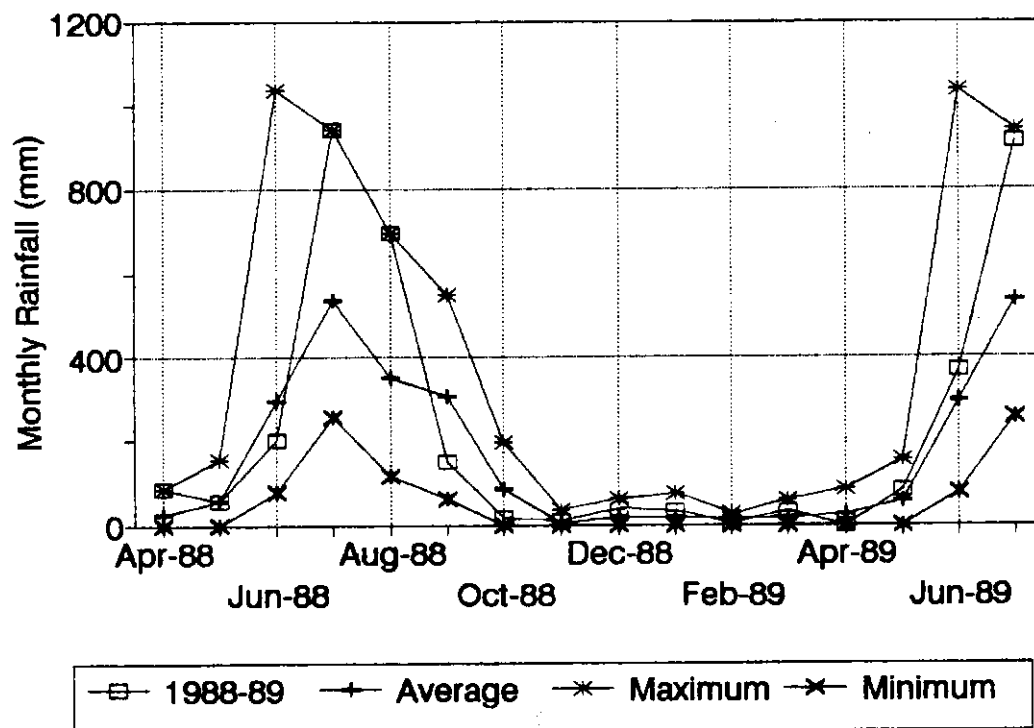
Crop	Head Branch (50 ha)			Middle Branch (70 ha)			Tail Branch (92 ha)		
	Yield (t/ha)	Samples (#)	Area (%)	Yield (t/ha)	Samples (#)	Area (%)	Yield (t/ha)	Samples (#)	Area (%)
<i>Monsoon</i>									
Rice	3.75	7	100	4.00	8	100	3.35	7	100
<i>Winter</i>									
Wheat	3.69	6	35	3.10	6	24	2.07	7	12
Mustard	0.75	5	24	0.81	4	5	0.95	2	5
Lentil	1.27	3	31	0.91	2	53	0.98	2	17
Lentil and Mustard		0	10		0	18		0	6
Fallow			0			0			60
<i>Spring</i>									
Maize	2.19	6	34	2.17	7	15			0
Fallow			66			85			100
Cropping Intensity			234%			215%			140%

Though the crop-cut sample is small the trend is toward a slightly higher rice yield in the middle branch. Analysis of variance comparing the mean yield in the head, middle, and tail areas shows that there is no significant difference at a 95 percent confidence level. From the sample crop-cut estimates of rice yield one cannot conclude that the variation in water delivered to different parts of the system had an adverse effect on rice production. As an indirect indicator of the irrigation delivery performance this suggests that while the irrigation delivery may not have matched the planned delivery the supply was adequate for an above-average crop. The rainfall pattern and water status in fields that were regularly observed support this conclusion.

### Rainfall Pattern

In Figure 4.3, the monthly rainfall for the 1988/89 crop year is compared to the maximum, minimum, and average rainfalls for the period from 1970 through 1989 as recorded at the Bhairhawa Agricultural Station. The rainfall measured during the 1988 rice season from June 1988 to mid November was nearly 2,000 mm. The average for the same period is about 1,500 mm indicating that the 1988 rice season had a higher than average rainfall. Both July and August had record high rainfall, but September had slightly less than half of the twenty-year average rainfall.

Figure 4.3. Monthly rainfall in 1988/89, measured in the Chhattis Mauja command area, compared to the maximum, minimum and average of the period 1970-89 measured at Bhairhawa Agricultural Station.



### Water Status Plots

A number of rice fields were selected in each of the three sample branches to observe the ponded water status. Figure 4.4 is an example of the results. Because of high infiltration rates, the plots were observed two to four times daily and the highest observation reported. Rainfall is included in the figure to allow observation of the impact it had on the depth of ponded water.

If it is assumed that evapotranspiration and rainfall were reasonably uniform over the entire system; then irrigation supply, seepage and percolation, and overland drainage are the likely contributors to the variation of water status in the different plots. Except for periods of heavy rainfall no overland drainage was observed from fields in the head and middle of the system.

Even though the water supplied as illustrated by the DPR was lower than planned in the tail, it is clear from observing the sample rice fields that the plots in the tail branch had more days of standing water at least through September. In the head and middle plots water remained ponded for only short periods after water was supplied by irrigation or rainfall. In the tail, rainfall together with low levels of irrigation supply were nearly sufficient to maintain continuously ponded water in the early part of the season. This is largely due to lower seepage and percolation rates in the tail area of the system as was shown in Chapter 3.

### Analysis of Monsoon Rice Irrigation Distribution

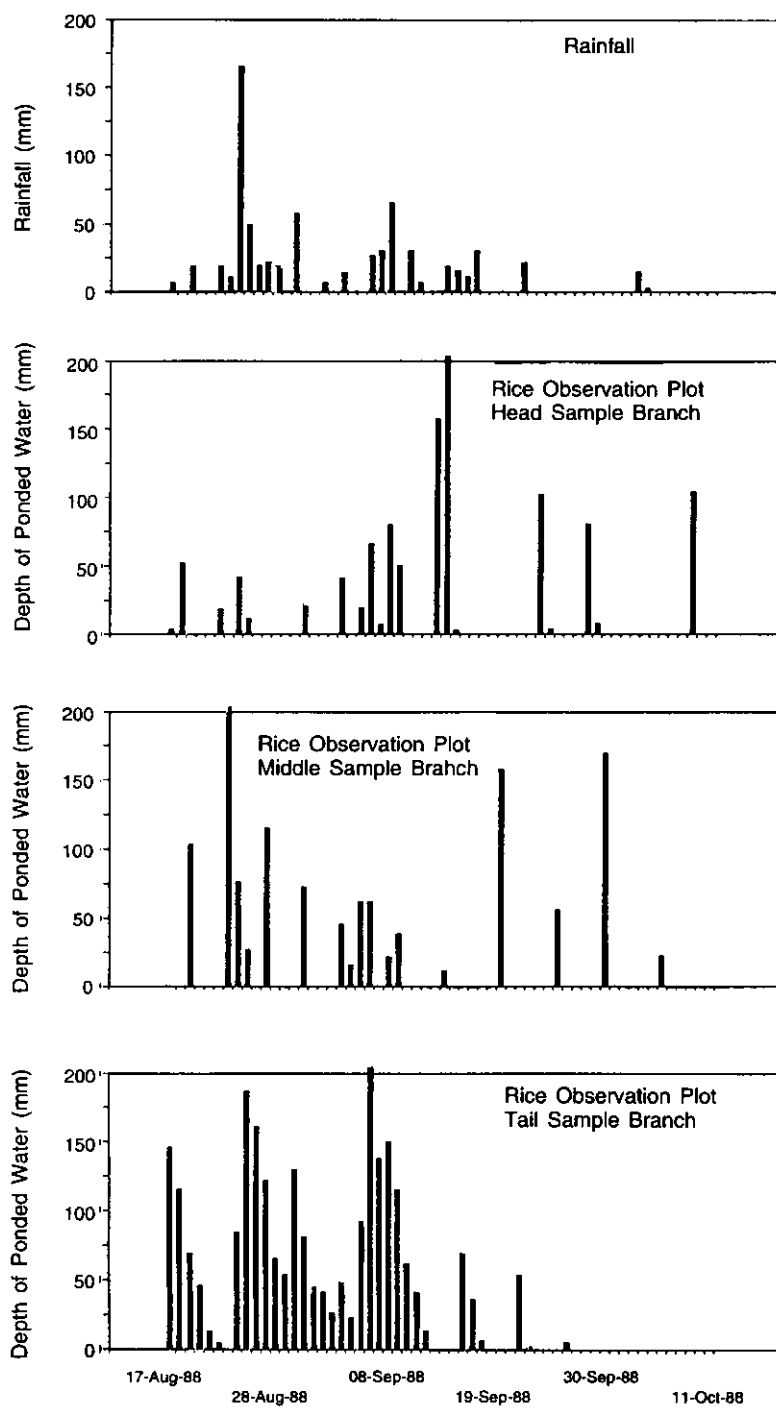
*Adequate and Timely Supply of Water.* Evidence of a uniform yield much higher than the national average for irrigated rice in the branches sampled suggests that the water supply was adequate and timely. Under conditions of uncertain water supply such as during the spring cropping seasons, some farmers let part of their land fallow. Except for several small banana plantations, all fields in the three sample branches were planted during the rice season indicating experience and expectations of a worthwhile crop.

Another indication of an adequate water supply was that there were no reports of water being taken illegally from the main canal in the 1988 season. The executive committee records show that fines were charged to a few head and middle branch canals in most years. In the 1988 General Assembly Meeting before the rice season, the fine for stealing water from the main canal was discussed (see Appendix 2). Farmers in the tail branches wanted the rate increased. They argued that the rate was far lower than the value of the water and, therefore, did not discourage illegal use. In the somewhat heated exchange a farmer from the head offered to trade land with a farmer in the tail because he felt farmers in the tail had the advantage of stealing water at night and that it took much less water to grow rice where the infiltration rate was so low.

Higher than average rainfall in the first two months of the growing season may have distorted normal differences in yield between the head and tail. During discussion with farmers from the tail they complained that they often do not have enough water and that it is delivered too late. However, except for complete rice crop failure during several years of drought in the early 1960s, it was not possible to establish that the rice yield suffered from lack of an adequate or timely irrigation supply.

*Equity in Water Distribution.* Comparison of irrigation distribution to the assumed water allocation plan indicates that the system did not achieve its goal. More than the entitled water was diverted in to the head and middle branches and less than the planned supply was available to the tail branch. However, several issues must be examined before accepting this conclusion. The first relates to the assumption about the water allocation plan. The second suggests that the goal of reducing farmer complaints takes precedence over strictly following proportionality rules.

Figure 4.4. Rainfall and observation of ponded water depth in fields of three sample branch canals in the Chhattis Mauja System.



The allocation plan assumed for computing the DPR was that water **entering the system** would be divided proportionally among the branches according to the kulara of water allocation. Without a means of verifying the losses due to seepage in the main canal or a means of easily adjusting the discharge in each branch, such an approach is impractical for the farmer irrigators. To maintain even reasonable accuracy, measurement, calibration, and adjustment would need to be a continuing process on account of changing hydraulic characteristics caused by siltation as the season progresses. Instead, the irrigators agree to divide the water flowing just upstream of each branch canal inlet proportionally to the kulara of water allocation at that point. This view of the water allocation plan accepts the seepage losses in the canal as an unavoidable consequence related to the location of one's land. Thus the DPR as used in the analysis should be adjusted according to losses in the canal because those losses are accepted by the allocation rule.

With an average rainy season discharge of  $3 \text{ m}^3/\text{s}$  at the diversion, Stevens (1991) estimated that losses from the main canal would be in the range of 80 to 90 l/s/km. This suggests that if  $3 \text{ m}^3/\text{s}$  as measured at the Sorah-Chhattis Divider is being delivered to the tail branch nearly 10 km downstream, about  $0.9 \text{ m}^3/\text{s}$  or 30 percent would be lost through infiltration. At lower discharge rates the percentage lost increases rapidly. The DPR was checked with simulated seepage losses. While there was a positive shift in the tail branch DPR so that it averaged nearly unity over the period through early October, it was still considerably less than for the head and middle branch canals.

A rule stating that water allocation to branch canals is proportional to the available discharge establishes the benefits for each canal relative to the others. Regardless of whether the basis for proportionality is land area or any other derived amount such as kulara in the Chhattis Mauja System, any branch canal that receives an average DPR greater than 1 is depriving one or more other branches from receiving their full share via the main canal. As explained in Chapter 3, while water was abundant through the first half of September, the excess water diverted in the head end was more easily available from the drainage system than by petitioning the chairman to deliver more equitably through the main canal.

Because water was adequate as indicated by ponded water in the fields, equity in water distribution with respect to the allocation plan had little meaning in the 1988 rice season. Observation of the day-to-day activities in carrying out the water distribution leads to the conclusion that the daily managers, the chairman and the mukhtiyar, were primarily interested in satisfying farmer demands. Instead of continuously trying to meet fixed proportional rules, they attempted to respond to demand.

Each branch canal organization was responsible to inform the system chairman if they felt that they were not getting their share of water. On 22 September, mukhtiyars from the tail branches informed the chairman that they were not receiving sufficient water. Branch canal inlets were checked and adjusted. This resulted in an increase in the DPR in all branches being monitored. In addition, irrigation delivery to the tail branch nearly reached the planned delivery even without taking seepage into consideration.

Adjustment was made again on 14 October at the request of irrigators in the tail branches. Observation of the adjustment process indicated that it was entirely based on experience of what is sufficient for crop requirements in each branch rather than measured proportionality.

Reviewing the mechanism for proportional irrigation delivery and the observed practices helps in understanding the rules in use. As mentioned in Chapter 3, the mode of operating the Chhattis Mauja System is largely dependent on the annual rainfall pattern. When possible, water is continuously delivered to each branch canal. If the water available in the source drops below a level at which it is feasible to distribute continuously to all branches, water is rotated by turn to one or several branches at a time with the delivery time computed in proportion to the kulara entitlement to water.

During conditions of continuous irrigation delivery to each branch canal, the written rules give explicit instructions for measuring and constructing the inlet opening to achieve proportional irrigation delivery. However, measurement of the branch canal outlets (see Chapter 3) showed that with the exception of two with a common sill that extended across the main canal all but a few of the openings were much larger than the rules allowed. As suggested in Chapter 3, because the inlets did not have a check structure to regulate the water level in the main canal and because siltation continually changed the hydraulic characteristic at the inlet, experience with water requirements for the crop rather than measurement was used to adjust the irrigation delivery.

The system leaders use proportionality criteria as a starting point in adjusting irrigation delivery from the main canal during continuous water distribution. They are more concerned about crop status and reduction of farmer complaints than exactness in discharge per allocation. However, during periods of water shortage, shifting to rotational delivery among branch canals improves the accuracy of complying with proportionality rules in water distribution and reduces farmer complaints about unequal sharing of limited water resources.

Consideration of irrigation delivery during rainy season drought periods, i.e., when delivery is rotated among branch canals for the rice crop, was the primary reason farmers in the head of the system gave for having increased their water allocation over the past three decades. As the next two sections will show, farmers in the tail have concluded that it is not possible to deliver water to their area during the dry season with the canal in its present unlined condition. They have, therefore, reduced their allocation to the minimum level feasible for reliable rice production to minimize their canal maintenance cost.

## WINTER CROPS

Winter season crops including wheat can be grown under rain-fed conditions in the Chhattis Mauja Command Area. Lentils, chickpea, linseed, and gram are examples of crops grown in the winter that are never irrigated. Mustard benefits from irrigation but in most years gives reasonable yield without irrigation. Even wheat can be grown with good results in some years without irrigation. However, over a period of years the average yield for wheat under rain-fed conditions is less than half that of irrigated wheat.

Figure 4.5 compares the 1988/89 winter season monthly rainfall to the average and extreme rainfall over the past twenty years. The total rainfall in the winter season was about 110 mm which is more than 50 percent above the 20-year average. More important, except for part of February, the rainfall was well distributed making it effective for the crops.

### Irrigation Distribution

In the 1988/89 winter season, the delivery performance ratio (DPR) for the three sample branches could not be computed. Though measurements were made of the irrigation delivered to each of the three sample branch canals, the area irrigated was continually changed.

Because water was not a limiting factor during most of the wheat season, both the head and middle sample branches diverted more than their share of water from the main canal. This made delivery convenient without resorting to rotational distribution within the branch. The excess water from the head branch directly entered into the canals of six other branches and met most of their irrigation needs. For 31 of the 78 days between 12 December when wheat irrigation started and 28 February when irrigation was discontinued, no water was used by the head branch. On other days only part of the total discharge flowing through the branch was

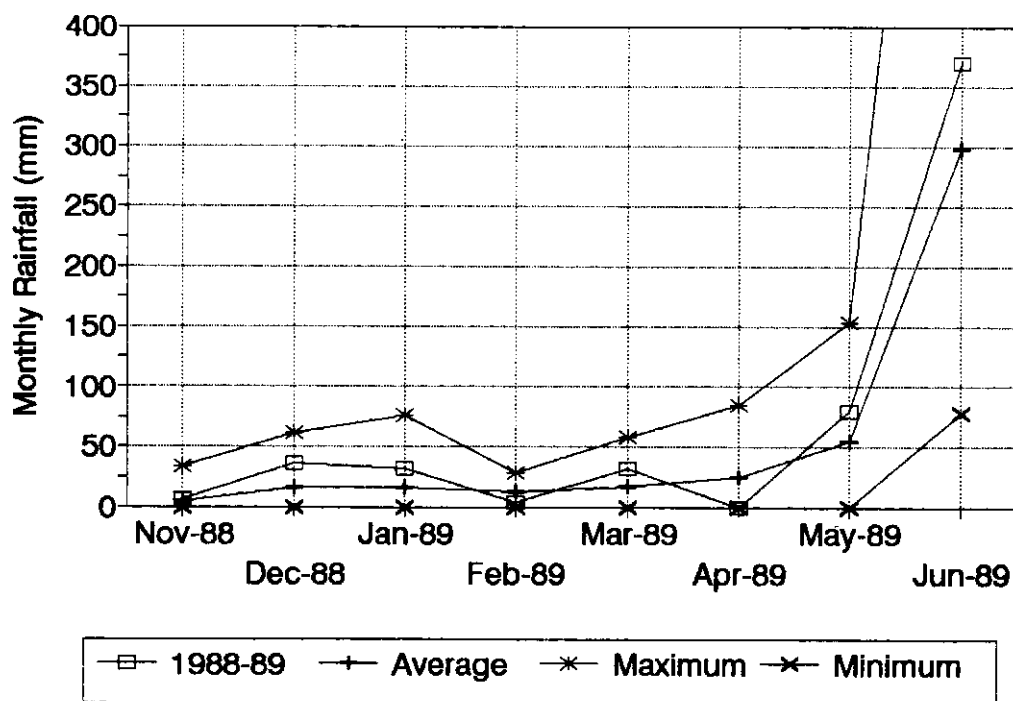
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used. The same was true for farmers in the middle sample branch. For more than half of the days they did not use the water that was being diverted into their canal and allowed it to flow directly from their canal into several other branch canals.

As explained in Chapter 3, the farmers in the tail branches do not have a tradition of growing wheat. The indigenous Tharu of the tarai which make up about half the population of the tail branches do not traditionally use wheat in their diet. However, due to the high seepage losses in the main canal, non-Tharu farmers in the tail have concluded that growing a winter season crop that is dependent on irrigation is too risky.

In a questionnaire administered to farmers in the sample branches, farmers were asked about their preference for winter crops and the basis for deciding on which crops to grow. Almost all responded that the type of food required for the family was the most important reason for crop selection. Overall, about 65 percent of the crops grown in the winter are consumed by the family of the cultivator. However, anticipation of water scarcity was the primary reason given by farmers in all three sample branches for not growing wheat on a higher percentage of their land. About half of the farmers in the tail sample branch responded that the moisture content of the soil was too high in their fields to sow wheat. Inability to drain lowlying fields in the tail branch makes it difficult to sow wheat in time for a profitable crop.

Figure 4.5. Comparison of monthly rainfall in Bhairhawa Agriculture Station in the 1988/89 winter and 1989 dry seasons, to records of the past twenty years.



Farmers indicated that the discharge in the main canal was average or slightly better than usual in the 1988/89 winter season. The fact that farmers could access irrigation on demand for nearly the entire wheat season as mentioned in Chapter 3 was related more to timely rainfall than the level of irrigation available. Without rain all farmers would have been requesting more irrigation water. From past experience farmers know that there is considerable



risk in investing in wheat production if there is no rainfall in January and February, because the irrigation delivery alone will not be sufficient to irrigate the entire area.

### **Wheat Yield**

The estimated yield from crop cut samples for the 1988/89 winter wheat season is given in Table 4.2 above. Slightly over 2 t/ha in the tail is less than 50 percent of the yield per hectare in the upper part of the system. Interviews with farmers cultivating the fields sampled in the tail found that farmers attributed their low yields to excessive rainfall in December and January rather than water stress.

Even with reduction due to excess moisture, the average yield of samples from the tail branch were only slightly lower than the national average. In the head and middle branches the sampled plots had a significantly higher yield than the production target set for the year 2000.

### **Potential for Increasing the Area Growing Wheat**

A question important for the national goals of increasing food production is how much of the command area could have been growing wheat given the irrigation supply available in the 1989/90 winter season. All of the area in the head and middle parts of the command area were being cropped during the winter season, but 60 percent of the tail area was fallow. Intensifying cropping and substituting high-yield for low-yield crops was not a stated national goal in 1990. However, the irrigation master plan (DOI 1990) drew attention to the need to examine this as another area that could contribute to future food production targets.

Figure 4.6 gives the irrigation delivery per hectare of the area growing wheat in the sample branch canals in the 1988/89 winter season. For comparison, the figure also shows the main canal discharge per hectare for the entire command area, under a hypothetical 100 percent cropping intensity. This main canal discharge was measured at the Sorah-Chhattis Divider.

Without consideration for distribution losses, discharge as measured at the Sorah-Chhattis Division for the period from 24 November through 31 March would have resulted in 250 mm of irrigation if distributed over the entire Chhattis Mauja command area. This does not include the contribution of rainfall to the available moisture. In his study of the Sorah Mauja, Stevens (1991) determined crop water requirements for each of the main crops. He used local evapotranspiration data and FAO recommendations for deriving crop coefficients. His estimate of crop water requirement for wheat in the period from 24 November through 31 March was 234 mm. The irrigation supply in 1988/89 was sufficient to irrigate the entire command area provided distribution losses were greatly reduced.

Farmers grew about 825 ha of wheat in the Chhattis Mauja command area in the 1988/89 winter season. Based on the measured irrigation supply and estimates of crop water requirements and assuming no moisture contribution by rainfall, the overall irrigation delivery efficiency for the wheat season was about 22 percent. Under the same conditions but with the entire command area growing wheat, the overall irrigation system delivery efficiency would need to be 94 percent.

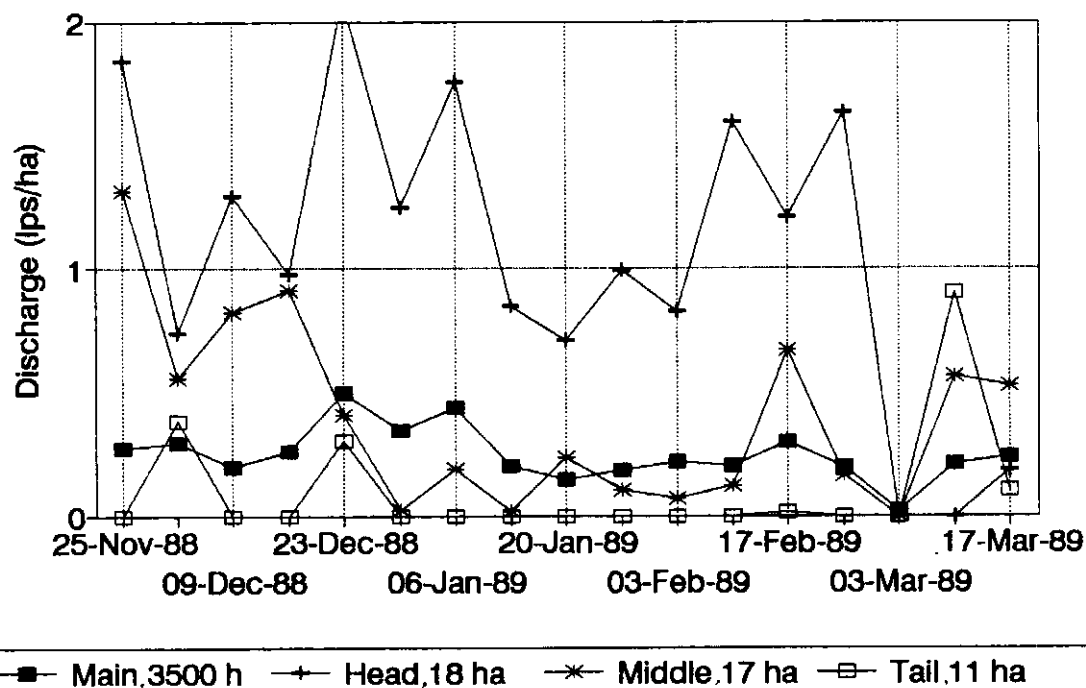
In the year 1988/89, farmers could easily have expanded the area growing wheat. However, farmers correctly observe that they cannot depend on rainfall during the winter season. Without rainfall the base flow in the Tinau River is also likely to drop, reducing the irrigation supply. Given the high infiltration rates in the main canal under low flow conditions and the risk of not getting useful rainfall during January and February, the Chhattis Mauja farmers have chosen the near optimum area for irrigated wheat and selected the most

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appropriate crop mixture to minimize production risk. If higher risks were acceptable they could improve the irrigation distribution efficiency well above the 22 percent measured in 1988/89 without modifying the canal. However, even with full lining of the main and branch canals it would not be possible to achieve the necessary efficiency in irrigation distribution to grow wheat on the entire command area.

Farmers indicated unreliable winter rain and limited irrigation availability as the main reasons that they were reluctant to risk growing more wheat. High production costs compared to the market value were factors identified by farmers as determinants of acceptable risk. Without addressing those, changes in the physical system to make irrigation delivery more efficient are not likely to bring large increases in the area growing wheat.

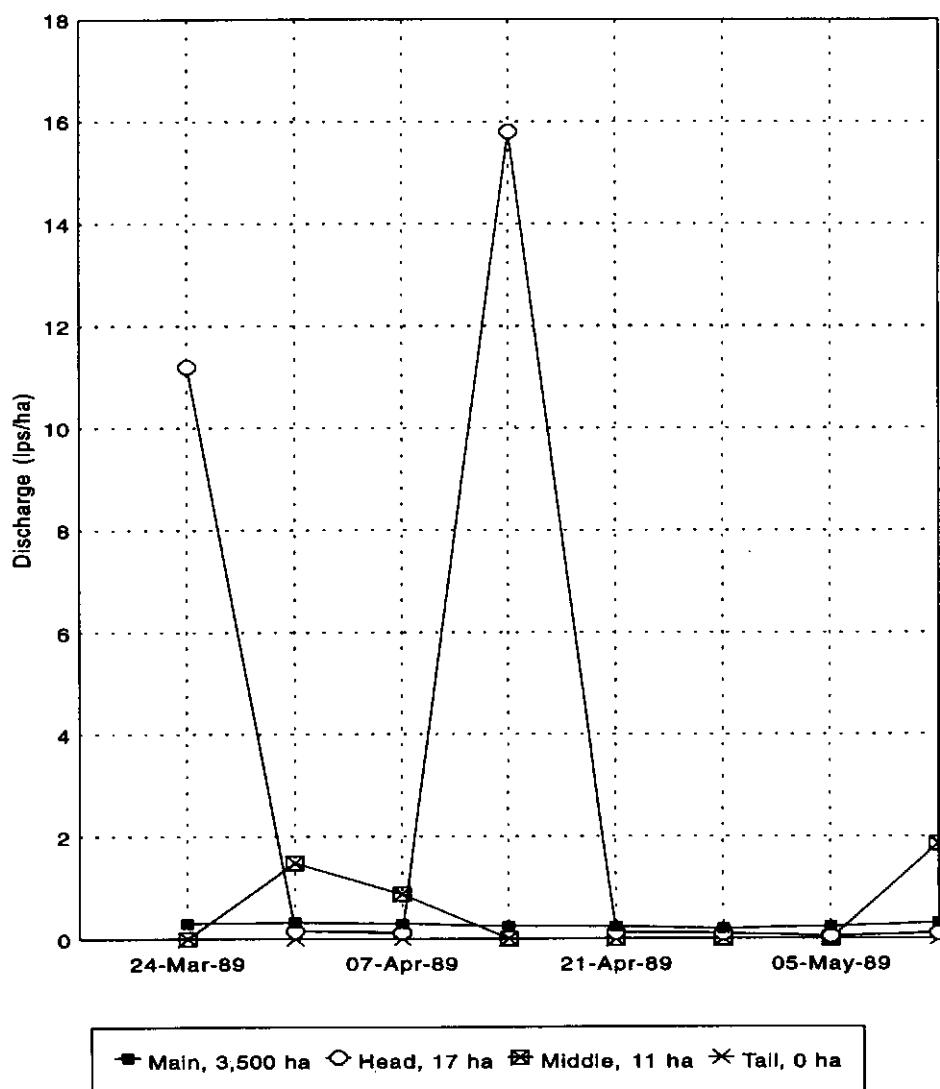
Figure 4.6. Irrigation water delivery per hectare of wheat in the sample branch canals, in the 1988-89 winter season, as compared to the total water available in the main canal at the Sorah/Chhattis Divider.



## SPRING (DRY SEASON) CROPS

While crops in the winter season can be grown without irrigation, irrigation is essential for crops planted in the period from March through April. After a 30 mm rain on 12 March 1989, there was no additional rainfall in the Chhattis Mauja command area until mid-May. Only maize that received sufficient irrigation reached maturity. After mid-May, rainfall was above average (see Figure 4.5) and helped sustain maize that was planted late in the season, but irrigation had to be used for germination and during the early growth period.

Figure 4.7. Irrigation water delivery per hectare of maize in the sample branch canals, in the 1989 dry season, as compared to the total water available in the main canal at the Sorah/Chhattis Divider.



Maize was planted in 17 ha of the head sample branch's total 50 ha and in 11 ha of the 70 ha in the middle sample branch. The remainder of the command area in these and the tail sample branch was fallow after the winter harvest until rice seedbeds were established in May and June.

### **Irrigation Distribution for Maize**

Rotational delivery for maize was started on 23 March in 1989. The rotation started from the head end of the system but excluded the branch canals above the Sorah-Chhattis Division where water was taken continuously. Three branch canals received water in the first group and three hours were allowed per kulara irrigation allocation. It took 25 days to complete the first rotation which included delivery to all branch canals even if the water was only used for domestic purposes. The second rotation started on 17 April and lasted 36 days. During this time the supply available in the river dropped to a very low level. The entire discharge of the canal was used by a few farmers at a time.

Though water was in extremely short supply and some farmers lost their maize crop, water stealing was not reported during this period. The main deterrent was the ease of detection. With water flowing to only a few farms at a time it is easy to spot illegal use. Farmers waiting their turn were continually checking the progress of applications upstream and did not tolerate even a small deviation in the timed rotation.

Figure 4.7 shows the irrigation deliveries for dry season maize in the head and middle sample branches. Both are compared to the main canal discharge per hectare under a hypothetical 100 percent crop intensity over the entire command area. The head and middle sample branches received sufficient irrigation to plant maize in March or early April. The head sample branch received its second irrigation in mid-April. As with wheat irrigation, water not used in the head branch during the week of 14 April was allowed to flow directly into several branch canals adjacent to the head branch. By using this arrangement, the entire discharge of the Chhattis Mauja System was routed through the smaller branch canals to a large area. This was done to reduce the time necessary to move the water from one branch to the next and to avoid excessive losses in to the main canal. Farmers were quite aware that a high percentage of the water infiltrated in to the wide bed of the main canal when the total discharge was only a few hundred liters per second.

Because irrigation was routed through successive branch canals, Figure 4.7 does not reflect all of the irrigation supply received by the middle sample branch. On 14 and 15 April water was supplied via an upstream branch canal that bypassed the measuring flume.

### **Maize Yield**

The maize yield from the sample crop cuts is reported in Table 4.2. Both the head and middle branches had fields with yields of about 2 t/ha. This is slightly better than the current average for irrigated maize in the tarai area but well below the target for the year 2000. However, the maize yield in 1989 varied considerably depending on when it was planted. Maize planted during the last irrigation rotation did much better than some planted in early March. Some early maize did not fill ears at all and was cut for fodder because it matured during the extremely hot and dry period in April. Late maize received adequate rainfall in May.

### **Potential for Increasing the Area Growing Maize in the Dry Season**

The average discharge in the main canal in the period from early March through May was about 550 l/s. Stevens (1990) estimated that the crop water requirement for maize during this

period was 574 mm. If one assumes that the same level of discharge could be distributed uniformly without losses and that there was no moisture contribution from rainfall, the theoretical maximum area for a maize crop would be 1,100 ha. In this period there was about 100 mm of rainfall. If all the rainfall was available for use by the maize crop, up to about 2,000 ha could have been planted to maize.

About 550 ha was planted to maize by the Chhattis Mauja farmers during this season. This implies that the overall irrigation efficiency was nearly 50 percent without considering the rainfall contribution. If all the rainfall was used by the crop, then the overall irrigation efficiency was slightly more than 25 percent.

Evidence available from observing the irrigation distribution process during the maize season indicates that there is little room for improvement. The irrigation supply was rotated effectively for the entire period. The farmers used the shortest possible canal routes and avoided using segments of the main canal whenever possible to reduce seepage losses. Even with responsive management that allowed extra time between rotations to irrigate areas missed during the rotation, some fields had a high moisture stress and were harvested for fodder instead of grain. Short of major improvements such as lining the main and branch canals, it is not feasible to increase the area planted to maize.

## RICE SEEDBEDS AND TRANSPLANTING

Rice is considered by all Chhattis Mauja farmers as the most important crop. With supplemental irrigation the preferred transplanting time is mid June to mid July. This allows maximum benefit from the rainy season and assurance of a crop in most years even if the irrigation system fails. This requires that rice seedbed preparation be done through mid-to-late May which is usually when the irrigation supply is at its annual low. If the premonsoon rains are light, there is total reliance on the meager irrigation supply to establish and maintain the seedbeds and begin land preparation for transplanting. Land preparation and transplanting can begin before reliable rains in June or July but only a few branches of the Chhattis Mauja would be able to complete land preparation and transplanting with the available irrigation supply if it were not augmented by increased discharge in the river caused by rainfall in the hills.

When there is a limited supply of water for seedbed preparation, farmers in nearby areas of the tarai frequently use dry rather than wet seedbeds. The dry seedbeds are moistened and protected by mulch instead of keeping them in a continuously flooded condition. Seedlings can be grown satisfactorily by this method with very little water. However, all the farmers in the Chhattis Mauja use wet seedbeds. Though farmers in tail branches complained that water is delivered to their fields much later than in the head branches, selecting wet rather than dry seedbeds indicates that irrigation reliability is high enough for them to use the method they consider to be superior. In 1989, seedbed preparation and transplanting was greatly facilitated by well-spaced rains. Transplanting was completed about one week earlier than normal.

### Irrigation Distribution

The daily irrigation discharge for the rice seedbed and transplanting period in the Chhattis Mauja System is shown in Figure 4.8. Spikes of increased discharge are caused by rainfall in the upper catchment of the Tinau River. Water was rotated to several branch canals at a time to establish and irrigate the seedbeds from the last week of May through the first of July.

Figure 4.8. shows that there was a gradual increase in the base flow of the river from about mid June. By the beginning of July the base flow was more than five times greater than

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during the dry season. This allowed continuous irrigation delivery to each branch canal at about the time that the majority of farmers were ready for land preparation and transplanting. Farmers considered the irrigation supply for the 1989 seedbed and transplanting period as nearly ideal. Continuous supply to each branch canal instead of rotational delivery allowed rapid progress in transplanting.

### **Irrigation Distribution Compared to Irrigation Allocation**

The DPR for the seedbed and transplanting period is given in Figure 4.9. The rotation progression from head to tail for seedbed initiation is seen in the period from 26 May through 16 June. Above-average rainfall in June and July (see Figure 4.3) allowed the branches in the tail to take much of their irrigation from drains rather than depend on the main canal. This is reflected in the drop in irrigation delivery to the tail after mid-July.

Even without considering seepage losses in the main canal, this is the period during the entire irrigation year when the irrigation delivery was closest to the planned delivery. The average DPR from the start of transplanting in each sample branch canal to the end of transplanting in each was 1.3, 1.0, and 0.7 for the head, middle and tail respectively.

*Figure 4.8. Daily irrigation discharge in the Chhattis Mauja System, measured at the Sorah-Chhattis Division Structure in 1989.*

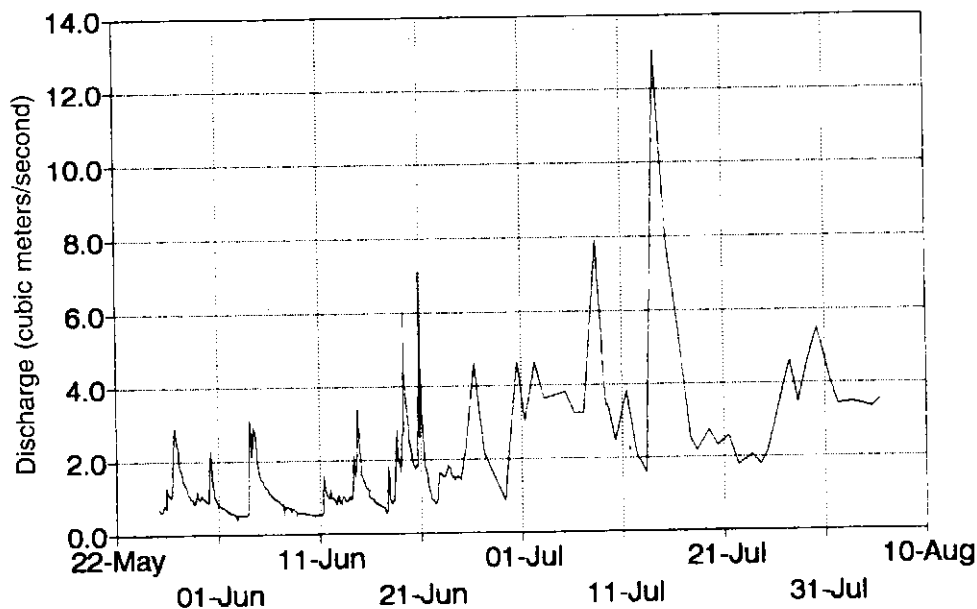
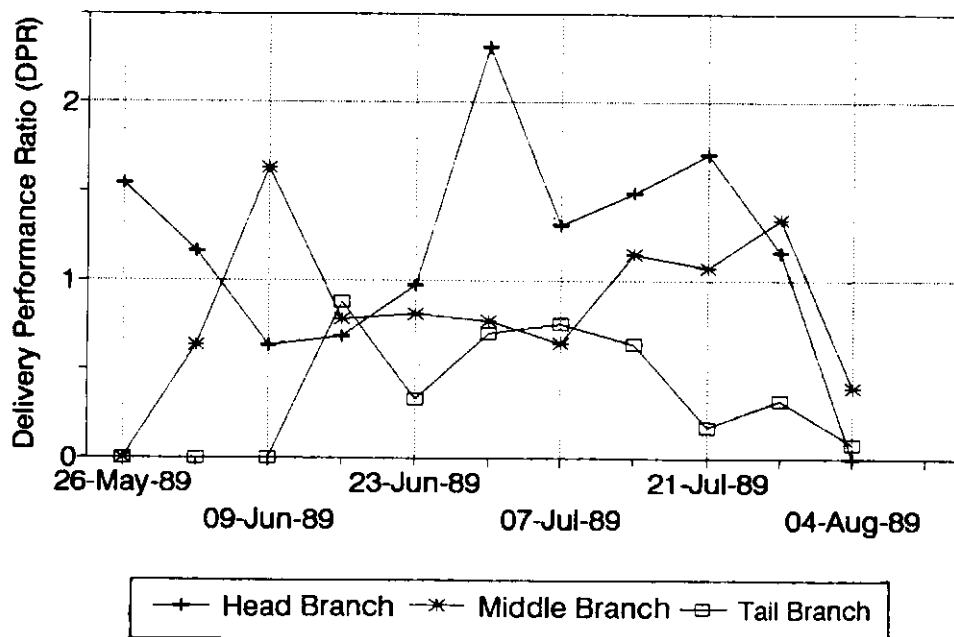


Figure 4.9. Delivery performance ratio of the three sample branch canals, for the 1989 rice seedbed and transplanting period.



Note: For definition of Delivery Performance Ratio, see page 47.

## CONCLUSIONS

Above-average rainfall in 1988 and 1989 masked potential problems that the Chhattis Mauja System faces in meeting its irrigation delivery goals. Irrigation for maize in April and early May was the only period in which irrigation delivery was not able to meet the water demand. Farmers consider seedbed initiation through rice transplanting as the period most critical for irrigation delivery and often the most problematic. All farmers plant rice and wish to utilize irrigation to get the crop started in time to maximize use of monsoon rains. This places heavy demands on the irrigation system for this period in most years.

The delivery performance ratio indicated that greater effort was made during the rice transplanting period to deliver the planned irrigation supply to all parts of the system than at any other time of the year. The effectiveness of rotational irrigation during the water short period of the maize season illustrated the measures that are reported to be common practices during rice transplanting in most years. However, until the base flow in the river increases after the dry season, progress in land preparation and transplanting remains extremely slow regardless of the efficiency of irrigation delivery.

The delivery performance ratio for the 1988 rice season indicated poor performance in delivering water to the tail sample branch via the main canal. However, the water status observation plots and rice yield indicated that water was not a serious limitation. Intensive rainfall, lower seepage and percolation losses, and reuse of drainage water were contributing factors.

Both the irrigation delivery measurements and observation of the organization's internal processes indicate that proportional water delivery is only important if most farmers are not satisfied by ad hoc adjustments to the physical delivery system. Though the tail sample branch received little water delivery from the main canal during the 1988 rice season they only contacted the executive committee after rainfall and drainage water were no longer sufficient. The measure taken to satisfy their demand for more water was to reduce diversion of water in the upper branches and initiate monitoring of irrigation delivery. When the tail branch farmers did not persist in their complaints, the promised weekly checking and adjustment of each branch canal inlet did not take place. Farmers in the tail branches, however, agreed that they could have insisted on rotational delivery and received it if serious water stress had developed in their fields. As in many irrigation systems managed by engineers, the daily managers of the Chhattis Mauja System relied on farmer complaints as their primary monitoring tool.

Using the crop yields as an indirect indicator of the irrigation performance in a year of above-average rainfall indicates that except for maize, the Chhattis Mauja System is already performing at the level of the targets set for the year 2,000.

As shown in Table 4.2, the cropping intensity drops from around 230 percent in the head sample branch to 140 percent in the tail. This reflects the difficulty in moving the limited irrigation supply down the main canal during the winter and dry seasons. Examination of estimated crop water demand and the irrigation delivery at the Sorah-Chhattis Division during the winter and dry seasons showed that water was indeed a limiting factor in the system in those seasons.

Though the water stress risk is lower for wheat the profitability of wheat under 1989 market conditions does not make it attractive for farmers to increase the area planted to this crop. There is a good market early in the dry season for green ears of maize sold for roasting. In 1989, the early maize was severely damaged by water stress. The conclusion that farmers have reached is supported by the observations and measurements of the field study, they have expanded the irrigated area in the winter and dry seasons to the extent of acceptable risk under current conditions. Lining part of the main canal to reduce losses and pumping ground water for conjunctive use with the canal in the tail region are two possibilities for increasing the cropping intensity.



## CHAPTER 5

### Management of Maintenance

THE CHAIRMAN OF the Chhattis Mauja System when asked about system maintenance summed it up as: "Maintaining the system is a *dukha* (aggravation, pain, or bother) that never ends. First we must fight with the river to make it enter the canal and then sweat for many days to remove the unwanted sediment."

The Tinau River has a catchment of about 550 km<sup>2</sup>, in the second range of southern Himalayan Hills. Heavy rainfall events frequently trigger landslides throughout the watershed and the accompanying floods carry the sediment into the tarai. Material deposited by floods on the alluvial fan where the Chhattis Mauja diversions are located cause the main channel to shift. The diversion structure must then be modified or moved to accommodate the new condition. Even minor floods can seriously damage one or both of the intakes.

Sometimes it is more destructive when the diversion does not fail and the uncontrolled flood water enters the canal.<sup>2</sup> The raging water erodes the canal bank and damages the branch canal openings. The heavy bed load of stone, gravel, sand and silt is deposited in the canal network. Erosion and silt deposits continually change the hydraulic characteristics of the branch canal inlets necessitating cleaning and adjustment after each flood to maintain proportional water distribution.

Desilting the canal network is one of two primary maintenance tasks. The other is managing flood damage by mobilizing labor and materials on an emergency basis. This chapter first describes the management practices associated with maintenance and then examines the activities of annually cleaning sediment from the canal network and the emergency maintenance necessary to keep the system operational.

### MAINTENANCE RULES

#### Changes in Maintenance Practices

Several older persons in the community who had served as mukhtiyars before there was an elected chairman explained how the system was managed when the majority of irrigators were Tharu people. Each village had a *badghar* (community leader) who supervised village civic activities including irrigation. The badghars from villages using the irrigation system appointed a mukhtiyar to organize all of the collective irrigation activities. The mukhtiyar

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2 In 1987, a gate was built to control water entering the main canal through the Ittabhond Diversion but it could not be operated until a second gate to flush sediment from the intake canal was installed in 1989. The Kanyadhunga Intake Canal does not have a control gate.

notified the badghars when to initiate canal cleaning or other maintenance. In addition, the mukhtiyar decided whether the work period was *bhojbandi*, where they leave for work at dawn taking along cooked food and return at dusk, or *sidabandi* when each worker takes uncooked food and they camp at the assigned work place until the work is complete. It was customary at that time to have one adult male from each household participate in the work. No records were written nor was any cash used for system operation and maintenance. After the influx of settlers from the hill in the upper reach of the canal after the early 1940s, the present form of organization was installed.

Since adopting the new hierarchical organizational structure and governing constitution in the late 1950s, additional changes have taken place. While there is still talk of *maujani khetra*<sup>3</sup> for maintenance work, this has not taken place in recent years. As the institution of kulara of water allocation and resource responsibility moved away from a land area basis to a concept that could be adjusted to irrigation needs with accompanying obligations for maintenance, labor mobilization as *maujani khetra* has been largely abandoned in favor of responsibility in proportion to water entitlement.

### System-Level Maintenance Rules

An important set of rules set out in the constitution relates to the meth mukhtiyar's leadership role in carrying out the executive committee's directives for system maintenance. He 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 penalties assessed if they are not. In addition to calling for labor to maintain the system, the meth mukhtiyar informs the irrigators about tools, and quantity and type of materials, especially brush and other forest products, to be brought to the work site for making repairs.

During main canal desilting, the meth mukhtiyar assigns each village-level organization a segment of canal to clean with specifications for depth and width and time for completion. If it is not completed on time the village-level organization must pay a fine and make the payment before the next phase of desilting work is allocated. If a village refuses to do their share of desilting the executive committee can close their branch canal. While the constitution states that all irrigation users must contribute to desilting the main canal, as under *maujani khetra*, this is now interpreted to mean as directed by the village-level organization. With the initiation of assignments to each village-level organization rather than all irrigators working as one group, the meth mukhtiyar's job was reduced to proportioning the work assignment according to each branch canal's water allocation and checking that the work has been completed.

The constitution identifies *sabik*, *double*, and *jhara* labor requests as referring to one, two, or four persons per kulara water allocation respectively. In practice there are sometimes calls for *triple* labor meaning three persons per kulara as well. Generally there is a request for *sabik* mobilization which in 1989 meant that 175 (one person for each kulara of water allocation) should report to work. If the mukhtiyar determines that more labor is needed, he can ask for double or *jhara*.

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3 *Maujani khetra* is used to refer to the mobilization of all irrigators. The definition seems to have undergone some evolution. While the community elders indicated that before the new organization it meant all irrigators (one person from each household), Pradhan (1983) found that the system records referred to one person for each 1.25 ha of land area irrigated.

Other rules not spelled out in the constitution but generally accepted relate to qualifications and behavior of persons sent to work. For example, only males above the age of 15 are allowed to work during emergency maintenance. Two reasons are given for this rule. Since much of the work is difficult and heavy, women and children would not accomplish as much as adult males. To ensure equality of work output only adult males are allowed to work. Persons having relatively equal ability simplifies the assignment of tasks. If women and children were present the tasks would need to be assigned according to ability. Concern for uniform effort by all at the workplace is seen in another rule stating that umbrellas are not allowed at the worksite. Workers obviously cannot juggle an umbrella and work effectively, but the real reason for the rule is to keep persons appointed to supervise a work group from sitting idly under the shade of an umbrella. As well as specifying who can work, conditions for exemption from work are also understood. Serious illness, death in the family, and weddings, are acceptable reasons for allowing a person to be absent.

### Village-Level Maintenance Rules

*Labor Mobilization.* The most important rules at the village level regarding maintenance are those defining the rate of resource mobilization. The general observation, which was confirmed in the sample branches studied in detail, was that in each branch canal a single set of rules govern resource mobilization for branch canal operation and maintenance and main system obligations. There is, however, considerable variation among branches in how this is done.

Each village-level organization has autonomy in managing operation and maintenance activities. They are free to organize the delivery of their resource obligation to the main system level in whatever way they choose within the guidelines of timing, quantity, and quality. Table 5.1 outlines the rules used by the three sample branch canals in 1988. All specify the basis for contributing labor.

Most village-level organizations adjust the labor requirement to somewhat match irrigation benefits with varying levels of precision and equality. In the middle branch, for example, the accepted rule requires one-third work share for one-fourth water share from small landholders. Those with access to one-half or a full share of water provide a half or full share of work respectively; the smallholder pays the largest percentage. In this particular case the small holders were in minority and the difference in obligation was minor enough that no complaints were registered.

In the tail branch, as in a number of others, the rule is simply a request for one person per household to work when called, i.e., there is no distinction between those receiving more or less benefit from the collective labor effort. While seemingly inequitable, several reasons were given by farmers in support of this practice. Cultural values was the most important reason given. The tail branches have the highest Tharu population, the indigenous tarai dwellers who dug the first Chhattis Mauja Canal. Their practice has always been to organize labor on a household basis regardless of family size or landholding. Another reason was cost. They suggested that the cost of additional organization—staff, recordkeeping, and attending meetings—required to manage proportional obligations was not worth the minor benefits they would receive.

*Cash Instead of Labor.* All branch canals have an option allowing members to pay in cash instead of providing labor. The rules for the three sample branches are given in Table 5.1. In all the cases investigated, this payment exempted the individual from all labor obligations including main canal desilting and emergency maintenance as well as branch canal maintenance. Paying cash to the village-level organization instead of providing labor gives flexibility

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for farmers who either do not have enough labor available or who have other jobs that conflict with being available to work on the canal. This supplies much needed cash for payment of salaries, supplies, and fines while allowing those with few cash resources to contribute only labor. The rate is set well above the market value of labor and cash mobilized in a normal year.

Table 5.1. Sample village-level maintenance rules used in 1988.

<b>HEAD BRANCH</b>			
No. of households	Land Area (ha)	Labor Share <sup>a</sup>	Cash Rate <sup>b</sup>
5	< 0.67	0.25	
11	0.67-1.34	0.50	
11	1.34-2.65	0.75	
3	> 2.68	1.00	
15		Exempt	NRs 1,500/ha
Total 45			
<b>MIDDLE BRANCH</b>			
No. of households eligible	Water Share <sup>c</sup>	Labor Share <sup>d</sup>	Cash Share <sup>b</sup> (NRs)
19	0.25	0.33	400
22	0.50	0.50	600
28	1.00	1.00	1,200
Total 69			
<b>TAIL BRANCH</b>			
No. of households	Labor		Cash <sup>b</sup>
37	One person per household		
18			NRs 300/ha
Total 55			

<sup>a</sup> Fraction of maintenance days households in this landholding category are required to work.

<sup>b</sup> Optional farmer payment instead of providing labor. In 1988, NRs 4,600 was paid by farmers in the head branch, NRs 9,800 by those in the middle branch, and NRs 6,200 by farmers in the tail branch.

<sup>c</sup> Shares of water are allocated on the basis of land area with labor and cash incremented at these break points.

<sup>d</sup> Fraction of maintenance days households with this land of water share are required to work.

Sources: Village-level records and field observations.

Note: US\$1.00 = NRs 25.10 in 1988.

*Field Observation.* Examination of village records and discussion with farmers showed some inconsistency with stated rules in the mobilization of labor both at the system and at the village level. At the system level, the reason was to make management of labor mobilization more flexible and responsive. Travel distance for some villagers to the diversion structures in Butwal is considerable. If notice is sent by messenger to the tail branches they will not be able to respond until the next day. However, if the meth mukhtiyar calls for labor from villages near the head soon after daybreak, he can count on workers reporting to work on time for a full day of work. If the repair is urgent, labor is called from as many branch canals near the head as needed on double, triple, or jhara (four persons per kulara) basis. These branches are then exempted for an equivalent mobilization at a later time when there is opportunity to give notice to branches in the tail. Inconsistency arises when there are long periods between earning exemption and work being excused. Formalizing this procedure and establishing better recording methods would remove any question about favoritism that now arises.

Labor records of the head sample branch indicated that larger landowners were not contributing their full share of labor. For example, the largest farmer in the branch with 4.4 ha of land only contributed three days of labor without penalty instead of twelve as required. When the mukhtiyar of the tail branch was asked about uneven labor contribution by farmers in the branch he explained that it was a result of the rotational pattern they use to determine whose turn it was to work. At the beginning of each year they start a rotation by calling farmers with land at either the head or tail of the branch and at each request for labor send the next group. However, by the end of the year the rotation usually has not made a complete cycle or has started on the second cycle and some have been requested to work more and others less. Instead of keeping a careful record of who has worked they simply try to start the rotation the next year where they had left off previously. When farmers were questioned about these apparent discrepancies in the labor records they indicated that in the long-run it all evened out.

With the exception of feelings that four branch canals above Tara Prasad Bhond were free-riding, there was little evidence of conflict over the assignment of maintenance work. Equity of work responsibility was never mentioned in meetings nor was it a topic of informal discussion in the year of meeting with farmers and system officials.

## CANAL DESILTING

The Chhattis Mauja farmers indicated that the monsoon of 1988 deposited relatively less sediment than average. The first 3.4 km of canal, the section from Kanyadhunga Diversion to Tara Prasad Bhond operated and maintained jointly by the Sorah and Chhattis Mauja, did not need to be cleaned. To determine the approximate cost of canal cleaning, attendance was monitored and the volume of excavated material measured for the 50 village groups that participated in the main canal desilting. The number of work days was adjusted by computing all on a uniform seven-hour basis which is the standard for hired labor in the area.

The results are shown in Table 5.2 and indicate that over 12,000 m<sup>3</sup> (about 20,000 t) of material was removed from the main canal below the Sorah-Chhattis Dividing Weir. In total, 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. On average, about 760 persons were working each day of the main canal desilting.

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Table 5.2. Main and branch canal desilting.

Description	Head Sample	Middle Sample	Tail Sample	System
Main canal desilting (only the 7.6 km of canal below Sorah-Chhattis Division):				
Labor (person-days) <sup>a</sup>	186	174	74	7,599 <sup>b</sup>
Material removed (m <sup>3</sup> )	533	409	132	13,700 <sup>b</sup>
Material removed (m <sup>3</sup> /person)	2.9	2.4	1.8	1.8
Branch canal desilting:				
Length of branch (km)	0.2	0.7	2.3	
Labor (person-days) <sup>a</sup>	138	198	162	7,304 <sup>c</sup>
(person-days/km)	690	282	70	

<sup>a</sup> Computed on a seven-hour-per-day basis.

<sup>b</sup> Monitored and measured by field observation.

<sup>c</sup> Extrapolated from three sample branches.

Sources: System records, interviews and field observations.

Note: For details of the three sample branches, see pages 21-22.

Comparing the amount of material removed per person is not a reliable indicator of work efficiency among branches because some sections of the canal have loose material and were relatively easy to clean, while in others the material was compact and the canal banks were high making the job difficult. However, the system's average material handling of 1.8 m<sup>3</sup>/day/person can be compared to national norms for contracting. National norms suggest that 1.25 m<sup>3</sup>/day/person is average for handling material of this type by hand. The overall system average rate for material handling was 40 percent above the national norms. The analysis of the cost of operation and maintenance and equity in sharing the costs among branches are examined in detail in Chapter 6.

Material removed from the canal was piled on the bank of the canal. In some parts of the canal the sediment was a clean sand and gravel mix ideal for use in construction or surfacing roads. Though there was a market for this material and it has been sold in the past, a conflict has developed with the town of Butwal over marketing rights. Butwal has a marketing industry for stone and sand that is freshly deposited in the riverbed each year. Until marketing rights and procedures are resolved the Chhattis Mauja System is not allowed to sell any of the sediment they remove from the canal.

### Main Canal Desilting Observation

Main canal desilting in the past was done sometime between April and June. This is the hot dry period when daytime temperatures are often above 40°C. With the irrigation season

imminent this is considered to be the easiest time to mobilize labor for cleaning the canal and completing the job quickly. In 1988, a decision was made in the General Assembly Meeting to do the desilting in February when the temperature was more favorable. Those arguing against changing the date suggested that weeds would grow back and that animal and human traffic would necessitate additional cleaning before use at an extra cost. Early cleaning was carried out on a trial basis with success in 1989 and continued again in 1990. Improved water delivery for dry season irrigation in some of the head branches and a better water supply for washing and bathing in the hot season in the middle branches where wells frequently dry up at this time of the year helped overcome the skepticism of early desilting.

On the selected day to start canal desilting, all village-level mukhtiyars and executive committee members met at the *satkule* (seven canal) division which is considered to be the termination point of the main canal. The meth mukhtiyar then made the first of three work assignments for each village group. This consisted of identifying the location and quantity of work to be completed by each. A rope was used to measure an approximate 80 m length of canal for each kulara allocated to the village. Instructions were given to each mukhtiyar on the depth and width required (the clean canal cross section was approximately 3 m wide and 1 m deep in the lower end of the canal). Adjustments were made in the length of canal to be cleaned if it appeared that more material needed to be removed than in other segments or if that village-level group had exemptions for executive committee members. While making the measurement villagers gave their opinions and suggestions but the meth mukhtiyar's judgement was accepted as final without dispute.

The second and third work assignments were each for shorter distances. At the upper end the main canal was wider, the depth of silt deposited greater, and the canal bank higher making it harder to remove the silt. One of the reasons for making a series of assignments rather than allocating the entire canal length at once was to compensate for the uneven amount of work required in different sections. Over the 4 km length of canal cleaned in the first assignment there was a good deal of variation in the amount of silt deposited. Farmers assigned a segment with deep silt in one work assignment would subsequently be assigned segments with relatively less silt, so that over the course of desilting all are assigned roughly the same amount of work.

Five days were allowed for completing the first assignment. The second assignment had to be completed in two days and the third in three days. Some groups worked long hours and completed their first assignment in three days and others worked shorter hours and took the full five days. How each group arranged to complete their assigned work was the responsibility of the village-level organization. Responsibility to define and control equity of work among members of the branch canal was also that of the village-level organization.

Decentralizing management of desilting simplified the system-level rules and made monitoring of compliance easier than in the past when all irrigators worked as a group. The meth mukhtiyar assigned the work with specific instructions on how wide and deep to clean. The general assembly set the number of days allowed for the first assignment. So the meth mukhtiyar only had to check that each group had completed their assignment correctly and on time and did not need to worry about worker attendance each day which in the past had been a formidable task with at times up to several thousand persons working at a time.

Main canal desilting work assignments were made to village-level organizations irrespective of their branch canal inlet location. Those at the head end contributed to cleaning the entire main canal same as those from the tail. The exception being the four village-level organizations with outlets above the Sorah-Chhattis Dividing Weir who only assist in canal desilting above their own outlets.

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### Branch Canal Desilting Observation

Since each branch canal acted independently to desilt their respective lower canal systems, the approach and timing varied. Village-level meetings were called by the mukhtiyars to decide when to carry out the desilting. The head and tail branches delayed desilting until they were ready to use irrigation for preparing the rice seedbeds.

Farmers in the tail did not expect to receive water in their section of the canal until after seedbeds were prepared in the head and middle branches. Except for a more pleasant working temperature they had nothing to gain from early desilting. Since weeds would again need to be removed and sections where paths crossed the canal repaired immediately before use in any case, there was incentive for waiting and doing all of the cleaning at one time. They elected to wait until late May to clean their branch canal.

In the head branch some water was available regardless of canal status and they made the same arguments for delayed maintenance as in the tail branch and delayed cleaning until mid-June. However, in the middle branch there was a clear advantage in early cleaning because it increased the dry season water availability. Since a better water supply for watering of animals, washing of clothes, and bathing during the hot season was to many as important as the meager though valuable irrigation supply for maize, they cleaned the canal in mid-March.

In the head branch, the irrigators agreed to work from 6:00 a.m. until 6:00 p.m. with a three-hour break in the middle of the day when the temperature was highest. It took three days to complete the head branch desilting with an expenditure equivalent of 138 seven-hour days. No one was absent from work. Though this branch is only 0.2 km long, siltation was severe compared to the other sample branches as is seen by the labor required per kilometer of canal in Table 5.2.

In the middle branch, all of the work was done in the early morning so that those with other obligations would be free after 10:00 a.m. Their work was spread over seven days with an equivalent of 198 seven-hour days. There were a total of 17 absentees each paying NRs 20/day in fines. The income from the fines was used for general operating expenses of the branch-level organization such as paying the system-level messenger.

The tail branch completed their desilting in an equivalent of 162 seven-hour days. A total of 10 were absent during the desilting period and paid a compensating fine. To encourage rapid cleaning, the mukhtiyar assigned a series of two to three meter canal segments to each irrigator. The instructions were to complete each segment in 15 minutes after which the next assignment was made.

### EMERGENCY MAINTENANCE OBSERVATION

Almost all emergency repairs to keep the system operational take place during the monsoon season. Repairing the diversions is the major task. Since the conflict with the four branch canals above the Sorah-Chhattis Division, the joint-committee mukhtiyar and messenger have been given the responsibility to monitor the diversion structures continually and to call for labor and materials as necessary to keep them operational. Messages are sent to the respective meth mukhtiyar or executive committee chairman and they then contact village-level organizations as appropriate.

Table 5.3 illustrates the pattern of emergency labor mobilization in 1988/89. The head branches are frequently requested to provide three workers for each kulara water entitlement at short notice to take care of an urgent problem. Villagers further away are called more frequently for single mobilization at which time the head branch is exempted from work to



compensate for the extra work they have done. However, the total work load is well balanced as seen by comparing the work required per kulara. In the head branch there were 94 person-days per kulara, in the middle 91 and in the tail 87. If the head branch had worked one day less and the tail branch one day more of quadruple mobilization, all would have had 90 or 91 work days per kulara. Over the year, about 7 percent of the requested labor was absent in the three branches sampled.

Table 5.3. *Emergency labor mobilization in three sample branch canals.*

Mobilization	Frequency (days)	Work Required (person-days per kulara)	Absent (person-days)	Days Worked (person-days)
<b>HEAD (5 kulara)</b>				
Single <sup>a</sup>	47	235	5	230
Double	8	80	8	72
Triple	9	135	14	121
Quadruple	1	20	0	20
		<u>470 / 5 = 94</u>		<u>443</u>
<b>MIDDLE (4 kulara)</b>				
Single	73	292	21	271
Double	7	56	2	54
Quadruple	1	16	2	14
		<u>364 / 4 = 91</u>		<u>339</u>
<b>TAIL (2 kulara)</b>				
Single	59	118	11	107
Double	10	40	3	37
Quadruple	2	16	2	14
		<u>174 / 2 = 87</u>		<u>158</u>

<sup>a</sup> This includes 140 person-days of work done earlier at the Sorah-Chhattis Dividing Weir for which they were given credit.

Sources: Mukhtiyar's record and field observations 1988/89.

In the general assembly meeting (see Appendix 2), a list was read that gave the number of person-days each village-level organization was absent together with the fine they were to pay. A total of NRs 32,095 was assessed for workers being absent. At the same meeting, canal desilting dates were established and it was stated that according to tradition the second work

assignment would not be made to any village-level organization that had not paid all of their fines.

In addition, the executive committee had passed a new regulation:

*... all fines charged against laborers absent from main canal emergency work during the previous rice season must be paid before the second phase of the work is assigned during main canal desilting. If all the emergency work fines from any village are not paid to the executive committee by this time, the executive committee must refuse to give a work assignment to that village for the second phase of the desiltation.*

By denying a village the opportunity of working on the main canal, the committee can also refuse to allocate irrigation water to that village. As a result, a whole village may be denied irrigation water if a few persons do not present themselves for canal work and do not pay the designated fine on time. The objective was to get neighbors to pressurize each other to assure that the work is completed and that fines are being paid.

Extrapolating from the three branches to the entire system suggests that about 16,000 person-days of labor was requested for emergency work. This is 15 percent less than the 18,900 person-days reported to the general meeting (Appendix 2). The discrepancy is in part due to differences in the period of time recorded and in part to the small sample used to estimate the total. Records of the three sample branches compared to the observed labor mobilization do not give cause to question the executive committee secretary's report on emergency maintenance.

Generally labor is not requested from both Sorah and Chhattis Mauja on the same day unless major repair work requiring more labor than one system can supply is required. It is up to the joint-system mukhtiyar to balance labor requests according to the agreement for water allocation and for the two organizations to monitor the process and suggest changes through the joint committee. The status of work sharing among the systems was one of the agenda items at the Annual General Meeting where explanation was made for excess work by the Chhattis Mauja System.

To determine labor mobilization for a severe emergency, repairs were observed and the labor involved quantified. A flood on 16 July damaged the wing wall of the Ittabhond Diversion. The Kanyadhunga Diversion was damaged but still diverted some water into the canal. Since land preparation and rice transplanting was in full swing the demand for irrigation and farm labor was heavy. Table 5.4 shows the daily work record of the Sorah and Chhattis Mauja systems. The unusually high number of persons absent from work illustrates the flexibility of the system. A farmer who had arranged for land preparation and transplanting with hired labor or in a labor sharing arrangement viewed his time as more valuable at home than the cost of a fine at approximately the market wage rate. It is generally impossible to mobilize labor during the rice planting season in Nepal for any type of project. Mobilizing over 2,000 person-days of labor in a nine-day period for irrigation maintenance was quite remarkable. If more labor had been required for the diversion repair, jhara mobilization would have been called.

The first work day was two days after the flood peak when the water level in the river was still quite high. The receding flood allowed assessment indicating many more workers were needed and both organizations were called on subsequent days. In order to maintain the work balance between Sorah and Chhattis Mauja, only single mobilization was requested from the Chhattis Mauja about half the time. Fifty seven percent of the labor was requested from the Chhattis Mauja (actually supplied 53 percent but paid fines for the remainder) for this particular task, and adjustments were made in the next call for labor to increase their share to 60 percent as required by the agreement between the two systems. Table 5.4 also shows that

persons worked less than the normal seven-hour day. On average, they worked just under six hours per day at the work site not counting travel time or gathering brush on the way to work as directed by the joint-system meth mukhtiyar.

*Table 5.4. Emergency repair of Ittabhond Diversion after the 16 July 1989 flood.*

Date	Sorah Mauja Labor (person-days)				Chhattis Mauja Labor (person-days)			
	Request <sup>a</sup>	Labor	Absent	Adjust <sup>b</sup>	Request <sup>a</sup>	Labor	Absent	Adjust <sup>b</sup>
18	184 d	121	63	104	none			
19	184 d	171	13	146	174 s	115	59	98
20	184 d	76	108	65	348 d	174	174	149
21	184 d	108	76	92	348 d	165	183	141
22	184 d	118	66	101	348 d	171	177	146
23	184 d	122	62	105	348 d	143	205	122
24	184 d	150	34	128	174 s	160	14	137
25	184 d	100	84	85	174 s	140	34	120
26	184 d	165	19	141	174 s	156	18	133
Total	1,656	1,131	525	967	2,088	1,224	864	1,046

<sup>a</sup> Labor requested by joint system meth mukhtiyar from respective executive committee (s=single, d=double mobilization per kulara).

<sup>b</sup> Labor adjusted to seven-hour work day.

Sources: Field observations and system records.

The Department of Irrigation supplied five tons of wire for use in repair work after this flood. The wire was used for making woven (gabion) cages that were filled with rock to strengthen the wing wall. A large quantity of brush and tree branches were also used to seal leaks.

## MATERIALS AND EQUIPMENT FOR MAINTENANCE

During the 1988 monsoon season, the diversion structures were repaired 34 times with many additional minor improvements. It was estimated that 15,000 bundles of *jhalapat* (brush and branches) weighing about 5 kg/bundle were used in repair of the upper diversion and 7,000 in the lower. This means over 100 t of forest products were used to maintain the diversion structures in 1988. *Simali*, *dhayaro*, *hahane*, *bhogate*, and *kalikath* are local names of some

of the brush used. These are mostly rapidly growing species with little commercial value as fuel or building materials. If they are cut on hillslopes, however, their removal contributes to erosion.

It is increasingly difficult to get forest products near the diversions. The town of Butwal has expanded and much of the nearby forest has been cut for firewood and the land used for settlement. In the past it was easy to cut brush on the hillside above the town of Butwal but this is now protected forest area. Farmers are not allowed to cut branches from saal and other valuable trees and have at times been arrested for cutting brush as well. To the extent possible villagers are instructed to bring brush and branches with them when they come to work. Since brush grows profusely during the rainy season they can cut much of what they need along the canal banks and road ditches on their way to the diversion. Transporting the brush, however, is difficult and costly.

Bricks, cement, and steel have been used to a limited extent in the construction of structures such as the Sorah-Chhattis Dividing Weir and the Ittabhond Gate. However, these materials have little application in maintenance tasks. In the past two decades the Chhattis Mauja officials have been successful on several occasions in getting contributions of wire from various government departments for weaving large baskets (gabion crates) to fill with stone as building material for the diversion structure. These gabion crates are appropriate for this application because they can be built by the farmers, are somewhat flexible if there is slight shifting during a flood, and have a relatively low cost compared to any other type of building material except forest products. The stones for filling the crates are readily available in the river bed.

On several occasions after severe silting problems at the diversion and in the main canal the joint committee and Chhattis Mauja officials have been successful in getting the government to loan either a bulldozer or front-end loader to assist with the desilting. The usual arrangement is for the irrigators to pay for fuel plus food for the operator and his helper. With the appropriate equipment a great deal of time and labor can be saved. On most occasions the Chairman of the Chhattis Mauja System supervised the work of the machine operator and pushed him to work efficiently.

## **SYSTEM MAINTENANCE AND IMPROVEMENT**

### **External Assistance**

In the 1988 General Assembly Meeting, the chairman told the farmers that he had been informed that they would receive NRs 300,000 from the government to improve the diversion. He asked for suggestions on what work should be done. One farmer reminded the assembly that only a few years earlier they had received a grant of NRs 416,000 and a committee was formed to supervise the work. However, the wall that was completed was washed away in the same year by a flood. His appeal was that they should not be so foolish this time but build something permanent so that maintenance work would be reduced.

The chairman explained that a government engineer had been assigned to supervise the work the last time. When the committee cautioned the engineer that the river carried stones and trees when flooded and that the gabion wall proposed was too exposed and would be damaged he refused to listen. He said that the farmers do not know how to build the structure or where to build it. The chairman said: "We had to accept what he did and you all know what happened."

Other farmers again raised the issue that whatever they do they should make it strong enough that it would not be washed away. The chairman replied that this time they would use their own experience and ideas. That is why he was asking for their suggestions. A number of farmers made suggestions about the design of the structure but there was no consensus. In order to close the discussion the secretary suggested that experienced farmers form a committee to consider the problem.

Only a part of the promised money became available to use in 1988 and a part in 1989. The structures that were designed by the farmers were still operating after two rainy seasons.

### **Unilateral Decision by the Chairman**

The chairman was observed in action resolving a canal boundary dispute. He was working in the organization's small office when the messenger arrived with information that there was a problem just upstream of the Sorah-Chhattis Division Structure. The Chhattis Mauja had successfully lobbied the regional government into providing a bulldozer for a few days to clear silt from the canal. A farmer was refusing to allow silt to be pushed onto the canal bank. The chairman immediately excused himself from the office and proceeded to the work site.

The farmer had stationed his elderly mother on the canal bank and refused to have her moved. The desilting operation had come to a halt and precious time was being lost. The chairman called the farmer and they together examined the canal bank. During a flood the canal bed had shifted slightly and the farmer had taken advantage of the shift by extending his field onto what had previously been the canal bank. The bulldozer operator was instructed to straighten the canal by rebuilding the banks in their original location. The chairman pointed out to the farmer that his land title only extended to the original canal bank and that he had no legal claim to this land. Since the farmer's fields were frequently being flooded by the canal damaging his crops, the chairman offered to use the bed material to construct a dike that would protect his fields. By appealing to the farmer to be reasonable and offering a solution that also benefitted the farmer he was able to convince him to allow the canal to be restored to its original location. The chairman instructed the bulldozer operator to take care not to push material onto the farmer's original field and that the material was to remain on the bank as a dike to protect the fields.

Within an hour from the time the messenger delivered the message to the chairman that desilting was again underway. All the work that was not completed by the bulldozer when it was returned to the Roads Department was done by hand during the canal desilting period in the following week. By his prompt action the chairman enabled a great deal more work to be done by the bulldozer and possibly reduced the hand work by hundreds of person-days.

## **ADDITIONAL OBSERVATIONS**

### **Inflation of Labor Records**

As a part of the presentation of accounts to the general assembly each year, the executive committee secretary enumerates the labor mobilized for canal desilting and emergency maintenance. The total emergency maintenance labor reported was close to the observed amount. However, the secretary's report for main canal desilting stated that 31,500 person-days of labor had been used over a 12-day period. This is over four times the 7,600 person-days observed during the 10 days of main canal desilting. Even if the secretary included branch canal cleaning with the main canal desilting, his report still doubles the observed time used.

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In the period of organizational transition in the early 1950s, canal desilting was done by requesting maujani khetra where one person must work for every 1.25 ha of land cultivated. The meth mukhtiyar was responsible to organize the work and the executive committee recorded all who had worked in order to fine those who had not. As the water allocation and resource mobilization responsibility changed from a land area basis to a demand basis, the desilting work was made the responsibility of the village-level organization. The executive committee no longer collects daily labor records for desilting as it does for emergency maintenance.

The secretary estimates desilting labor on the assumption that labor is mobilized under the old system of maujani khetra where one person must work for every 1.25 ha of cultivated land or where it is about 2,600 persons per day. In contrast it was observed that the daily average was about 750 persons per day. In some years more silt must be removed which requires more labor than in 1988, but there was no indication that there was ever a year requiring four times as much. In its attempts to mobilize external resources the executive committee makes frequent reference to the high labor mobilization requirement they have for maintaining the canal. Mobilization of labor for desilting, however, seems to include an assumption that results in a large overstatement of the actual labor used.

The certainty that hundreds of farmers will respond immediately when called to maintain the system allows flexibility in the planning and execution of maintenance. The inability to construct permanent structures that reduce or remove the need to respond to emergencies has enabled farmers to develop strong management patterns even though their administrative procedures, such as recordkeeping, are often deficient in form and precision. Decentralizing the management has reduced conflict by requiring accountability to be at the village level.

### **Fertilizer Value of Silt**

The quotation from the Chhattis Mauja chairman that opened this chapter was only part of his statement. After a long tirade about the difficulties of using the Tinau River water for irrigation because of its tendency to flood and silt, he went on to say that the Tinau water was excellent for irrigation since it also brought valuable "fertilizer." Many irrigators in Nepal praise the fertility value of the surface irrigation water they use. It is one of the reasons farmers with access to government subsidized deep tubewell water gave for not dropping out of the Chhattis Mauja System even though the maintenance cost is high. The contribution of surface irrigation to soil fertility and soil structure should be investigated to determine the value, if any, of the farmers' claims. This would help in understanding farmer behavior, such as opposition to gated intake structures or proposed smaller canal size that farmers view as limiting their access to flood water, when plans are made for assisting farmers in improving their existing systems.

## CHAPTER 6

### The Cost of System Operation and Maintenance

A STRONG ARGUMENT can be made for separating analysis of system operation from maintenance activities in most agency-operated irrigation systems. However, there is a great deal of overlapping of these functions in farmer-managed systems. Agencies frequently hire private contractors to carry out desilting and repair work, effectively separating the maintenance activity from the persons responsible for water delivery and other operational decisions. While farmers using agency-managed systems may provide some of the hired labor, contractors often find it more convenient and beneficial to import labor.

Chhattis Mauja farmers manage their system without systematic or dependable resource contributions from an outside agency and the distinction between operation and maintenance blurs. While the annual desilting is clearly a maintenance activity, farmers consider much of emergency repair work they do as part of the operational activities to keep water flowing properly, analogous to adjusting gates in an agency-managed system.

The farmer irrigators provide all operational and most maintenance inputs. Many users of the Chhattis Mauja System are subsistent farmers with few cash resources and prefer doing the maintenance with their own labor rather than make cash payments to hire labor for maintenance. Having observed the failure of the government's attempt to build a permanent diversion weir on the Tinau River just below the lower Chhattis Mauja Diversion at Ittabhond for a new right-bank irrigation system, and from their own experience, they are keenly aware of the damage floods cause to even expensive "permanent" structures. When limited to their own resources the Chhattis Mauja farmers use a cautious approach with small incremental improvements in attempting to make the physical structures more durable. They generally view system improvement activities as system maintenance. However, in discussions about their desire to reduce the amount of labor they provide for operation and maintenance, irrigators pointed to the substantial cash payments they have made to construct permanent structures as evidence of their desire and commitment to improve the system.

The major concern of the Chhattis Mauja farmers is to obtain a reliable irrigation supply at the lowest possible cost. The largest single expenditure for operation and maintenance of the system in the year observed was labor for emergency maintenance. The irrigators did not distinguish this from operational costs. They tended to view all irrigation related activities, whether attendance of a meeting, emergency repair of the main diversion structure, desilting canals, or improvement of their own field channel as an effort to improve the irrigation supply to their individual fields. With the exception of one system-level messenger who did not own land, all 113 persons holding functional roles in the four main levels of the Chhattis Mauja Organization, used the system to irrigate their own or rented fields. Their perspective of managing system operation and maintenance was simple and to the point: to do whatever is necessary to deliver water to the fields on time and in the right quantity at the lowest possible cost.

## RESOURCE MOBILIZATION

Comparison of the level of resource mobilization among irrigation systems is complicated by differences in boundaries for determining operation and maintenance costs. The cost of system operation generally does not include the farmers' individual cost of applying water to his fields. Frequently only the cost of operating and maintaining facilities used by all irrigators such as the diversion structure, storage reservoir, and main canal are considered. In agency-managed systems, only the cost of agency contributed operation and maintenance inputs are usually included. Farmer contribution in many agency-managed systems is only at the field-channel level and considered a part of the water application cost. However, in some, there is considerable farmer involvement in operation and maintenance activities well above the field channel even though much of this farmer input may be informal.

In the Chhattis Mauja System farmers work individually or in family units to spread water on their fields. At times they individually make minor improvements in the field and branch canal to increase the supply diverted to their fields. Some activities, such as adjustment of the branch canal inlet, opening and closing branch and sub-branch canals for rotation of the supply are done by individual farmers under supervision of the village mukhtiyar or the system-level meth mukhtiyar. These activities are informal in the sense that records are not kept. Farmers generally could not distinguish among these informal activities and the emergency maintenance requested by the meth mukhtiyar when reporting the quantity of labor they provided for irrigation operation and maintenance.

### Boundary for Cost Analysis

The analysis that follows includes the cost of maintaining the organization and cleaning, repairing, and operating the main and branch canal system. It excludes the informal activities of individual farmers in improving the reliability of their water delivery and on-farm irrigation activities.

Only the cash and labor recorded by the formal organization responsible for initiating the activity, i.e., village-level, executive committee or joint-system level officials, are used in the analysis. Canal desilting and much of the emergency repair work were observed and labor and quantities measured to verify the official records. Because the informal farmer activities are not included, the analysis does not reflect the total cost farmers of the Chhattis Mauja System pay for irrigation water. However, using the main system and branch canal operation and maintenance as the boundary for analysis is perhaps the best level at which comparisons can be made to other systems, including those managed jointly by irrigation agency staff and farmers.

## CASH INCOME AND EXPENDITURE

### Village-Level Income

The branch canal organization raises most of its cash by selling labor exemptions to irrigators. Fines to individual irrigators for being absent from work are another source of cash but complete records were not accessible. Instead, it was assumed that payments by the village-level organization to the executive committee for absent labor were being paid by the persons missing work. The analysis underestimates the actual cost by at least the amount of absentee-



ism for branch canal cleaning. Fines for water theft are minor sources of cash. Since they were not documented by the village-level organizations in the sample branches, these fines are not included in the analysis.

Table 6.1 gives the village-level organizations' cash income for the three sample branches. The total cash income for all 54 villages is assumed to be the average for the sample branch times the number of villages.

*Table 6.1. Village-level organizations' cash income and expenditure for operation and maintenance activities (NRs).*

Description	Head Sample	Middle Sample	Tail sample	System <sup>a</sup>
<b>Income</b>				
Cash instead of labor	4,600	9,800	6,200	370,800
Fines for absent labor on main canal <sup>b</sup>	540	500	320	21,636
Cash for missing work on branch canal	c	c	c	c
Cash for stealing water	c	c	c	c
	5,140	10,300	6,520	392,436
<b>Expenditure</b>				
Mukhtiyar	200	900	200	23,400
Village messenger	3,750	700	0	80,100
Batteries	0	275	0	4,950
Office and management expense	0	2,913	0	52,434
System messengers (NRs 55/kulara)	275	220	110	9,625
Fines for absent labor on main canal	540	500	320	21,636
	4,765	5,508	630	192,145
<b>Reserve</b>	375	4,792	5,890	200,291

<sup>a</sup> Extrapolated from the three sample branches.

<sup>b</sup> Assumed to be collected from farmers for missing work.

<sup>c</sup> Not documented.

*Source:* Village-level and executive committee records.

*Notes:* For details of the three sample branches, see pages 21-22.

US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

### System-Level Income

The executive and joint committees require cash in conducting their affairs. The three regular sources of income for paying their expenses are: 1) Fines for absent labor from emergency maintenance, 2) Fines for stealing water, and 3) Periodic cash assessment on a per kulara basis.

In 1987, the total paid by the village-level organizations to the main system organization for absent labor was NRs 25,895 and in 1988 NRs 21,636. The fines for stealing water, though an important management tool to maintain control over water distribution, totaled only NRs 400 in 1987 and NRs 1,075 in 1988 (Appendix 2). Since none of the three sample branches paid a fine to the executive committee for stealing water in 1988/89, this source of income was not included in the analysis.

The only regular cash assessment is designated for paying the messengers. The village-level organization is responsible to pay the executive committee an annual fee of NRs 55/kulara of water allocation. Most other cash assessments are made for purchasing construction material or paying skilled labor for specific well-defined physical improvements. For example, in 1987 the executive committee collected NRs 600/kulara for constructing wire crates at the Ittabhond Diversion. Collection of all fees and fines from individual farmers is done by the village-level organization and paid to the executive committee secretary for deposit into the Chhattis Mauja bank account. No cash assessment for repairs or improvements was made in 1988 or 1989.

Increasingly, there is a fourth option for cash income. When materials are donated by the government for improving the system they do not always match the requirements. For example, a government agency may be able to provide cement but not cash to pay for skilled labor to properly utilize the cement. Frequently the joint-system executive committee sells part of these supplies to raise cash to purchase other necessary inputs. Income from this source is considered external to the system. Income from external sources documented by the executive committee is shown in Table 6.2.

### Cash Expenditure

Detail and consistency in bookkeeping at the executive committee level gives confidence in the accuracy of the record of income and expenditure of major items. However, there is no comprehensive cash expenditure statement for operating the joint committee and executive committee offices. Amounts for purchase of office chairs, daily allowance for committee members, and bicycle repairs were reported to the general assembly. Some village-level organizations keep an excellent record of accounts but others make only rudimentary notes, if any. Local travel, refreshments, etc., are usually paid from petty cash and not itemized. Table 6.1 shows the documented cash expenditure by the village-level organizations for operation and maintenance of the main system and the three sample branches.

Some village-level organizations collect cash or grain to make the cash payments for the system-level messengers. Others use the cash reserves they have from selling labor exemptions and fines to make the payment. In most branch canals the cash income from sale of labor exemption and fines is sufficient for all normal requirements for cash. By making all labor contributions requested of them, many farmers in the Chhattis Mauja System only make periodic cash payments for improvement projects that they approve of in the general assembly meeting.

*Table 6.2. Resources mobilized from external sources for improving the Chhattis Mauja Irrigation System from 1986 through 1988.*

Year	Agency	Quantity	Remarks
1986	FIWUD <sup>a</sup>	NRs 120,000	Sorah-Chhattis Mauja Proportional Division Structure
1986	Butwal Town Panchayat	NRs 5,000	Fuel for bulldozer loaned by the Dept. of Roads
1986	Zonal Commissioner Office Butwal	NRs 332,195	Gate at Ittabhond Intake
1988	District Panchayat	100 bags cement	Gate at Ittabhond Intake (Cement was sold for approximately NRs 5,900 in cash to pay for skilled labor)
1988	District Panchayat	NRs 7,100	Gate at Ittabhond Intake
1988	Zonal Commissioner Office Butwal	NRs 4,983	Gate at Ittabhond Intake

<sup>a</sup> Farm Irrigation and Water Utilization Division, Department of Agriculture.

Source: Joint Committee Records, 1989.

Notes: US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

## COST OF SYSTEM OPERATION AND MAINTENANCE

### Cash and Labor Payment by Farmers

Table 6.3 lists all identified and documented investment made for operation and maintenance by irrigators of the Chhattis Mauja System. The operation and maintenance payments are separated into main system and branch canal components for analysis.

The rate charged by the three sample branch canals for labor exemption varies among branches and was given in Table 5.1 as about NRs 1,500/ha in the head sample branch and NRs 300/ha in the tail. Table 6.3 shows the total cash plus labor expenditure for operation and maintenance to be NRs 410/ha in the head sample branch and NRs 285/ha in the tail. The rate for labor exemption is adjusted periodically to ensure an adequate labor supply. In the head branch the rate for labor exemption is nearly four times the total cost of operation and maintenance. Even at such a high rate, payment was made for about three hectares' equivalent exemption as shown in Table 6.1.

The labor used for canal desilting presented in Table 5.2 and for emergency maintenance in Table 5.3 are the basis for computing the cost of operation and maintenance labor. In 1988, the market rate for manual labor in the Butwal area was NRs 25/day for a seven-hour work day. After some debate during the 1988 General Assembly Meeting, the rate for missing mandatory work at the system-level was adjusted from NRs 15/day to NRs 20/day. While

Table 6.3. *Payment by irrigators for operation and maintenance (NRs).*

Description	Head Sample	Middle Sample	Tail Sample	System
<b>GENERAL INFORMATION</b>				
Water allocation and labor responsibility (kulara)	5	4	2	175
Land area (ha)	50	70	92	3,500
No. of households	45	69	56	2,500
<b>PAYMENT FOR OPERATION AND MAINTENANCE<sup>a</sup></b>				
<b>Main System</b>				
Desilting labor <sup>b</sup>	3,720	3,480	1,480	151,980
Emergency maintenance Labor <sup>c</sup>	8,860	6,780	3,160	299,091 <sup>d</sup>
Fine for absent labor	540	500	320	21,636
Messenger (NRs 55/kulara)	275	220	110	9,625
Main System (NRs)	13,395	10,980	5,070	482,332
(NRs/kulara)	2,679	2,745	2,535	2,756
<b>Branch Canal</b>				
Desilting labor <sup>b</sup>	2,760	4,200	3,480	153,120
Cash instead of labor <sup>e</sup>	4,600	9,800	6,200	370,800
Branch Canal (NRs)	7,360	14,000	9,680	523,920
<b>Total Main + Branch Canal<sup>f</sup></b>				
(NRs)	20,480	24,760	14,640	996,672
(NRs/ha)	410	354	159	285
(NRs/household)	455	358	261	399

<sup>a</sup> Daily wage rate of all labor NRs 20/day.

<sup>b</sup> Labor from Table 5.2, plus fines paid by absentees.

<sup>c</sup> Labor from Table 5.3.

<sup>d</sup> The observed total labor was slightly higher than the sample branch average.

<sup>e</sup> Each village-level organization provides an option for farmers to pay cash for exemption from providing any village- or system-level operation and maintenance labor.

<sup>f</sup> "Messenger" payments are excluded because they are primarily paid by "cash instead of labor" village-level income.

*Sources:* Field observations, 1988/89 and village-level, executive committee and joint committee records.

*Notes:* For details of the three sample branches, see pages 21-22.

For US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

several village-level organizations had established higher rates for fines, the majority agreed that NRs 20/day was enough to encourage most farmers to contribute labor rather than pay cash. The objective of the fine was not to penalize but to provide farmers with a flexible payment option while maintaining the right balance of labor and cash resources. The daily labor wage rate of NRs 20/day is used in the following analysis and provides a conservative estimate of costs.

While all labor reported was used for operation and maintenance of main and branch canals, all of the cash was collected and used by the village-level organization. The village-level organization needed some cash to pay the main system messenger and fines for labor shortages during emergency maintenance of the main system. Cash in excess of needs for salaries, office overhead, and fines paid to the executive committee were available as a reserve fund for use by the village-level organization.

The relative use of the total cash and labor contribution for different activities is shown in Figure 6.1. About 30 percent of the total cash and labor contribution was used for emergency maintenance. Main canal desilting and branch canal desilting each used about 15 percent of the total. Salaries and office expenses amounted to 16 percent of the total farmer contribution. About NRs 200,000 or 20 percent of the total cash and labor contribution paid by farmers was held in reserve by the 54 village-level organizations in 1988/89. Some kept the reserve funds in the bank and others made it available for short-term loans in the village. In general, however, there is a preference for keeping the reserve as low as possible. This is done by increasing the rates for purchasing labor exemption and the fine for missing work. Higher rates encourage people to work instead of paying the exemption or fine. This increases the labor force and decreases the actual time individuals are required to work. Even with the funds handled locally and the accounts open for inspection by all, mismanagement of cash is recognized as a potential problem that can be avoided by increasing the labor and reducing the cash payment to balance the need for each.

### **Analysis of Farmer Payments**

The total estimated value of farmer labor and cash contributions for branch and main canal operation and maintenance in 1988/89 was about NRs 997,000. The three major reasons for contribution were emergency maintenance of the diversions, canal desilting, and cash used for salaries.

Nearly 15,000 person-days of labor were used to maintain the diversion and main canal under emergency conditions. This amounted to a contributed value of about NRs 300,000. For each of the 175 kulara of water allocation, 91 person-days of labor were requested for emergency maintenance. Eighty-five person-days/kulara were delivered and the village-level organizations paid a total of NRs 21,000 in fines to the executive committee for absent labor. The amount from fines was enough to pay all the salaries and overhead costs for the executive committee members.

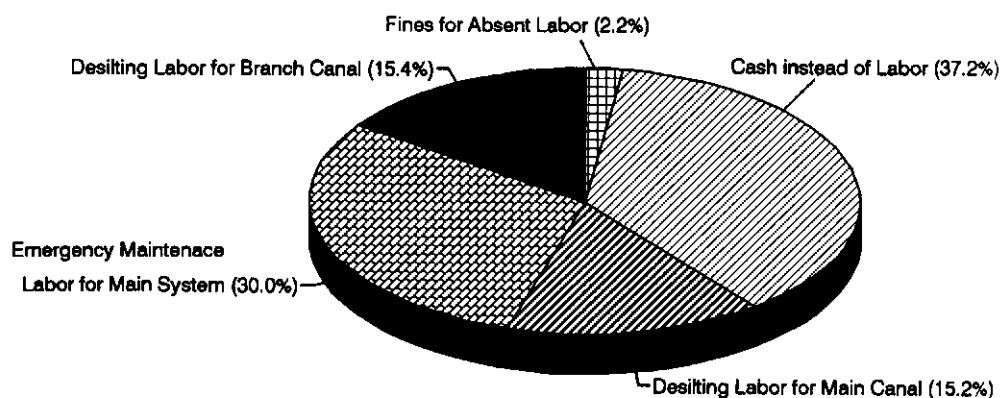
In 1989, according to the system leaders, there was less silt in the upper reach of the canal than usual. The cost of silt removal in the main canal was about NRs 152,000 or half of the cost of emergency maintenance. However, each village-level organization also had its branch canal and field channels to clean. The combined branch and main canal desilting totaled NRs 305,000 or slightly more than the emergency maintenance work that was done.

Dividing the total NRs 997,000 cash and labor payment for operation and maintenance by the total 3,500 ha command area, the average cost for operation and maintenance was about NRs 285/ha. Shrestha et al. (1984) computed the operation and maintenance cost of four agency operated gravity diversion schemes in Nepal of similar size to the Chhattis Mauja.

They found that the actual expenditure ranged from NRs 83/ha to NRs 216/ha compared to an estimated NRs 175-300/ha needed for proper operation and maintenance.

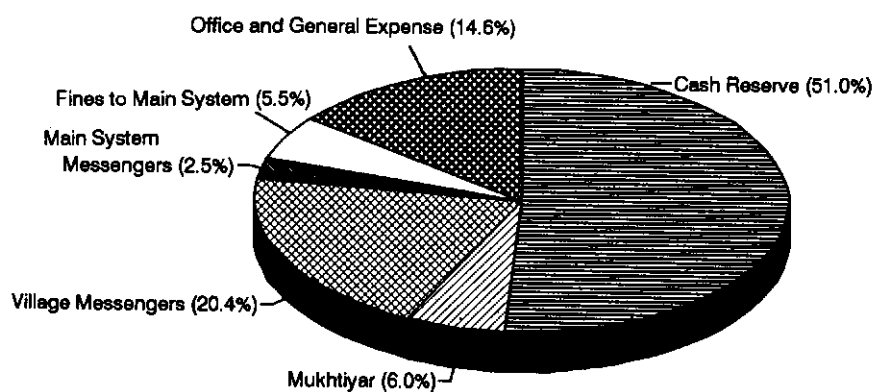
*Figure 6.1. Origin and purpose of the NRs 987,000 labor and cash payments made by farmers in the 1988/89 monsoon, winter, and dry seasons.*

(a) CONTRIBUTIONS BY FARMERS, IN LABOR OR IN CASH EQUIVALENT, TO HIGHER ORGANIZATIONAL LEVELS.



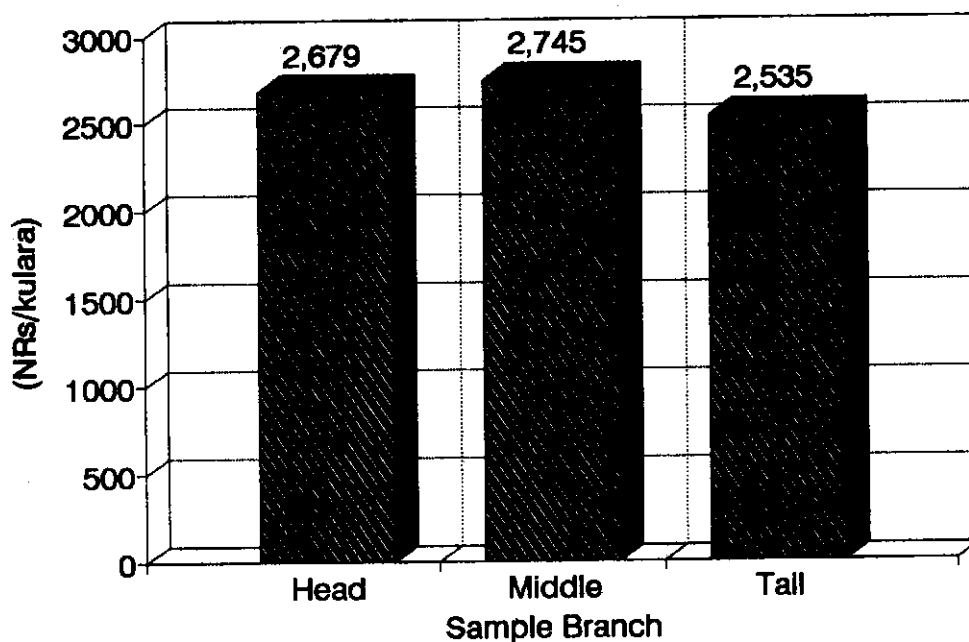
TOTAL VALUE OF CONTRIBUTIONS = NRs. 997,000

(b) APPLICATIONS OF CASH RESOURCES BY VILLAGE ORGANIZATIONS.



TOTAL CASH RESOURCES = NRs. 392,000

Figure 6.2. Comparison of main system operation and maintenance payments per kulara by the head, middle, and tail sample branch canals (cost per unit of water allocation).



#### Village-Level Payment for Main System O&M

Except for individual fines and penalties for breaking operation rules and the occasional material and equipment procured from sources external to the system, all resources used for main system operation and maintenance are from the village-level organizations. Cash and labor is paid in proportion to the kulara irrigation allocation and maintenance responsibility. Comparison of actual payments per kulara among branch canals is an indicator of performance in achieving equity in paying for expected irrigation services. The cost of main system operation and maintenance per kulara water allocation is given in Table 6.3. Figure 6.2 shows the same information graphically.

Among the three branch canals monitored, the largest difference exists between the middle and tail with payments of NRs 2,745/kulara and NRs 2,535/kulara respectively. This 8 percent difference is primarily due to short-term considerations of flexibility in labor supply and response time to emergencies. Given the complexity of labor and cash mobilization the difference is reasonable and in line with the need to maintain equity in payment of irrigation costs relative to the expected benefits.

Rules and institutions for mobilization of labor are well developed and capably managed. In the period of field observation, contribution to system operation and maintenance in proportion to expected water delivery proceeded without conflict with the exception of the four uppermost branch canals which did not contribute to maintenance below their outlets.

#### Cost of Main and Branch Canal O&M

The head sample branch canal is short but has a great deal of silt deposited in it each year that must be removed. The tail sample branch is much longer but has relatively less material per

kilometer to remove. The cost of branch canal cleaning is shown in Table 6.3 together with the total cost of system operation. For each branch canal the total operation and maintenance cost per hectare and per water allocation are also given.

On a per-hectare basis it costs the farmers in the tail sample branch about NRs 160/ha compared to NRs 410/ha in the head and NRs 354/ha in the middle sample branches. However, the tail also had a much lower cropping intensity. On an annual harvested area basis the cost per hectare is roughly the same among all the sample branches. This comparison was made by multiplying the area in each sample branch by the cropping intensity given in Table 4.2. The total area harvested in 1988/89 was 117 ha, 151 ha, and 129 ha for the head, middle, and tail branches respectively. The cost of irrigation per hectare harvested was NRs 170 in the head, NRs 160 in the middle, and NRs 111 in the tail branches.

Relative to their water entitlement, the tail branch with only two kulara of water and a longer branch canal to clean paid more than either of the other two branches. As shown in Chapter 4, farmers in the tail branch have less reliable irrigation delivery from the system. However, as will be seen in the next section, compared to the incremental increase in production that can be attributed to irrigation, the amount paid for irrigation and maintenance is about the same among the three sample branches.

### Effective Rate of Taxation (ERT)

In Chapter 4, the proportional equivalence between the entitlement to irrigation and the actual delivery of irrigation was examined. Comparison of the delivery performance ratio (DPR) among the sample branch canals during the rice growing season when water was relatively abundant showed that the head branch received more and the tail branch less than expected. In the 1989 seedbed and transplanting period, when water was restricted though not in drought conditions, the performance was considerably better. In this chapter, resource mobilization for main system maintenance per kulara responsibility was compared among the sample branch canals. This was found to be nearly equal among the sample branches.

The relatively higher equivalence in resource mobilization to responsibility, but lower equivalence in irrigation delivery, raises several questions. What are the incentives that keep this consistent level of resource contribution going in the tail branch? To what extent is there proportional equivalence between resource mobilization and benefits of agricultural output? While the cost of irrigation per annual harvested area gives a rough comparison of equivalence in agricultural output, it is not conclusive because the cost of crop production and value of the harvest are not considered.

In her study of three irrigation systems in Nepal, Hilton (1991) examined cost recovery and local resource mobilization by evaluating the effective rate of taxation (ERT). She defined the effective (irrigation) rate of taxation as:

$$ERT = \frac{\text{Resources Paid for Irrigation}}{\text{Marginal Income from Irrigation}}$$

By using the ERT as a standardized measurement, Hilton was able to overcome the problem associated with comparing absolute levels of resources mobilized when many "other" conditions are not equal. Using the marginal income as the basis for standardization incorporates both the production costs and the value of production. The marginal income from irrigation was defined as the income from irrigated agriculture minus the income from unirrigated agriculture. Marginal income is the appropriate measurement because payment for irrigation costs are only important when there is irrigation.



The ERT was computed for the three sample branch canals. The model used and assumptions and conditions for computing the ERT are given in Appendix 3. In computing the ERT, measured crop production, cropped area, and observation of practices were used to the extent available. However, many inputs such as labor used for agricultural production, cropping patterns and yield for nonirrigated conditions were not measured or monitored. Data compiled and evaluated by the Irrigation Master Plan (DOI 1990) were used as the best available estimate when observations and measurements were not available. The results together with the ERT's sensitivity to changes in several variables are given in Table 6.4.

While farmers complain about the continuing high cost of maintaining the irrigation system, the returns for their effort are high. On average over the system, for each NRs 1.73 spent on operation and maintenance, NRs 100 was gained in production above that of unirrigated agriculture. The ERT for the observed and estimated conditions in 1989 show that the total cost of irrigation as a percent of the marginal income was 2.13, 1.79, and 1.90 for the head, middle, and tail branches respectively (condition 1 in Table 6.4).

The ERT range of 1.79 to 2.13 between the middle and head branches is not large. That the head and tail are even closer in their ERT indicates that there is a high level of equivalence among branches between the responsibility for paying the cost of operating and maintaining the system to the marginal value of production. The adjustment in water allocation and maintenance responsibility has given an equitable distribution of the benefits from irrigation with respect to the costs.

*Table 6.4. Effective Rate of Taxation for three sample branches of the Chhattis Mauja Irrigation System.*

Condition	Labor (NRs/day)		ERT (%)			
	Maintenance	Field	Head Sample	Middle Sample	Tail Sample	System Average
1. Estimated conditions in 1989	20	16	2.13	1.79	1.90	1.73
2. Estimated land area based allocation of irrigation delivery and maintenance responsibility	20	16	1.47	1.69	2.86	1.73
3. Estimated conditions in 1989 with doubled labor rates	40	32	4.09	3.00	3.15	2.98
4. Wheat and maize crops fail and rice crop as of 1989	20	16	3.73	2.38	2.43	2.49
5. Wheat and maize crops normal and rice crop 50% of 1989	20	16	3.67	3.15	7.92	3.77

*Notes:* For details of the three sample branches, see pages 21-22.

US\$1.00 = NRS 25.10 in 1988.

US\$1.00 = NRS 28.10 in 1989.

In contrast, if the water allocation and maintenance responsibility had remained land area based (condition 2 in Table 6.4) the estimated ERT would have been 1.47, 1.69, and 2.86 for the head, middle, and tail branches respectively. This assumes that within-branch costs remained the responsibility of the branch but main canal and diversion maintenance activities were allocated proportional to land area within the total system; a scenario similar to the

conditions in many agency-managed systems. As a percentage the differences seem relatively minor, however, they translate into major changes in the relative irrigation cost per hectare without any change in the benefit from irrigation. In the head branch the cost would drop from NRs 410/ha to NRs 280/ha and in the tail it would increase from NRs 157/ha to NRs 242/ha. The middle branch has not changed its water allocation significantly from that of its original land area basis and hardly changes in per hectare costs.

The fine for being absent from work for a day was adjusted from NRs 15 to 20 in 1988. It was assumed that enough workers would be available even though the market rate was NRs 25. To test the sensitivity of the ERT to the labor rates for desilting and emergency repairs as well as field labor, the 1989 rates were doubled (condition 3 in Table 6.4). The model gives an estimated ERT ranging from 3.00 to 4.09 with a doubling of labor rates.

Conditions 4 and 5 in Table 6.4 examine the sensitivity of the ERT to crop production. Condition 4 assumes that the wheat and maize crops fail entirely and that the rice crop is normal. This condition results in a relatively higher increase in the ERT in the head than in the tail where wheat and maize are less important. However, if the rice output is reduced as in condition 5, there is a relatively large increase in the ERT in the tail branch. If such failure happened on a regular basis it is not likely that farmers from the tail branches would continue to invest in operation and maintenance of the system.

Losses in rice yield higher than 50 percent resulted in dramatic increases in the ERT in all branches. The sensitivity analysis indicates that even with doubling of labor rates or with large reductions in yield, operating and maintaining the irrigation system remains a profitable enterprise.

Hilton (1991) examined the ERT of three irrigation systems in the Dang Valley of the Rapti Zone. One was a farmer-managed irrigation system serving about 500 ha that had received only minor assistance from the local government. The estimated system average ERT ranged from 17 to 20 percent depending upon the level of resources mobilized. The second system irrigates about 250 ha and is also managed by farmers. It received substantial assistance from the Agricultural Development Bank and CARE Nepal for improving the diversion and lining some segments of the canal. The estimated system-level average ERT ranged from 10 to 14 percent depending upon the level of resources mobilized. The other example was a system constructed by the Department of Irrigation (DOI). The command area of 265 ha had previously been irrigated by five farmer-managed irrigation systems. The Department operates and maintains the new diversion and main canal. The ERT was found to be 1.4 to 3.2 percent dependent upon the level of farmer resources necessary to maintain the secondary canals. This excludes DOI's cost of operation and maintenance. The ERT of the Chhattis Mauja System compares favorably with that of the DOI operated system even while including all operation and maintenance costs of the main and branch canal system. When compared to a very limited sample of taxation rates in other systems, it appears that farmers in the Chhattis Mauja System are managing quite well.

## EXTERNAL RESOURCES

The nature of government or landlord involvement in the original construction of the Chhattis Mauja Canal is unknown. No written or oral records have been found to establish such a link but it is likely that the holder of a large tax-free land grant contributed to the construction and possibly even organized the work. Certainly the Malla and Dixit families made substantial contributions to operation and maintenance of the system and may also have mobilized outside resources.

In recent years, Chhattis Mauja farmers have frequently lobbied effectively for government assistance. Table 6.2 lists assistance from government agencies from 1986 to mid-1988. Although records were not found, there were reports of numerous instances of minor assistance for use of earthmoving equipment from the Department of Roads, for materials to improve retaining walls near the intakes, and to construct several bridges over the canal from 1951 to the present.

While it is easier for subsistence farmers to mobilize labor than cash, working on the irrigation system is not viewed as a frolic to be perpetuated. All possible effort is directed toward making the system functional with reduced labor inputs. Permanence of structures was frequently discussed in meetings together with recognition that even massive structures and huge investments are not always successful. The failed attempt by engineers to build a permanent gated barrage on the river a few hundred meters below the Chhattis Mauja Diversion is a continual visual reminder of this.

The effectiveness of outside assistance was cause for continual discussion at general assembly meetings (Appendix 2). In general, there was frustration that the needs and priorities of the irrigators were not met by this assistance or that funds were squandered in building structures that were not useful. The basic concern seemed to be loss of control over decision making when a government agency provided funds. For example, when the control structure was designed for the Ittabhond Intake it called for a gate on the main canal, another gate to control flushing of silt from the diversion canal, and a trash rack to keep stones and debris from entering the canal. The farmers objected to the trash rack saying that there was no way to clean it and that it would block and restrict flow into the canal. When funds were not sufficient to complete the control structure, the flush gate not the trash rack was dropped from the plans because the gate was the more expensive item. Without the flush gate the farmers were not able to close the main canal gate without backwater overtopping and damaging the diversion canal. Their only recourse was to lock the canal gate open until they managed to construct the gate to control flushing. When the trash rack blocked as predicted by the farmers it buckled under the load and had to be removed by them, a waste of their labor input and government resources.

Overall, when compared to the cumulative resources mobilized by the irrigators, the input from outside sources is not substantial. What farmers in the Chhattis Mauja valued most about the external resource was access to materials that they would have otherwise needed to purchase with cash. While they also received professional engineering assistance they tended to view it as a negative input (Appendix 2) tolerated only because it provided access to cash.

## **MAINTENANCE REDUCTION THROUGH PHYSICAL IMPROVEMENT**

Improvements made in the canal over the years have had mixed results in reducing maintenance requirements. The permanent structure dividing the Chhattis and Sorah Mauja water is a successful example. The control gate at the Ittabhond Diversion was not operational two years after construction because the complimentary flush gate had not yet been completed. The flush gate was built by the farmers in 1989 by hiring six skilled masons who were paid on a volume of work completed basis. While outside assistance was received for these improvements, internal resources were also mobilized. Cash and labor are mobilized for permanent improvements in the same way as emergency resources and often not distinguished from the emergency repair activities.

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For installation of the main gate at the Ittabhond Diversion in 1987, NRs 106,200 in cash was raised by assessing each village-level organization a fee of NRs 600 per kulara. In 1989, about 2,000 person-days of labor was mobilized but there was no additional cash to complete the work by installing a flush gate. Approximately 25 percent of the total cost of installing the two gates at the Ittabhond Diversion was paid by the farmers and the rest from several different governmental sources.

## ADDITIONAL OBSERVATIONS

Temporary facilities for water diversion from the river, unlined canals, and lack of gated distribution structures are common features of farmer-managed irrigation systems. Although the farmers of the Chhattis Mauja System have managed to mobilize their own and outside resources to construct a number of permanent structures in the past two decades, they must still rely primarily on mass mobilization of labor to maintain the system and keep it operational.

As mentioned in Chapter 5, in the past the practice for mobilizing labor for canal desilting and serious emergencies was on the basis of one person per 1.25 ha. The secretary still reports annual levels of labor contribution for main canal desilting to the general assembly meeting computed by multiplying 2,600 persons per day times the number of days worked. Monitoring of the desilting work indicated that on average about 750 persons worked each day to complete the work assigned to each village. If the higher level of labor contribution were correct, the average cost of system operation and maintenance would increase from the estimated NRs 285/ha to nearly NRs 420/ha. However, the average ERT for the system would increase from 1.73 to 2.56. Certainly not enough to compromise the profitability of the system.

Table 6.3 shows that farmers in the tail branch are paying NRs 159/ha for the irrigation they receive from the Chhattis Mauja System. Several nearby villages that are still members of the Chhattis Mauja System could access irrigation from the Department of Irrigation's tubewell project for only NRs 133/ha in 1989. Interviews with farmers showed that they were aware that the tubewell water was cheaper. Villages have slowly shifted from the Chhattis Mauja to the tubewell project, however, many still prefer to retain membership in the Chhattis Mauja System. Some farmers claimed that the silty water from the river contained valuable nutrients that are not available in the clean tubewell water. Others fear that the tubewell will not be dependable and cannot be repaired by mobilizing labor. However, the most defensible argument is their hope that government assistance will be forthcoming and improve the Chhattis Mauja System and reduce the maintenance costs, making it much cheaper than tubewell water. Farmers are afraid that if they relinquish their membership in the system they may not be able to get water again even if improvements are made.

## CHAPTER 7

### Summary and Conclusions

#### EFFECTIVENESS OF THE SYSTEM'S INSTITUTIONS AND PROCEDURES

##### Tailoring Institutions to Meet the Needs of the System

THE TERM "CRAFTING INSTITUTIONS" used by Ostrom (1992) appropriately describes the dynamic evolution of the Chhattis Mauja Organization and its rules. Rules governing the operation and maintenance activities were devised, tried, modified, and tried again. This process continues as the institutions are tailored to fit the changing needs and interests of the irrigators. The influx of hill people reduced the size of the average landholding and the small holders insisted on proportional equivalence between benefits and costs. Off-farm employment has had an impact on the relative availability of cash and labor. Willingness to change, make adjustments, try new patterns, and accept new ideas are important ingredients in the sustained output of the system.

Change in the irrigation allocation and maintenance responsibility has perhaps been the most important factor in maintaining the high level of support by the irrigators. Decentralization of decision making for activities below the branch canal inlet has allowed the diversity essential to fit the different cultural and economic concerns among villages. Linking representation for system-level decision making to irrigation allocation encourages compliance to the rules in use. Graduated penalties that match the severity and frequency of the infraction are enforced by elected officials. Social pressure is applied at meetings to encourage violators to pay their fines and comply with the rules. The ultimate discipline is denial of water to a branch canal that has not met its obligation. Nearly complete compliance to resource mobilization requests in each sample branch canal affirms the acceptance of the rules for operation and maintenance of the system.

General assembly meetings and general meetings provide an important open forum for exposing problems. The same is true within the branch canals at village-level meetings. The area-level and executive committee meetings improve decision-making efficiency while bringing balance through geographical representation. Accountability of system-level officials to the general assembly has reduced, though not eliminated, favoritism and fraudulent behavior. Accountability is often hampered by poor recordkeeping.

The importance of effective communication is recognized by all of the irrigators. Information about changes in irrigation distribution procedures must be available to everyone. With the penalty for being absent during maintenance equivalent to the daily wage rate, farmers cannot afford to miss work because they were not informed. In total, 47 messengers are employed by the irrigators to facilitate communication within the system.

Even with a strong and effective organization several weaknesses are apparent. Accounts are audited and open for public inspection but recordkeeping is not as systematic

as expected. This continues to allow conflict that could be dispelled with better documentation. However, inability to monitor and modify the alleged free rider behavior of the four upper branch canals is the most serious problem faced by the system.

Irrigation allocation rules, as explained by the executive committee, state that there will be proportional distribution of the irrigation supply with respect to kulara of resource mobilization responsibility of each branch canal. The rules indicate that this is accomplished by adjusting the size of the branch canal inlet opening. Observation of the rules actually used, suggest a quite different approach during periods when the irrigation supply ranges between scarcity and abundance.

The discharge is adjusted and temporarily fixed by the meth mukhtiyar according to his estimate of fair distribution. Under these conditions changing the settings will only be made if there is sufficient pressure from farmers who feel they are not receiving enough water. This suggests that the executive committee does not play a proactive role but only responds to pressure, a situation that is easily abused. Ultimately, farmers can insist that irrigation delivery be shifted into a rotational mode where proportional delivery can be accomplished by timing delivery to each farm. Rotational delivery is much more rigid and carries somewhat higher operational costs. As with irrigation systems observed in the hills, rotational delivery among branches is delayed as long as possible in the Chhattis Mauja System. It was not observed during the 1988 monsoon rice season.

### **The Alleged Free Rider Problem**

The four branch canals with inlets above the Sorah-Chhattis Division Structure are frequently accused by other members of the system of taking more than their share of water and not fulfilling their share of maintenance. While their diversion of extra water has not been measured, it was observed that rice was transplanted in their fields long before it was transplanted in those of the head sample branch. Most of their fields were irrigated throughout the dry season. It appears that the executive committee has no control over the upper branches and that they use their privileged head-end location to maximum advantage. The system-level records show that they do not contribute labor or cash to improve the system below their inlets, in defiance of the system rules and practices of the rest of the irrigators.

One positive contribution that the four upper branch canals make is immediate mobilization of emergency labor. They can be called with only a few hours notice to repair the diversion. They are compensated by not being called when there is enough time to notify villages further from the intake.

While these four branch canals do contribute to the maintenance of the two diversions and the jointly operated segment of the main canal, they do not contribute to main canal desilting below the jointly operated canal and are not fined for this by the Chhattis Mauja Executive Committee. Though they refused to fully participate in the Chhattis Mauja operation and maintenance activities, they were still allowed to vote in the Chhattis Mauja General Assembly Meeting Election. The Chhattis Mauja Organization encourages their voting as further evidence in its claim to authority over the entire organization and the physical infrastructure from the upper diversion to the last branch canal. The Chhattis Mauja Organization maintains this is their right because the first diversion and canal were built by villages still using the system.

The problem with the upper branch canals stems from government intervention in what the Chhattis Mauja considers to be its own creation. The local government pressured the Chhattis Mauja to open the uppermost branches as a domestic water supply in the area immediately below the town of Butwal. The upper branches are able to continue their claim for use of the system as a domestic water supply and in 1989 continued to receive local

government support for their claim. The outcome of the intervention is that the Chhattis Mauja no longer has the ability to use its ultimate form of discipline which is closing the branch canal inlet, when these branches violate the rules and other attempts to discipline them are not effective.

The local government was likely justified in intervening to allow use of canal water for domestic purposes. Pressure on the Chhattis Mauja Organization to reach a negotiated and binding agreement along the lines of those with other branch canals would, however, have been more tenable. It is very likely that local government officials were not aware of the nature and extent of the institutions that had evolved in the Chhattis Mauja and did not realize the potential damage that abrogating the ultimate control mechanism could have. Inability to control the upper four branches is an irritation to the rest of the members of the system but because it is a relatively small area that cannot be expanded it is not likely to threaten sustainability of the system.

The lesson, however, is clear. Care must be taken that outside intervention, for whatever purpose, does not diminish the authority of the organization. Pressure can be applied to improve rules during negotiation, but when authority is diminished for enforcing rules it weakens the entire organization.

### **Proportional Equivalence of Benefits, Costs and Representation**

The Tharu builders of the Chhattis Mauja System, who managed it until about 1950, used a method of resource mobilization similar to recent practices in the far western tarai. Pradhan et al. (1988) found that under conditions of abundant land but shortage of labor, the Tharus of Kailali District required all able-bodied persons from each household to work on canal maintenance irrespective of the size of landholding in the command. This practice changed in the Chhattis Mauja System when large numbers of hill people settled in the command area and land rather than labor became limited.

For emergencies the hill settlers continued to mobilize labor on a household basis but insisted on equivalence between benefits and maintenance burden for the annual desilting. Land area was used as a convenient standard for attributing proportional shares of irrigation and maintenance responsibility among the branch canals. With recognition that land area-based irrigation shares were not sufficient for growing rice in the newly opened head region of the system where infiltration rates are high, the rules were again modified to allow branches to adjust their allocation to match their needs.

Decoupling irrigation allocation from a land area base was possible because of the responsibility rules for maintenance that were attached. Necessity for relatively high labor and sometimes cash contribution for annual desilting, emergency maintenance, and periodic system improvements keeps individual villages from trying to capture an excessive amount of water. In addition to a one-time application fee of NRs 500 for changing the allocation, the annual cost for main canal maintenance was NRs 2,700/kulara in 1989. This was equivalent to 135 person-days of labor per kulara to be shared among the households of a branch canal. For large landholders this cost is not a serious constraint. However, farmers with small landholdings prefer to reduce costs and use irrigation efficiently. They oppose accumulation of an excessive irrigation allocation even though it would make it easier to irrigate and would increase yield in critical water-short seasons.

A need-based mechanism has allowed change in irrigation allocation to best match the requirements in each part of the canal. In the head end, villages have increased their allocation and accepted the increased share of the maintenance burden while tail branches have decreased their share to reduce operating costs. The middle sample branch continued with about the same 1 kulara per 17 ha share as distributed during the land area-based allocation (see Table

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3.1). The head sample branch increased its share to 1 kulara for each 10 ha and the tail sample branch decreased its share to 1 kulara for each 46 ha.

Several factors are important for successful implementation of rules requiring proportional equivalence of benefits, costs, and representation. Branch canals must be dependent on each other for mobilizing the resources for successful maintenance. If a few branches could accomplish all of the maintenance and improvements on their own, it is doubtful that proportional equivalence could be established to the larger community. There are two related reasons for increasing the number of branches and allowing additional units of irrigation allocation in the Chhattis Mauja. A large labor pool is needed in times of emergency to promptly restore operation of the system and a large number of shares reduces the cost of operation and maintenance per share. The limit to expansion, of course, is the ability to deliver adequate and timely irrigation. Willingness of each branch canal organization to pay their share of the cost depends on whether they feel they have received their fair share of the irrigation supply. Interdependence of high but shared maintenance costs and proportional sharing of benefits is a strong incentive for cooperation.

The ability of the organization to enforce its rules is also important. If the desilting work assigned to a village is not completed or if fines for absentee labor are not paid, a branch canal can be closed. The mechanism for ensuring equitable irrigation delivery is less direct. Since the elected executive committee manages irrigation delivery to the branch canals, representation for electing those officials is one mechanism of enforcing the concerns of the majority. Each branch canal has as many votes as kulara irrigation allocation. However, this spreads the vote widely and requires considerable campaign effort and skill if issues such as fair irrigation delivery are to be addressed in the election. Evidence of attempting to address irrigation delivery issues was seen in the 1989 election.

Social pressure by large groups of farmers in meetings has a more visible impact on behavior. General meetings, where each branch canal is represented by its mukhtiyar, gives tail-end branches with lower allocation per hectare some advantage in dealing with irrigation delivery issues. When irrigation delivery is not proportional to the payments being made, branch canals can insist on rotational delivery. When problems persist, especially when other attractive alternatives such as cheaper tubewell irrigation are available, the ultimate action a branch canal organization can take is to withdraw from the system. This increases the maintenance burden on the remaining irrigators.

One useful result of high maintenance costs and the interdependence of the branch canals of the Chhattis Mauja System with regard to the provision of resources for maintenance is that it obliges the managers to provide more equitable irrigation distribution. Otherwise farmers would not respond when called to contribute labor and cash for maintenance. Martin and Yoder (1988) reported similar findings from their study of eight farmer-managed irrigation systems in the hills of Nepal.

Where continued operation of an irrigation system is dependent on maintenance that can be performed by the irrigators, it should be possible to move toward a system of proportional equivalence between irrigation cost and benefits. The Chhattis Mauja irrigators have introduced an effective allocation mechanism that allows individual branch canals to increase or decrease their allocation to match irrigation requirements. It works because they also accept the corresponding proportional change in maintenance responsibility.



## SYSTEM OUTPUT PERFORMANCE

### Performance Compared to System-Level Goals

In both 1988 and 1989, the farmers were satisfied with irrigation delivery for rice seedbed preparation and transplanting. Timely rains in 1989 allowed completion of transplanting in each sample branch about a week earlier than usual. The delivery performance ratio indicated reasonably good adherence to the allocation rule with the head sample branch taking about 30 percent more and the tail sample branch getting about 30 percent less than their entitlement without considering infiltration losses.

Over the entire 1988 rice season, irrigation delivery from the main canal to the head sample branch was about 2.4 times and to the middle branch about 1.5 times their allocated amounts. This is without taking into account the seepage loss in the canal which would make the ratio even higher. The tail sample branch received about 30 percent of its allocated supply via the main canal. However, water available from the drainage system, together with rainfall, provided an adequate water supply to the tail branches where the infiltration rate is much lower than in the head branches.

Although farmers in the tail branch of the system received almost no irrigation delivery through the main canal and grumbled about it during the early part of the monsoon season, they took very little action. As long as there was rainfall they did not approach the chairman to press for increased irrigation delivery. After the rains stopped they did request and receive irrigation for a few days. However, they did not find it worth the effort to persist in their claim for additional delivery when the supply again diminished, since fields with early maturing varieties no longer required irrigation. The continued investment of substantial resources in main system maintenance indicates that the tail branch farmers perceive present and future benefits to offset the payments they make for system operation and maintenance.

Irrigation delivery for wheat in the winter of 1988/89 was excellent to all parts of the system requesting irrigation. Well-spaced rainfall contributed more than usual to the crop water requirement and many farmers irrigated their wheat only once instead of the customary two or three times.

For the duration of the study period, only in the 1989 dry season was the irrigation delivery less than what the farmers expected. Maize planted early suffered water stress and some fields did not produce grain. Maize planted later in the season benefitted from premonsoon rainfall and produced a successful crop. During the period of low irrigation supply, strict rotational delivery was observed. Seepage losses in the main canal and delivery time were minimized by routing the irrigation delivery from one branch canal to the next wherever possible. Though the supply was not adequate for the first two months of the dry season, the entire irrigation resource was used and few conflicts reported.

Rotational irrigation is computed for proportional delivery according to the allocation of each branch canal. High infiltration losses in the main canal prompted some adjustment of delivery times to disadvantaged areas further from the main canal in the upper branches and to the branches further from the intake. In an average dry season and with less than average rainfall in the winter, most of the water is lost in the canal bed when trying to deliver to the tail branches. Proportional sharing of the available irrigation resource has little meaning during these periods since measured adjustment of losses is not possible. Taking this into account, farmers make pragmatic cropping decisions during the winter and dry seasons. If possible they grow some crops not requiring irrigation or may leave some or all of their fields fallow.

The priority for meeting system-level irrigation delivery goals followed a hierarchical pattern. The chairman and the meth mukhtiyar's mode of operation was to respond to farmer complaints. Monitoring irrigation delivery was not important when there were no complaints.

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When farmers reported that not enough water was being delivered, the first response was to try and increase the supply. If it could be increased sufficiently all farmers were satisfied. If it could not be increased then the existing delivery had to be adjusted which decreased the satisfaction of the farmers who had to give up the extra supply they were accessing. In the 1989 rainy season, the chairman was able to satisfy most farmers by making ad hoc adjustment of delivery to each branch canal. The adjustment was made by the meth mukhtiyar and agreed to in writing by the mukhtiyar of each branch. When such adjustment does not satisfy irrigation needs, i.e., individual branches are not satisfied that they are getting their share of the irrigation supply, the chairman can shift to rotational delivery. Since rotational delivery to a few branches at a time is less convenient for farmers and less flexible in accommodating variable needs, farmers are agreeable to ad hoc adjustments of continuous delivery as long as possible. Rotational delivery is the mechanism for reducing conflicts and ensuring efficient irrigation delivery during water short periods.

Even with rotational delivery farmer satisfaction is important. Flexibility is practiced in giving extra time if necessary to complete irrigation coverage. Farmers can argue that rainfall, broken diversions, etc., decreased the water available to their branch compared to others during the rotation period. The chairman has the authority to allocate extra delivery time if it is warranted by the circumstance. If he determines that such a decision will be controversial he consults the executive committee and follows their advice.

Evidence was given in the preceding chapters that irrigation related activities are less intensive in the lower than in the upper part of the system. The cropping intensity is lower and the organization for irrigation management is less structured. Table A3.8 shows that the net income per hectare in the tail is less than half that in the head end of the system. Is this evidence of inequitable irrigation delivery and poor management performance by the executive committee?

Until four or five decades ago, only monsoon rice was irrigated by the Chhattis Mauja System. Because of the high seepage losses in the canal, dry season discharge in the river cannot be delivered to the tail reach of the system, and farmers in the bottom half of the system have never attempted to irrigate from the system in the dry season. While irrigated winter crops could be expanded, analysis shows that wheat could not be reliably irrigated in the entire command area. While improved management would undoubtedly enable increased cropping intensity and make irrigation available to farmers further from the upper end of the system, total production would decrease if the irrigation supply were spread uniformly over the entire command area in all seasons.

Lack of strong organization in the tail branch canal reduced their effectiveness in lobbying for improved irrigation delivery toward the end of the monsoon rice season. The type and style of organization in the tail branches reflect cultural values and experience of Tharu farmers who are in the majority in that part of the system. Settlers from the hills have historically taken advantage of Tharu farmers and in many parts of the tarai taken over land and water rights formerly held by these indigenous farmers. The executive committee and the functionaries it employs take a reactive approach to management. Unless farmers from a branch canal complain that they are not getting their share of water, action will not be taken to ensure equitable distribution.

As mentioned above, the tail end farmers lobbied for more water toward the end of the monsoon season but did not sustain their effort. As a result only two adjustments were made to direct more water toward the tail end of the system. The effort and cost of additional lobbying appears to have been higher than the value placed on getting additional water. Since many farmers in the tail branch grow early varieties to avoid water stress at the end of the season, not all supported the effort to increase the supply, and so the group's effectiveness was reduced.

There are several avenues open to the Chhattis Mauja farmers for increasing the responsiveness of the executive committee and its functionaries. They can send stronger, more able representatives to the executive committee, and they can elect a chairman, vice-chairman, and secretary of the executive committee that would better represent their needs. In reducing their responsibility to provide resources for maintenance, through giving up kulara of water allocation over the past decade, the tail end villages have also reduced their entitlement to representation in the General Assembly, since this also is in proportion to their holding of kulara. At the same time the head end farmers have increased their representation. The net effect has been a gradual shift of power to the head end of the system.

Though it is regrettable to see the farmers whose ancestors built the system gradually reducing their involvement in the system, before one can conclude that this reflects inequity and poor management by the executive committee, a more careful study must be undertaken of the influence and relative benefits of newly available groundwater for irrigation by the tail end villages. The gradual manner of reducing their water allocation suggests that the tail end villages are experimenting carefully in adjusting their water allocation to balance the value of the water to its costs.

### **Performance Compared to National-Level Goals**

*Yield.* The present, average production level for irrigated crops in the region of the Chhattis Mauja was met or exceeded by all three sample branch canals for all crops. Production targets for the year 2000 were nearly met or exceeded by the head and middle sample branch canals for rice and wheat. Yield for the tail sample branch was not far below the future targets. Only maize, which suffered from insufficient irrigation, was substantially below future targets.

Poor drainage in the tail sample branch and the tail region in general reduced wheat yields. Excess soil moisture also limited the extent of nonirrigated crops that can be grown, resulting in about 60 percent of the tail sample branch being fallow in the winter. This was in contrast to the head and middle branches where the entire area was cropped in the winter.

*System Boundaries.* The national priority is to expand the irrigated area. For the period between about 1940 and 1970, the boundaries of the system expanded. This expansion was unique because it opened areas in the head reach of the system rather than extending irrigation further from the source. This had a number of important implications. Possibly the most important was dramatically higher infiltration rates in the expanded head area of the system. While these well-drained soils are ideal for irrigated nonrice crops they require much higher irrigation delivery for rice. The same irrigation supply could irrigate a much larger area in the tail region of the system.

In the 1970s and 1980s, a Department of Irrigation initiated tubewell project included some of the area in the tail region of the system. As a consequence, some villages have given up their irrigation allocation and dropped out of the Chhattis Mauja System. In years of adequate rainfall, these villages are still able to tap the excess water draining from the Chhattis Mauja Command Area but have an assured supply from the tubewells during drought. One can only speculate that if groundwater had not been available there would have been much more intensive pressure to expand the irrigated area in the tail.

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## **COST AND BENEFITS OF IRRIGATION**

The cost of irrigation operation and maintenance for the main and branch canals ranges from just over NRs 400 /ha in the head sample branch to about NRs 160 /ha in the tail. The average for the system is about NRs 285 /ha which falls in the range suggested as necessary to maintain irrigation systems managed by the Department of Irrigation.

While irrigation delivery did not match the irrigation allocation perfectly in all seasons, responsibility for maintenance was remarkably equitable. The main system operation and maintenance payments per kulara maintenance responsibility were compared among the sample branch canals and found to be nearly equal. Exceptionally good compliance with the rules for mobilizing resources to maintain and improve the system is a strong indicator that the internal processes of the system are working well.

The effective rate of taxation was computed to examine the level of proportional equivalence between the cost of irrigation and the incremental production benefit derived from irrigation over rain-fed conditions. This confirmed that the adjustment in irrigation allocation and maintenance responsibility has given an equitable distribution of the benefits from irrigation with respect to the costs among the three sample branches. It also showed why the farmers continue to be willing to invest in operation and maintenance of the system. The farmers' total payment for irrigation is only 1.73 percent of the marginal income from irrigation, i.e., the increment of agricultural income attributable to irrigation. Even though it requires considerable expenditure, irrigation is a highly profitable enterprise for the Chhattis Mauja farmers.

## **IMPROVEMENTS**

### **Can Production be Increased?**

This concluding section returns to the questions presented in the introductory chapter that were used to guide the study. While one would like a field study to provide clear-cut answers and directives, it raises many additional questions. It is important to know where the one-year snapshot of performance fits in the longer cycle of good monsoon rains and drought. Indications are that both the total rainfall and its distribution in critical crop growth periods were better than normal during the study. How different would system output and internal processes look in a year with less than normal rainfall? Only speculative answers are drawn here from the farmers' experience over many years of production as reflected in the cropping decisions they made during the study year.

As indicated above, the yields were higher than average for similar irrigated areas. It is not likely that they will increase significantly with changes in irrigation delivery. Drainage to decrease moisture after the rice crop and other inputs and farming practices are more likely to have a positive impact on yield. Except for early maize, irrigation was not a serious constraint for the crops planted in the sample branch canals in 1988/89.

The area cropped with rice would not increase with a larger irrigation supply, since essentially, all of the area is presently planted to rice in the rainy season. However, the area planted to maize and to a lesser extent wheat could be increased with additional irrigation delivery. It would also be possible to grow spring rice if water was not limited. In 1988/89 additional wheat could have been sown with the irrigation supply available. However, given the input costs and low market value, farmers had no incentive to increase the area beyond

what they had observed could normally be irrigated. With early maize the area planted extended slightly beyond the boundaries for which sufficient irrigation was available. Without increasing the irrigation supply at the field level it is not likely that farmers will be willing to increase the area planted to wheat and maize.

All of the irrigation supply available to the Chhattis Mauja in the dry season was diverted from the Tinau River during the year of study. The only way to increase the supply to the fields would be more efficient distribution or tapping additional groundwater if possible in the tail areas of the system. From observation of rotational irrigation delivery during the water short period during the 1989 maize season, it was concluded that distribution efficiency could not be increased by changing management practices. The rotational distribution was moving the available irrigation supply as effectively as possible in the existing canals.

This suggests that the available irrigation resources are used to the extent possible, given the physical condition of the system. Production is not likely to increase unless additional irrigation delivery allows expansion of the irrigated area during the winter and spring seasons.

One exception that merits further field investigation is the extent to which, if at all, the upper four branch canals are overusing irrigation during the winter and spring seasons. Possibly there would be benefits from redistributing this to other branches in the system. It would also be useful to examine irrigation application and management practices in the tail branches at the end of the rainy season. Early maturing varieties and reduced late-season irrigation application may be effective in reducing excessive moisture that delays sowing postmonsoon crops.

### **Physical Improvements**

The Chhattis Mauja farmers have over the years made many improvements to the system. When investing only their own resources they have used a cautious approach with small incremental additions and modifications to make more durable structures. They place priority on structures that improve the reliability of irrigation delivery and reduce the maintenance burden.

They would like to strengthen the wing walls of both diversions to reduce the frequent emergency maintenance necessary during the rainy season. Given that the wing walls are directly exposed to severe floods, the cost and the risk would need to be considered carefully. The farmers are especially keen to reduce the need to cut and carry brush and branches to the diversion to use in reducing leakage. They indicated that it is increasingly difficult to find enough brush to cut. Some of the forest products used have alternative value. A few species are useful as fodder for goats and cattle. If brush is cut from the nearby hills it contributes to erosion. However, the majority of the brush were cut along the canal and roadside and they were primarily rapid growing varieties with no commercial and little agricultural value.

The irrigators have completed the gates necessary for controlling the lower diversion and would benefit from a similar improvement at the upper diversion. These could be used to decrease the magnitude of bed load entering the system each year which would reduce the desilting cost. If operated properly they would also limit the peak flows that have eroded the canal banks.

Except for farmers whose fields border the main canal, few are complaining about the severe erosion that has taken place and made the canal very wide in a number of locations. Lining the main canal under present conditions would be costly, because backfilling would be required first to reduce the cross-section to an appropriate size. The width creates problems at the branch canal inlets. Constructing appropriate structures for canal bed and water head regulation is costly, discouraging branch canal organizations from making the improvement with their own funds.

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While main canal lining would improve non-monsoon irrigation delivery into the lower areas of the system, a careful analysis of cost and benefits would need to be done. Some of the irrigation now applied in the head branches during the dry season would need to be shifted to lower branches if canal lining were used to reduce infiltration in the canal bed. While this would improve equity in irrigation distribution, it is not clear without further study that it would greatly increase production. Losses in the main canal are currently so high that farmers in the tail branch canal do not attempt to grow maize following winter wheat. That allows head branch farmers to use most of the supply in the upper reaches of the system during this season. It is possible that canal lining would only redistribute the location for growing crops rather than increase total production; an important equity consideration.

Farmers discussed the desirability of permanent branch canal inlets that would reduce maintenance requirements. However, they did not identify gates as being important. Of the 15 branch canal inlets that have been improved by farmers only a few have installed gates. They tend to be used primarily as on- or off-devices rather than as variable discharge regulators.

Improved drainage and conjunctive use opportunities in the tail branches of the system are possibly among the best options for increasing production. Farmers are well aware of opportunities for installing tubewells. That this has not been done on their own initiative may indicate that such development does not have economic viability. Farmers have much less experience with drainage. Investigation is necessary to determine what results could be achieved by changing irrigation practices as mentioned above or whether installation of drains would be useful.

### **External Assistance**

While the Chhattis Mauja farmers welcome and actively search for external assistance in improving their physical system, they resist losing control of their activities. Successful integration with the Sorah Mauja System shows that outside intervention can be successful in helping negotiate a settlement that is fair to all parties. The situation with the four upper branch canals illustrates the need for full understanding of the goals of the system and the rules being used before imposing modifications.

Discussions in general assembly meetings showed that the farmers were concerned that they receive the utmost benefit possible from outside investment. They were unhappy that the system leaders (including those of the joint system) had not done a better job of controlling the design and decisions concerning the purchase of materials. Given the farmers' long observation of their system under all types of conditions, they should participate in the selection of the type and design of all improvements undertaken.

A major consideration for farmer participation in design in this case is to ensure compatibility with the rules and procedures that they have in place. If improvements encourage independence among branch canals or enable irrigators to ignore the established rules, they will likely lead to long-term decline rather than increase system sustainability. In their search for external assistance, especially if large amounts of money are involved, system leaders sometimes overlook the long-term consequences and allow inappropriate modifications. Improvements should be approved by the general assembly and allowed the widest possible review by farmers to gain legitimacy.

Most efforts by Chhattis Mauja farmers for gaining external assistance have been focussed on the local government at times of emergency and for minor system improvements. Consolidation of various government agency irrigation activities into the Department of Irrigation has made it more difficult for farmers to access minor assistance. The purpose of the District Offices of the Department of Irrigation is to be responsive to decentralized

assistance needs. It is assumed that decentralization will be a more effective mechanism for providing incremental assistance to systems such as the Chhattis Mauja. It was observed that the farmers plan system improvement activities on nearly an annual basis to match the labor resources that they can provide. Matching external system improvement activities to this pattern would enable maximum participation by the farmers and avoid shifting operation and maintenance responsibility to the government.

Several areas of assistance would be beneficial. There needs to be a study of alternative ways for diverting or removing bed load and sediment from the canal. The study should include consideration of costs for continuing the present manual removal of sediment. Another alternative to be investigated is provision of a bulldozer or endloader to be shared among all the irrigation systems diverting water from the Tinau River. The sharing and partial cost recovery could be done through rental agreements. The design of a hydraulic alternative for bed load removal should also be investigated, but the likelihood of proper operation and maintenance must also be considered. While such a study of alternatives is beyond the means of the Department of Irrigation's District Offices, implementation of improvements should remain decentralized and require farmer involvement so that maintenance responsibility does not shift to the government.

The canal banks should be stabilized to reduce erosion and canal widening which are currently taking place. Intake structures should also be renovated. Simple check structures are needed at each branch canal intake to improve control of irrigation delivery. The farmers have shown that they are able to build and maintain these structures, but have found it difficult to mobilize their own resources for constructing them.

Finally, external assistance should not be limited to physical construction. Every opportunity should be used to strengthen the operation and maintenance rules and the accountability of the system's elected and hired officials. It is particularly important to assist the leaders in improving the documentation of income, expenditure, decisions, and activities that may be cause for concern to irrigators from any part of the system. The Chhattis Mauja Organization has demonstrated repeatedly that it is capable of effective decision making and implementation of change. External assistance should support and enhance, not diminish, this valuable asset.

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# Appendix 1

## CONSTITUTION OF THE CHHATTIS MAUJA KULO PANI SAMITI<sup>4</sup>

### BACKGROUND

THE CHHATTIS MAUJA Irrigation System is located in the northeastern part of Rupandehi District where the land is very fertile and suitable for agriculture. However, due to the lack of systematic organization in the past, the irrigation system has not performed up to its productive potential. In addition, the irrigation system has not performed well because of the scarcity of the water supply which is due to: 1) The nature of the Tinau River which makes it difficult to effectively divert water; 2) The high variation and unreliability of rainfall causing alternately low discharge leading to drought or flooding; 3) The settlement of more people in the area which has led to an increasing demand for a domestic water supply for drinking, washing, laundry; and 4) Deforestation in the Tinau Watershed which has reduced the dry season water supply available from the Tinau River.

The existing management system has been unable to solve these problems and effectively manage the Chhattis Mauja Irrigation System under these changing conditions. Therefore, a new system of management and organization is required.

About 450,000 [*sic*] person-days of labor per year are required for operation and maintenance of the system which has a command area of about 6,700 ha [*sic*]. The Tinau River carries stones, logs, and sediment into the irrigation canals. The resources available to clean the canals are simply the farmers with their picks and shovels. The farmers encounter great difficulty in cleaning 20-25 km of canal 3 to 6 m in width by manual labor every year. For this reason the existing organizational structure must be improved by institutionalizing systematic rules and regulations.

This constitution has been prepared for the sake of the farmers and their agricultural lifestyle. Only the basic irrigation management rules are listed below.

This irrigation system has existed for nearly a century [*sic*]. It expanded and at one time provided a water supply from the Tinau River to 36 (*chhattis*) villages (*maujas*) so that the management organization was named the *Chhattis Mauja Kulo Pani Samiti* (Chhattis Mauja Executive Committee). However, the irrigation system has continued to grow to the point that presently fifty-four villages in the Butwal Town Panchayat, and Anandaban, Karaiya, Makrahar and Shankarnagar village panchayats use water under the direction of this committee. Nevertheless, the name of the committee remains the same.

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<sup>4</sup> Translated by R.B. Thapa from the 1979 constitution. All amendments made up to February 1989 have been included. Editing for consistency and readability has resulted in slight modification of the original translation. Material in parentheses has been added by the author for clarity.

1. Formation of the Chhattis Mauja Kulo Pani Samiti:
  - a. The general assembly meeting means the assembly of all the water users of the system. Two-thirds of all kulara (175 in 1989) will be a quorum. The general assembly meeting will be held twice a year.
  - b. The general meeting refers to the gathering of all the village mukhtiyars (presently 54) and the executive committee members. The general meeting will be held four times a year.
  - c. The chairman, vice-chairman and secretary will be elected by the general assembly of the Chhattis Mauja Kulo Pani Samiti.
  - d. Each village will send one representative for each kulara allotted to them and only they will vote for the chairman, vice-chairman and secretary. Election will be by the majority vote of the kulara representatives.
  - e. The term of office for the executive committee will be for two years. (This was changed from one to two years by the general assembly meeting in 1987.)
  - f. The villages under the Chhattis Mauja Irrigation System will be divided into nine areas. One of the mukhtiyars from each area (there is one mukhtiyar for each village) will be elected as the chairman of his area and will serve as an area representative to the executive committee.
  - g. Meth mukhtiyar(s) (main system leader/foreman) and the sipahis (messengers) will be appointed by the executive committee.
2. Responsibilities of the executive committee chairman:
  - a. The chairman will preside over meetings of the executive committee.
  - b. He will resolve conflicts on the spot if such conflicts are not resolved by the area representative.
  - c. He will be authorized to spend up to NRs 1,000.00 at a time.
  - d. He must submit expenditures with receipts in the executive committee meeting or in the general assembly meeting.
  - e. He will be responsible to supervise and take necessary action by calling an executive committee meeting for consultation.
  - f. Upon consulting with the executive committee in a meeting, the chairman will be authorized to punish the meth mukhtiyar, messengers, and secretary if they do not perform their duties satisfactorily.
  - g. The chairman can expel a member of the executive committee if he is absent from three consecutive meetings.
  - h. The income must be deposited in the bank within seven days. Checks will be signed jointly by the chairman and secretary of the executive committee.
3. Responsibilities of the executive committee:
  - a. The mukhtiyar members (area representatives) of the executive committee are responsible for water management within their areas. Problems arising regarding water management in their area must be resolved by that member as far as possible. Unsolved problems will be settled by the chairman of the executive committee.
  - b. If a proposal is submitted to the executive committee that either the chairman, vice-chairman, or secretary are failing to perform their duties, they can

be terminated from office by the approval of the majority of the executive members.

4. Responsibilities of the executive committee vice-chairman:
    - a. In the absence of the chairman, the vice-chairman will perform the duties of the chairman.
  5. Responsibilities of the executive committee secretary:
    - a. The secretary will keep the records of the members.
    - b. He will keep the accounts.
    - c. He will seek the approval of the chairman for granting leave to the executive committee's messengers and the meth mukhtiyar.
    - d. If the executive committee staff request leave for longer than a week the executive committee must approve it.
  6. Responsibilities of the executive committee meth mukhtiyar:
    - a. The meth mukhtiyar will mobilize the farmers for the operation and maintenance of the main canal under the direction of the executive committee.
    - b. He will collect *khara* (fines), keep records of attendance, and exempt the laborers from work on special occasions.
    - c. The fines collected by the meth mukhtiyar must be deposited (in the bank) either by the chairman or the secretary.
    - d. The meth mukhtiyar will be given a receipt by the secretary for the fines he has deposited.
    - e. The meth mukhtiyar can call for emergency mobilization of the laborers when emergency repairs of the main canal are necessary. In such cases, the date and time for labor mobilization need not be fixed.
  7. Responsibilities of the village-level mukhtiyar:
    - a. Under the direction of the executive committee and within the time the executive committee specifies, the village-level mukhtiyar must inform his villagers of all activities regarding irrigation management (mainly the main canal).
    - b. If the mukhtiyar fails to convey messages on time and a farmer is absent from the assigned work, the mukhtiyar himself has to be responsible for paying the fine to the executive committee.
    - c. Without consultation with the area representative, the mukhtiyar is not allowed to give permission to cultivate the main canal bund.
  8. Rules for disposing of silt from the main canal and use of drainage water:
    - a. Silt such as mud and sand must be thrown out of the canal as in the past.
    - b. Drainage water is defined as the water flowing from north to south in natural drains. It is water draining from natural springs and irrigated fields that does not re-enter the main canal. Drainage water can be used only by those villages and farmers who have contributed labor to main system management. If conflicts arise in this connection, the executive committee will make the final decision.
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9. Rules for sharing water from the Tinau River:

The long-standing tradition is to divide the total water flow of the river into 16 parts. Six parts have been allocated to the Chhattis Mauja, four parts to Sorah Mauja (on the left bank of the Tinau River), and six parts to the Khadawa, Sagrahawa and Panch Mauja systems whose intakes are located near each other close to Butwal Bazaar (on the right bank of the Tinau River). Previously, the Sorah and Chhattis Mauja systems' intakes were separate. But when the dam built with Indian assistance was constructed near the Sorah Mauja intake, Sorah Mauja's intake could no longer be used, and the Sorah Mauja joined with the Chhattis Mauja System for acquisition of water from the Tinau.

The combined discharge of the Sorah and Chhattis canal is divided at Tara Prasad Bhond about 3 km downstream from Kanyadhunga. Six parts of the discharge goes to the Sorah Mauja and ten parts to the Chhattis Mauja. This agreement was reached between the Sorah and Chhattis systems after intervention by the government. If in the future the Sorah Mauja obtains a separate intake, the water will need to be shared from the Tinau River.

10. Rules for opening a new outlet from the main canal:

- a. The executive committee has jurisdiction to permit construction of a new outlet if requested by any village. A fee of NRs 500 must be paid and the village must agree to mobilize one laborer per 16 hectares of land for maintenance as directed by the Chhattis Mauja officials.
- b. If any village wishes to move an existing outlet upstream from its present location, it must deposit NRs 500 with the executive committee and arrange compensation with the landowners for the land which the new outlet will occupy. If the request is to move the outlet downstream there must first be consultation with the executive committee. For moving the outlet downstream no fee need be paid to the executive committee but the farmers must make arrangements to compensate the owners of the land which the new outlet will occupy.
- c. No village or farmer is allowed to disturb the main canal. Water flow can be increased to the village canals only upon consultation with the executive committee. Violators will be punished according to the rules and regulations of the executive committee.
- d. *Mul Tapaha* (main canal) refers to the canal from Kanyadhunga to Chaprahatti and Jogikuti to Tin Kuliya.

11. Definition of terms:

- a. The main canal must be desilted by all irrigation users (maujani khetara). The executive committee can allocate the work according to regions for the convenience of the farmers. Work will be allocated on the basis of the number of kulara assigned to each village (branch canal) and work must be completed in the time allotted by the executive committee. If work is not completed in time, the delinquent village will be fined in accordance with the rules of the Chhattis Mauja Constitution.
- b. The main canal will be maintained (repaired after flood damage plus improvements made) by mobilizing farmers for assignments called *Sabik*, *Double*, *Jhara*., and *Sidhbandhi*.
- c. *Sabik* means one person from each village for each kulara allocation.

- d. *Double* means two persons per kulara.
  - e. *Jhara* means four persons per kulara.
  - f. *Sidhbandhi* means taking cooked food and working in the canal from dawn to dusk (this is seldom practiced anymore).
12. Income of the Chhattis Mauja Kulo Pani Samiti includes:
- a. Any amount received from His Majesty's Government of Nepal in cash or in kind.
  - b. The amount collected from the farmers as fines for being absent from work.
  - c. The amount raised from the farmers on a kulara basis for main canal improvement and maintenance work.
  - d. The amount received by selling stone/gravel, sand, and other material removed from the main canal.
  - e. The amount received for opening or moving the outlet of a branch canal.
  - f. The amount collected by the farmers for water stealing or violation of rules and regulations.
13. Appointment and remuneration of the chairman and the secretary:
- a. The chairman will receive NRs 700 per year plus NRs 200 for stationery.
  - b. The secretary will get NRs 500 per year.
  - c. The meth mukhtiyar will get NRs 2,500 per year plus a bicycle.
  - d. Each village (branch canal) is responsible to contribute NRs 55/kulara for supporting the messengers. Each messenger also receives NRs 300 per year from the executive committee fund plus the use of a bicycle.
14. Rules and sanctions of the Chhattis Mauja Irrigation System:
- a. No village (branch canal) may divert all of the water from the main canal for its use. Should any village do so, it will be fined NRs 50–500 after the first incident, and NRs 500–1,000 for a second offense. If the fine is not paid, the executive committee can close that branch outlet.
  - b. If a village steals water, a fine of NRs 100–500 after the first incident and NRs 500–1,000 for a second offense will be collected. If the fine is not paid the outlet of that village may be closed.
  - c. If a village steals water from another village, it will be fined as stated in article No. 14 b.
  - d. If any village fails to contribute its share of labor during main canal desilting it will be fined NRs 75 per kulara per day. The fine must be deposited with the executive committee before the next phase of work can be allocated to that village. If the work is not completed the village may not be allowed to use irrigation water for the following year.
  - e. Persons who fail to contribute their share of labor as assigned for main canal emergency repair (i.e. sabik, double, etc.) will be fined NRs 25 per person-day.
  - f. An outlet may be reopened by paying the executive committee NRs 100–500 as fines for lost labor contributions to maintenance plus NRs 500 for opening an outlet.
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**15. Auditing Committee:**

- a. An audit committee composed of three Chhattis Mauja irrigation water users will be formed to serve for a year. All the income/expenditure accounts must be audited once a year by the audit committee.

**16. Amendment of the rules:**

- a. The above rules and regulations are not rigid but can be changed according to the present needs of the farmers. A committee to propose the changes will be formed with the consultation of the farmers in the general assembly meeting.

## Appendix 2

### CHHATTIS MAUJA MEETINGS FOR MAIN CANAL MANAGEMENT

#### BACKGROUND

MEETINGS ARE HELD at all levels of organization in the Chhattis Mauja System. Research staff attended and recorded numerous events of these meetings during the one-year period of fieldwork. The dialogue presented here is of four meetings dealing with main system management.

It is important to remember that the Chhattis Mauja System shares responsibility for operation of the diversion structures and maintenance of the first few kilometers of canal with the Sorah Mauja System. The meetings reported here are only those of the Chhattis Mauja and not of the Sorah Mauja or of the joint committee.

Information is presented as reported in the meetings. In several cases there are slight discrepancies between what was reported and other available records. Some of the terms, features, and conversions important in understanding the dialogue are:

**Village level:** The part of the organization responsible for managing the affairs of a branch canal. In total there are 44 branch canals serving 54 villages. Each village has at least one appointed or elected leader called a mukhtiyar and most have additional functionaries.

**Area level:** The 44 branch canals are grouped into 9 areas with 3 to 10 branches in each. The village or branch canal mukhtiyar is the representative to the area-level organization.

**Executive committee:** This is the body responsible for day-to-day management of the main system. Its membership is composed of a representative from each of the nine areas, and a chairman, vice-chairman, and secretary elected by the general assembly.

**Joint committee:** A committee composed of three officials elected by the joint assembly of the Sorah and Chhattis Mauja systems, the chairman of both systems, and three members appointed by the Chhattis and one appointed by the Sorah Mauja systems. The joint committee is responsible to divide the water between the two systems. It also oversees improvements in the diversions and canal used jointly and ensures that resources are mobilized from the two systems in the same proportion as the water distribution.

**General assembly:** All irrigators belong to the general assembly and can join in the discussion at general assembly meetings. Voting rights in the general assembly are apportioned to each branch canal according to its water allocation (kulara). Two-thirds of all kulara must be represented to form a quorum. The constitution calls for two general assembly meetings each year.

**General meeting:** The general meeting is composed of the executive committee members and a representative from each village. Two-thirds of the 65 members must be present to form a quorum. A general meeting can be called whenever necessary and usually knowledgeable and influential irrigators are invited to attend in addition to the village representatives.

**Meth mukhtiyar and mukhtiyar:** The meth mukhtiyar is an employee appointed by the executive committee to look after the daily affairs of the main canal. Each village has a mukhtiyar elected or appointed by the members of that village to look after the daily affairs of their village or branch canal. Each branch canal mukhtiyar is a member of his area committee.

**Kulara:** The unit used to quantify a branch canal's water allocation, voting rights in the general assembly, and responsibility for system maintenance. During the monsoon of 1988 there were 177 kulara allocated to the 54 branch canals and in 1989, 175.

**Messenger:** The Nepali word used is *sipahi* which means guard. Possibly in the past their task was to guard the water but presently their main function in the system is that of messenger. They also perform other tasks which the meth mukhtiyar or the chairman designates.



## MEETING I: GENERAL ASSEMBLY (1988)

### Proceedings

The general assembly was held on Sunday, 12 June 1988 at 3:00 pm. The agenda prepared before the meeting stated that the meeting was to: 1) Present the accounts statement for the past year, 2) Inform the irrigators about the activities being carried out by the executive committee, 3) Discuss methods for constructing urgently needed structures, and 4) Make changes in the rules and regulations. A quorum for the assembly (representatives for two-thirds of the 177 kulara) was present. In total, 340 persons attended the meeting. The meeting started at 3:45 pm with the secretary's report.

### Presentation of the Accounts by the Secretary

In the introduction of his presentation the secretary stated that the work of leveling the proportional weir between the Chhattis and Sorah Mauja systems at Tara Prasad Bhond and the construction of stone crate walls had been completed.

The secretary then presented the report on the previous year's (1987/88) resource mobilization for maintenance of the canal:

*Secretary:* The total number of kulara is 177. The work carried out was as follows:

Emergency maintenance:<sup>5</sup>

Single maintenance: 66 days x 177 persons	11,682 person-days
Double work: 14 days x (177 x 2 persons)	4,956
Quadruple work: 4 days x (177 x 4 persons)	2,832

Regular maintenance:<sup>6</sup> 28,080

Total labor mobilized 47,550 person-days

Total cost at the rate of NRs 20/day x 47,550 = NRs 951,000

An audit committee was appointed by the executive committee last year (early February 1988) under the coordination of Mr. Krishna Paudel to audit the accounts of the year (1987/88). The following is the report submitted by the audit committee to the executive committee. All members are welcome to comment on the report.

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5 For emergency maintenance work, when the executive committee assigns "single work, one person for each kulara is required to complete the work. On double work days two laborers, and on quadruple work days four laborers for each kulara are required. It should be noted that often the executive committee only calls on a few branch canal organizations to provide labor on a given day. Emergency labor mobilization as presented by the secretary is thus considerably overstated.

6 Regular maintenance refers to preplanned, annual activity for main canal desiltation. The executive committee divides regular maintenance work on the basis of quantity of work to be completed per kulara but assigns it to the branch canal organization rather than individuals.

Income

Transfer from last year's (1985/86) income	NRs	27,890
<i>Khara</i> (fine for being absent from work) collection in 1986/87		25,415
Punishment for absentees		480
Cash collection from 156 kulara <sup>7</sup> at NRs 600 each for purchasing wire and weaving crates		93,600
Returned from Sorah Mauja (overpayment of construction expenses)		3,073
	NRs	150,458

Expenditure

Bill No. 3 to Bill No. 44	NRs	<u>95,450</u>
Balance	NRs	55,008

The audit committee report of June 1987 to February 1988 has mentioned that the secretary should keep the accounts and that all bills should be signed by the chairman before payment is made. Heretofore, bills had not been signed by the chairman. This year the suggestions of the audit committee's report have been followed.

*Farmer:* How was the total income generated in the last year?

*Secretary:* Most of the funds were raised from you farmers by charging at the rate of NRs 600 per kulara.

*Chairman:* About NRs 200,000 was collected for construction from the Sorah and Chhattis Mauja systems by the Sorah-Chhattis Joint Committee. In the end our share of the expense was only NRs 118,000. We had paid an excess of NRs 3,073 which was returned to us by the Sorah-Chhattis Joint Committee.

*Secretary:* Last year we had decided in our general assembly that regular maintenance work will be carried out in February instead of May. This decision and the schedule followed were preferable because: 1) It was not too hot to work, 2) Sufficient water was available during the winter season for irrigation and for drinking purposes, and 3) It was easy to collect fines from those who were absent. All the fines except from one person were collected.

[The secretary then presented the income and expenditure report for the period after February 1988 which had been presented in the executive committee meeting.]

*Secretary:* Fines were collected from the farmers who tried to steal water. The rule is that a fine between NRs 25 and 200 should be charged. The chairman determines the amount of the fine based on the amount of water stolen.

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<sup>7</sup> The remaining 21 kulara are located in the head area above the Sorah/Chhattis Division and seldom contribute resources for main system management.

Income

Last year's fines		
Panch Bari Mauja	NRs	75
Mauja Number Six		250
Mauja Number Three		<u>75</u>
Total		400
Khara (fines for not attending work) for 1987/88		23,280
Balance from last year as shown by audit		<u>55,008</u>
Total income	NRs	78,688

Expenditure

Amount given to Sorah-Chhattis Joint Committee	NRs	35,380
Office chairs		1,300
Salary to meth mukhtiyar and daily allowances to committee members		3,200
Bicycle repairs, office supplies, and tea		<u>300</u>
Total expenditure		40,180
Balance on hand	NRs	38,508

This income and expenditure statement will be audited and the audit committee's report will be presented at next year's assembly.

**Discussion**

*Farmer's question:* Where is the surplus money kept?

*Secretary:* In the bank.

*Farmer:* What about interest?

*Secretary:* Interest has not been added to the principal in this report. However, it will be included later on.

*Chairman:* If anyone has questions about the secretary's income and expense report now is the time to ask.

[There were no further questions.]

*Chairman:* I want to add that in addition to NRs 38,508 we have NRs 5,000 to be collected which will bring the net balance to NRs 43,508. Any questions?

[There were no questions.]

## Chairman's Report

*Chairman:* Respectable guests, Chhattis Mauja Executive Committee Members, *pancha* (elected village panchayat officials), friends, gentlemen, and all Chhattis Mauja brothers. This is the first general assembly at which an election for executive committee members is not being held. In previous general assemblies we would divide into groups of 8-10 members and discuss whom to support. Now the officials' term is fixed for two years, which has given me the opportunity to hear your comments and suggestions about the activities of the committee during the past year.

The general assembly has elected the members and given power to the executive committee. We are trying to function in accordance with your wishes. I seek your valuable suggestions as to how we can carry out necessary construction work on the canals and intake, how we can improve our management of water distribution, and resolve your water application problems.

The first item of business I want to present is related to the association's accounts. Rupees 416,000 in government assistance was spent on the Ittabhond Intake but we were unable to obtain sufficient water from this intake. We have been able to acquire sufficient water from the old intake near Kanyadhunga. We have received another NRs 300,000 from the government. We must decide how we want to utilize this money. Do we want to use the funds as we did last year, or are there other suggestions?

Downstream at Tara Prasad Bhond where the Sorah and Chhattis Mauja water is divided, the area has been carefully leveled and stone crate work has been completed. There may be a slight difference of half a millimeter but this is much less than before. I suggest that those who have not seen the work go to inspect what has been done. Floods should not damage the structure. Let us see if we get our share of water during this monsoon season.

*Interruption by a farmer:* Yes. I have seen what has been built. All the water goes toward Sorah Mauja and all the sand toward Chhattis Mauja.

*Chairman:* Sit down. I will explain. During the stone crate wall construction I reported to the Sorah-Chhattis Joint Committee Chairman that the wall alignment seems to have obstructed the Chhattis Mauja flow. The Sorah-Chhattis Joint Committee Chairman replied that it is his responsibility to provide the fixed share of water to each system, and I should not be concerned.

*Farmer:* No, I went a few days ago. It would be appropriate if the wall was aligned straight but it has been slightly curved and it is obvious that all water will be diverted to Sorah Mauja and we will starve.

*Chairman:* I asked the Sorah-Chhattis Joint Committee Chairman what will be done if the water flow is not in proportion to the allocation. He suggested that we use stones to adjust the flow. I think that if the flow is not correct, we can install an extra crate wall and adjust the flow. I assure all of you that the situation of starvation due to insufficient water will not occur.

*Farmer:* Why don't the farmers of Sorah Mauja contribute labor in proportion to their water share? If the situation does not improve we should separate ourselves from Sorah Mauja.

[All the farmers clapped.]

*Chairman:* First, try to understand the situation. I realize the contribution from Sorah Mauja has not been in proportion to their water share. We have already talked with the Sorah Mauja

Chairman about it. If Chhattis Mauja mobilizes 156 of regular kulara every day, the Sorah Mauja System should mobilize at least 104 regular kulara. We have found their numbers do not increase beyond 42-43 persons/day. But who monitors and evaluates this? That is why both the chairman and farmers agreed that we need someone from the Sorah-Chhattis Joint Committee to monitor and evaluate water share as well as resource mobilization. The Sorah-Chhattis Joint Committee has now been organized under the chairmanship of Chakrapani Pathak. We stopped the maintenance work on the main canal because Sorah Mauja did not contribute their proportion of the labor. I advised the Sorah-Chhattis Joint Committee Chairman that the Sorah Mauja farmers should first complete their part of the work before we start again.

On the question that we should separate from Sorah Mauja, both the intakes belong to Chhattis Mauja and we have full right over the intakes. We allowed Sorah Mauja to join our system so they would contribute labor and get a share of water. There is no question of separation at all. It is my responsibility to take care of both water share and resource mobilization and I will fight for this. You need not worry. I will not give you a chance to complain.

[The farmers appeared to accept the chairman's statement.]

Now let me know your reaction to the change of schedule for regular canal work in February instead of May. Last year I proposed this change of schedule in the general assembly and you accepted it. The work has been completed accordingly. If you have any problems or suggestions let me know.

*Farmer:* The schedule is okay. No need to change.

*Chairman:* Last year we had to struggle to acquire water for seedbed preparation. This year neither the discharge at Tinau has increased nor is there more rainfall in comparison to previous years, however you are not encountering as many problems for seedbed preparation this year. Also, we were able to irrigate maize easily this year. This is the result of our early desilting work. I request that you continue this work schedule.

*Farmer:* I have a suggestion on the work division during maintenance works. We work continuously for 10-15 or 7-8 days. However, the division of work is assigned to everyone at once for 4-5 days instead of on a daily basis. If we are working regularly on the canal this basis is a bit impractical. Can this basis be changed?

*Chairman:* Yes. Yes. We have no written regulation concerning this. We can easily change according to the farmer's suggestion during the time of work. I think your suggestion is more practical.

Now I want your agreement on the work schedule being followed since last year.

*All farmers:* We agree to this schedule.

*Chairman:* Due to this schedule which allows us to complete the desilting work early, the discharge in the canal has increased and water has been available up to Simara Village.

Next >>

## External Assistance

*Farmer:* We received NRs 416,000 as a grant from the government and a committee was formed to look after the work. The work was completed and in the same year it was washed away by a flood. What is the benefit of this assistance? We should try to work only after serious thinking and discussion. Whatever the quantity of work, we should try to make the structure strong and in a way that will benefit all farmers by reducing the labor needed to maintain the structures.

*Chairman:* I want to explain how the assistance was obtained and how we had to use the fund. The amount of NRs 416,000 was obtained through the zonal commissioner. It was understood that the divisional engineer of the Department of Irrigation (DOI) would prepare the design and the construction work would be carried out under his direction. The government money was spent under the supervision of the government officials.

*Farmer:* Why didn't the committee advise the officials of the farmers' suggestions? Why couldn't the committee control the money? The money was given to use for the farmers' benefit, but we did not benefit from it. It has gone as it came. What is the use of government money?

*Chairman:* We told the officials that the stone crate work should not be built at the place (upstream of the intake gate) where the engineer had suggested. We cautioned that during floods the river carries stones, trees, and other debris that would damage the work. Even if a flood would not damage the wall, it would very likely damage the canal, and we recommended that the location be changed. Instead of accepting our suggestion, the engineer said that the construction would check the stone/silt flow in the canal which otherwise may damage our fields. He said that we farmers do not know how to build the structure and where to build it. We had to accept his instructions because they are technicians and we are farmers. But you all know what happened to the structure—the flood came and swept it away. You can't blame the committee for not advising the engineer about the proper location for the structure.

*Farmer:* We simple farmers also know that when gates are installed, there should also be an escape structure upstream. Otherwise, when the gate is closed there is no place for the water to escape. Everyone knows that without an escape structure the side walls can easily be damaged and this is what happened. Why didn't the engineers think of these things that we simple farmers know?

*Chairman:* We discussed these things with the engineer. We suggested that a layer of stone crate should be laid at the bed and an escape structure be placed over it. But the engineers said this is the tarai [plain area] and we did not need to worry. Nevertheless, all our work was washed away as we feared would happen. This time a dozer is desilting there. We are now constructing a 15-foot wide escape structure upstream of the intake using our own resources and knowledge. The laying of stone crate at the bed has already been completed. Let us see if we are successful in protecting the canal.

*Farmers:* We will certainly be successful. The work is based on our experience and knowledge and not on the engineer's design.

*Chairman:* We have all realized that we should discuss and give suggestions on how to construct the structures based upon our own experience. That is why I am asking all of you for suggestions. This year we have received NRs 300,000 from the government for canal

improvements for Chhattis and Sorah Mauja. We want to spend the money to continue the stone crate wall. What suggestions do you have?

*Farmer:* We should make as many permanent structures as we can. We are ready to pay if additional money is required. But the work should be installed at the proper place and be made strong.

*Next farmer:* It should be made with gates at certain intervals along the walls. Otherwise, it may be swept away by flood.

*Another farmer:* We should form a committee of experienced farmers and the construction work should be carried out according to their suggestions.

*Another farmer:* We have not discussed the height of the walls. They should not be made so high. They should be kept low so that excess water may return to the river through overflow.

*Another farmer:* This suggestion is right. Nevertheless, gates should be constructed.

*Chairman:* One farmer has suggested that we keep six-inch openings between the walls at ten-foot intervals and insert rods in the openings. This would allow excess water to flow through the openings and we can close the openings with branches, leaves and brush during water scarce periods. What do you think about this kind of structure?

*Farmer:* Well, what happens if we close the openings with branches and brush during the day to divert more water but we do not know when a flood comes? If a flood came at night, it would again damage the sides.

[All the farmers agreed.]

*Chairman:* Whatever type of structure is built, gates are needed. Are we all agreed?

[The farmers discussed the issue among themselves but no clear consensus was evident. The discussion ended when the secretary announced that a committee of experienced farmers would be formed to consider the problem.]

### **Relations with Sorah Mauja**

*Chairman:* Now, I want to advise all of you about a problem that I am dealing with regarding Sorah Mauja. Our meth mukhtiyar was called to Driver Tole to discuss and arrange water shares. When he reached the school where 15-16 persons from Sorah Mauja were gathered, the Sorah Mauja farmers beat up our meth mukhtiyar. They accused him of giving extra shares of water to Chhattis Mauja and creating trouble in Sorah Mauja, causing water scarcity. They threatened to gather all their 700-800 people and destroy the proportioning weir and take all the water. The meth mukhtiyar from Chhattis Mauja could not do anything. He returned to advise the chairman.

After I learned of the event from the meth mukhtiyar I wrote a letter to the Sorah-Chhattis Joint Committee Chairman explaining what had happened. I also stressed that the Sorah Mauja farmers should be punished for giving trouble to the Chhattis Mauja Meth Mukhtiyar and for threatening to destroy the weir. A meeting was also arranged by the Sorah-Chhattis Joint Committee to discuss the issue. The person who had made the threat accepted the blame in front of the committee members and he was excused this time.

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That same day other damage to the weir was discovered. I investigated the case and again wrote a letter to the Sorah-Chhattis Joint Committee. In the meeting I recommended that a fine between NRs 5,000 to 10,000 be charged against the guilty party. However, since no regulations governing the case are in existence, the Sorah-Chhattis Joint Committee decided that we should excuse this incident and make rules to cover such illegal activities.

I observed in Sorah Mauja that when the committee calls for joint effort for that system, all the farmers gather within one hour, even at night. We should also have this kind of unity, only then can we get our water share. I ask you all to be strongly united.

Once again a farmer from Sorah Mauja was discovered destroying the weir. I reported to the Sorah-Chhattis Joint Committee and they called a meeting. According to our new regulation he was fined. Do not think that we will do whatever Sorah Mauja dictates. We try to keep peace and look upon them as our brothers. We should work jointly, but if they try to cheat us we will respond. Be assured under my chairmanship and support me.

*Farmers:* We will definitely support you.

### **Fine for Not Working on Main Canal Desilting**

*Chairman:* The fine rate is low; most farmers prefer to pay the fine instead of sending people to work in the canal. I propose that the fine be increased.

*Farmer:* Who wants to send people to work when the daily wage is worth NRs 40 and the fine is only NRs 15? It is reasonable to increase the fine.

*Chairman:* The low fine is causing problems. People do not send laborers and the fine currently charged is not sufficient to cover the cost of hiring other laborers. Raising the fine will encourage more people to become involved in the canal maintenance work.

*Farmer:* If we increase the fine rate it may effect the wage rate paid to laborers for other purposes. We should also keep in mind possible side effects of increasing the fine.

*All farmers:* Yes. Yes. You are right.

*Chairman:* I propose that we increase the fine rate from NRs 15 to 20. What do you say? Do you all agree?

[Farmers clap in agreement. The chairman asks them to clap loudly and the farmers do so.]

*Farmers:* How do we collect fines from those who have not paid their debt this year?

*Chairman:* We will charge NRs 15 per day until today and starting tomorrow we will charge NRs 20 per day.



### Resource Contribution from Large Landholder

*Farmers:* What about raising the rate for resource contribution from Rani Saheba<sup>8</sup> from the present rate of NRs 5,000?

*Chairman:* There was a meeting to discuss this issue at Chhapparghatti under the chairmanship of Kabi Raj. Kabi Raj said that Rani Saheba fought for the rights of the Chhattis Mauja Canal over the years and spent about NRs 66,000 toward this purpose. We should keep this in mind while collecting fines from her. The meeting then agreed to collect a NRs 5,000 fine from Rani Saheba instead of the previously set amount of NRs 7,500. Are you in agreement with this decision?

[There was a mixed reaction from the farmers. After discussion they accepted that her total land had decreased with time, and on the basis of the area irrigated that she now holds, the NRs 5,000 fine is appropriate.]

### Fine for Stealing Water

*Chairman:* Now let me make another proposal relating to water stealing. I want to be strict with violators and propose that we increase the amount of punishment for water stealing from the present rate of NRs 250 minimum to NRs 5,000 maximum.

*Some farmers:* Yes. Yes. The rate should be increased to NRs 500 minimum and NRs 5,000 maximum.

[There was a mixed reaction from the farmers.]

*Another farmer:* One amount should be fixed for all cases of water stealing regardless of the amount of water stolen. What is the reaction of the tail-end farmers? [The speaker was from the head part of the system.]

*Tail-end farmers:* We agree. The fine for water stealing should range from NRs 5,000 to 10,000. The head-end farmers always steal water and with it they produce more than the amount they have to pay for water stealing.

*Head-end farmer:* If you think we steal, you come to the head and I will go to the tail. I challenge you. It is you who come in the night and steal the water. Why do you only blame head-end farmers?

*The tail-end farmer:* There should be a larger fine for water stealing. I propose a range from NRs 500 to 5,000.

[Most of the farmers clapped in approval. The chairman and other members of the committee did not know whether to accept the proposal or not.]

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<sup>8</sup> Rani Saheba is from an old Thakuri family. She lives in Kumari Gaon, the oldest village in the Chhattis Mauja System. Previously, she owned more than 165 ha of land but now she only owns about 40 ha. She has the tradition of paying directly in terms of cash for main system operation and maintenance instead of sending laborers.

*Chairman:* It appears that everyone favors raising the fine to the range of NRs 500 minimum and NRs 5,000 maximum and I must agree with what the majority of the farmers want. But we should remember to be practical.

*Secretary:* It is easy to clap now but we must consider whether we can collect the fines from violators. In formulating any regulations we must consider whether we can enforce the rule. We should also consider whether farmers have the ability to pay this amount. We should fix the amount so that it is acceptable to all.

*Tail-end farmers:* No, look. One who can't pay the fine should not steal water. Once he is found guilty he must pay. You are trying to say that head-end farmers steal water and we should allow them to pay a small fine while we tail-end farmers must get along without sufficient water for our farms. We should fix the amount so high that no one will dare steal water.

*Secretary:* Setting rules won't do anything unless they are strictly enforced, therefore they should be enforceable. However, whatever amount we impose, if we farmers do not realize that water is community property and that no one should steal water, nothing can be done.

*Tail-end farmers:* There is also a provision of excusing a first offense for water stealing. How is this justified? The violator pays a NRs 50 fine and gains up to NRs 10,000 worth of benefit from the water. Is this justice?

*Head-end farmers:* Today, as per the instructions of the chairman, the tail-end farmers are using all the water for seedbed preparation. They sow 15-20 *pathi*<sup>9</sup> of seed while we sow 5 *pathi*. If we can earn NRs 10,000 from one-third of a hectare, how much can tail-end farmers earn?

[The size of landholding at the tail is larger than that in the middle or head sections of the system.]

*Chairman:* I know all these things, but we need to be practical. Why not set a range for the minimum fine as NRs 200 to NRs 500 this time? We can raise it in another meeting if this rate does not work well.

*Tail-end farmer:* Why don't you come out and say that "We farmers at the head-end steal water, so the fine should be low because we can't pay large fines?"

*Head-end farmer:* The fine should not be increased at all. I want to ask the tail-end farmers how many times they have found that head-end farmers have stolen water? How much did you collect? If you have not been successful at collecting the fine when the rate is low, how can you expect to collect a higher fine? The fine should not be increased.

[Head-end farmers clap, saying Yes, Yes.]

*Chairman:* Let me tell you which persons and which villages stole water last year and were fined:

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<sup>9</sup> One *pathi* = 4.57 liters which is 2.49 kg of rough rice.

Satghare	NRs	75.00
Mauja Number Six		250.00
Pande Tole		750.00
Total	NRs	<u>1,075.00</u>

*Mauja Number Six farmer:* We did not steal water. You received a false report. You need to prove that we stole water. We will not pay this amount as the fine for water stolen.

*Chairman:* You can pay the amount at any time, but it is the fine for stealing water. Let me propose that the minimum fine be set to range from NRs 100 to NRs 500, which I think is enforceable.

*Farmer:* Why not say only NRs 500 instead of 100 to 500? This range will allow you to charge the fine according to your own interest.

*Chairman:* You ask why there is variation in the amount of fine charged for different water stealing incidents? The fine charged is determined according to the amount of water stolen and the type of damage done to the outlet. It is not a question of the chairman favoring someone.

[All the farmers agreed and clapped and this ended the farmers' discussion.]

[The meeting ended after the secretary summarized the resolutions passed in the meeting.]

## MEETING II: EXECUTIVE COMMITTEE MEETING

### Agenda

The following is the dialogue of the Executive Committee Meeting of the Chhattis Mauja Irrigation System held on 1 August 1988. The executive committee is composed of the chairman, vice chairman, secretary, and area members from nine areas covering 54 villages. The meeting was called to: 1) Decide how resources should be mobilized to repair the intake at Mohanajot, at the tail end of the Chhattis Mauja System; and 2) To consider the meth mukhtiyar's petition that his salary be increased.

A flood had damaged the intake structure of Mohanajot Village's branch canal. This intake was constructed to collect the drainage water from the Chhattis Mauja Command Area and use it to irrigate approximately 130 ha. The repair of the intake would require the mobilization of large amounts of labor and forest products. At the time of the meeting, the farmers had not completed transplanting rice.

The meeting began when two-thirds of the total (12) members of the committee were present at 10:30 a.m.

### Repair of Flood Damage

*Chairman:* Our farmers from the Mohanajot Area have asked for help from the Chhattis Mauja Committee. I visited the area some days ago. One side wall has been severely damaged and it seems almost impossible for them to repair the intake alone in time to complete paddy [rice] transplantation. They are our brothers and we should help them in these situations. They also contribute labor for the main system operation and maintenance although they use only drainage water from Chhattis Mauja. We should help them. I have called this meeting to discuss how we could help them. Please present your opinions.

*Area member:* Why not advise the Sorah-Chhattis Joint Committee so that construction material can be obtained [from the government]?

*Secretary:* This case concerns only Chhattis Mauja. Furthermore, there is no time to start the process for receiving construction material. They are in urgent need of water. Why don't we try to help them make immediate repairs so that water can be supplied for transplantation? We can consider constructing a stone crate weir later on.

[All representatives seemed to agree and shifted discussion to the manpower necessary to carry out immediate repairs.]

*Chairman:* In my estimation the repair will require approximately 200 persons.

*Secretary:* Why not require the 13 villages at the tail end of the system to supply the labor necessary? The total number of kulara from these 13 villages is 31. If we call for quadruple the normally assigned number of kulara, the total number of laborers per day will be 124. If they work for two days, according to the estimation of the chairman, the work will be completed.

*Area member:* How should we assign the work for them? Will they agree?

*Secretary:* They will be excused from contributing labor for main system maintenance for eight normal days in consideration of their contribution for the repair of the Mohanajot Intake.

[All agree and pass the resolution.]

### **Increase of Meth Mukhtiyar's Salary**

*Chairman:* Let us go on to another issue. Our meth mukhtiyar has asked the executive committee to increase his salary. The executive committee has the right to do so. What do you think?

*Meth mukhtiyar:* You all know how much work I have to perform. I must even work at night. I distribute water without any partiality. Look, one day I saw more water being diverted to Kapil Mohada when extra branches were placed in the canal. I reduced the flow by removing the branches from the main canal even though the water supplied through this intake goes to the chairman's field.

[The committee members discuss among themselves whether to increase his salary.]

*Chairman:* I proposes to increase his salary.

[The secretary accepts the chairman's opinion. But no one immediately suggested how much the increase should be.]

*Vice-chairman:* Though you [pointing to the chairman] are in favor of increasing the salary and you say that the executive committee has the right to increase/decrease the salary of committee employees, we should try to be practical. We should use our right to benefit the farmers' community and also we must be able to defend the resolutions we pass. The meth mukhtiyar's salary was fixed only 2-3 months ago. Why should we increase his salary again and again without any significant reason? How will we reply our friends if they ask why we did this? There should be genuine cause for increasing the salary. I think we should call a general meeting and put the issue before them. We will then do what the general meeting decides.

[After a bit more discussion the secretary supported the vice-chairman's suggestion.]

*Secretary:* We have made the following resolutions:

- 1) The farmers from 13 villages at the tail end of the system be sent on a quadruple basis to Mohanajot.
- 2) A general meeting would be called to decide whether the meth mukhtiyar should have an increase in salary.

[All the representatives signed the register to show their agreement with the resolutions and the meeting adjourned.]

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## MEETING III: GENERAL MEETING

### Agenda

The General Meeting was held on 13 August 1988 to discuss the issues which the executive committee needed to present before all the members. The general meeting body is composed of the executive committee members and 54 representatives, i.e., one from each village.

The meeting was scheduled to start at 11:00 a.m. To conduct the meeting two-thirds of the total members, or 43 persons needed to be present. When a quorum had not arrived by 11:00, the chairman rescheduled the meeting for 1:00 p.m. and declared that any mukhtiyars who are not present by that time would be fined. The meeting finally started at 1:00 p.m.

*Chairman:* This general meeting was called to allow the members to help decide certain issues. They are: 1) To decide whether fee collection should be changed from collection in kind to cash, 2) To fix the meth mukhtiyar's salary, and 3) To discuss problems regarding water availability and distribution presented by the mukhtiyars.

### Messenger Payment

*Chairman:* Presently two messengers are paid in kind at the rate of five-and-a-half pathi of paddy [rough rice] per kulara. The mukhtiyars are responsible for collecting this amount. The messengers have complained that they do not receive the exact volume they are due, neither do they receive paddy [rough rice] of good quality. They also have difficulty in collecting payment. Therefore, should we change the basis of collection from kind to cash payments? Second, how should we convert the rate into cash and fix the total rate per kulara?

*Committee member:* I propose that the mukhtiyars be responsible for collecting the payment for the executive committee, and that the executive committee pay the messengers.

We can convert the rate like this:

Price of paddy is NRs 10/pathi and current rate of payment to the messengers is 5.5 pathi per kulara per rice season.

Rate of payment is 5.5 pathi/kulara x NRs 10/pathi = NRs 55/kulara

Total amount to be collected is:

156 kulara x NRs 55/kulara	=	NRs	8,580
Contribution from main committee	=	NRs	1,400
Total	=	NRs	9,980

Therefore, the monthly salary for one messenger is (NRs 9,980/2 persons/12 months) NRs 416.

*Secretary:* People from the head part of the main system have already changed to payment in cash. Only the middle and tail sections of the system are collecting contributions in kind. Therefore, we should first hear from the middle and tail end farmers.

*Farmer:* Why is this an issue?

*Secretary:* The messengers who receive the paddy payment have brought up this issue. They have also asked that their salary be paid directly by the executive committee instead of having to collect from all the village mukhtiyars. They have also asked for an increase in salary.

*A farmer:* It is the same whether we pay them in terms of kind or cash. It will not make any difference.

*Another farmer:* There should also be a provision of punishment when they fail to fulfill their responsibilities.

*Next farmer:* The messengers should work promptly. I have noted an incident of lack of proper, timely communication. They did not inform us about the change of schedule for work at the intake. We went to work at the designated time but no one was present for work, and we returned home. However, we later learned that the meth mukhtiyar had recorded that we were absent from work. We did not know that the date had been changed and were not present at the rescheduled time. But this is not our fault. We were not informed and the meth mukhtiyar cannot mark us absent that day and make us pay the fine. We also demand that this lack of communication not be repeated.

*Chairman:* [Addresses the Chhattis Mauja Meth Mukhtiyar] Please explain how this happened.

*Meth mukhtiyar:* I sent the message with the village mukhtiyar's daughter but she did not pass on the information.

*Chairman:* It is the duty of the meth mukhtiyar to inform all concerned persons about activities ahead of time. He should take the responsibility personally and should mobilize the messengers for this purpose. If someone does not report after he has been informed, only then can the meth mukhtiyar record him as absent and impose a fine.

*Shankarnagar Panchayat Chairman:* To avoid this communication problem we appointed two messengers. Now we are also having the person sign a paper when they have been given the information. The messengers should promptly follow this practice.

Actually, the messengers are only busy for six months when we must mobilize resources for operation and maintenance. Considering this, the present salary of NRs 832 for two messengers is more than sufficient and there is no need to increase their salary.

[The farmers clapped and the salary rate of NRs 832 for two messengers was approved.]

*Farmer:* Messengers are named for a full year. What work should we give them for the other six months?

*Shankarnagar Panchayat chairman:* I was counting the average number of working days for a whole year. If we think we need more defined rules relating to the messengers' work allocation as well as salary increments for them, those issues can be brought up in the general assembly. All we can do now is change the method of fee collection from kind to cash.

### **Structure at the Ittabhond Diversion**

*Chairman:* We have also called this meeting to discuss the type of structure to be made at Ittabhond. We have obtained ten tons of wire and 116 bags of cement from the DOI district

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office. We had tried to obtain the total amount in cash so that we can use the money according to our needs and preferences. We have obtained construction material and need to discuss how to utilize them.

*One farmer:* We should try to make as many permanent side walls as we can.

*Another farmer:* If we concentrate on the structure at Ittabhond, what about Kanyadhunga?

*Next farmer:* We have an engineer, Mr. Tiwari from IIMI, present at the meeting. Can we ask for suggestions as to the type of structure that can be made?

*Farmer:* We feel that the committee always wants to construct stone crate weir instead of making a permanent masonry structure because it allows them to make money from the annual construction work. With a permanent structure there will be no way to make money. Is it not true?

*Shankarnagar Panchayat Chairman:* It is easy to say that the committee has been corrupt in using the funds while making the structure. Can you prove it? Look, I am also a member of the Sorah-Chhattis Joint Committee. When Mr. Prem Nidhi was the chairman of the Sorah-Chhattis Joint Committee there was no problem at all. Some problems appeared when Mr. Pun was the chairman but we solved these. Now, during the present joint committee chairman's period quite a lot of conflicts have arisen. However, it is not wise to give the entire blame to him. He is working honestly. Let us pass a proposal to the Sorah-Chhattis Joint Committee requesting that a permanent structure be made at Ittabhond.

*Chairman:* Let me explain how material were provided by the DOI district office instead of cash. We had held a Sorah-Chhattis Joint Committee meeting and decided that we should purchase the wire ourselves. Meanwhile, officials reported that there was a scarcity of wire in Butwal. Nevertheless, we found about 10 tons of wire. A dealer agreed to sell the wire to us at the rate of NRs 22.60 per kg. But later the joint committee chairman reported to us that the district office had already purchased wire at the rate of NRs 24.75/kg. Thus, there was a difference of NRs 2.15/kg amounting to a difference in the total sum of NRs 21,500.

*Farmer:* Why did they purchase the wire themselves instead of providing the grant in cash to the Sorah-Chhattis Joint Committee?

*Chairman:* Let me explain. Myself and another person were given the responsibility to purchase the material after the grant money was obtained. But the chairman of the Sorah-Chhattis Joint Committee signed an agreement with DOI officials that the DOI should purchase the material and supply it to the committee.

*Farmer:* Why did only the chairman sign? Chhattis Mauja should oppose the decision.

*Chairman:* Wait. Do not blame the joint committee chairman alone. He was forced to do so. He has not made any money out of it. We farmers should have faith in one another after having the issue clarified.

*Secretary:* Let us stop this discussion and make some decisions.

*Farmer:* It has already been decided how to use the cement and wire. Why should we make another decision?



*Meth mukhtiyar:* I know the nature of the flow at the intake and may I suggest how to make the structure?

[Some farmers interrupt him.]

*Farmer:* We did not say that someone is making money out of the grant. We heard from others who said it.

*Chairman:* Let us end it here and go on to the next item on the agenda, the meth mukhtiyar's salary.

### **Meth Mukhtiyar's Salary**

*Farmer:* This issue should be discussed in a general assembly.

*Chairman:* No, the executive committee has the right to increase the salary of its employees.

*Farmer:* No, this is not legal. If someone questioned in the general assembly why and how the salary was raised, what will you do?

*Other farmers:* What will the general body of irrigators think?

[All agreed that the issue should be brought in a general assembly. The meth mukhtiyar opposed the decision.]

*Meth mukhtiyar:* You do not consider how much work I need to do. You only think that I wish only to increase the salary.

*Farmer:* Why did you agree to take the whole responsibility alone when we previously had two meth mukhtiyars? The salary was fixed recently in the past general assembly. It is not wise to increase again and again. You should wait until the next general assembly.

*Secretary:* It seems quite reasonable. Actually the messengers' work has been increased but not the meth mukhtiyar's. I propose NRs 60 per kulara as the rate for the messengers' salary instead of NRs 55 as they are working hard. It is not a big amount and we have no difficulty paying that.

[Most of the mukhtiyars clapped in favor of increasing the rate, however, one farmer stood up and spoke against the decision.]

*Farmer:* Why do you revise the proposal to pay NRs 55 after we have already approved it?

*Secretary:* I know we have already approved it. But we have not read the resolutions and have not adjourned the meeting. It can be revised.

[One farmer suggested they vote on the issue. Only five persons did not raise their hand in favor of paying NRs 60 to the messengers.]

*Farmer:* I know there is no difficulty in paying the increment of NRs 5 per kulara and I also know the majority of the farmers here want to support this. But the first thing we need among ourselves is unity. Up to now all resolutions have been passed unanimously. Remember, if

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the voting system is to be followed you might fall into trouble in passing resolutions in the general assembly. Also, we should not be so flexible in revising our proposals again and again. Less than an hour ago you proposed and we all passed the rate as NRs 55 per kulara. In an hour you are saying we should increase this by NRs 5. Now after one hour again another person might repeat the same proposal. Why didn't you suggest NRs 60 while we were discussing that proposal? Try to realize that we should not be so weak in revising decisions. Think of its effect in the long run and do not raise your voice only for short term benefits.

[Most of the farmers seemed to be persuaded by this farmer's argument. After more discussion the group agreed that the issue should be presented in the next general assembly.]

*Secretary:* We have passed the following resolutions: 1) the rate of collection for the messengers' salaries would be NRs 55.00 per kulara, and 2) the amount collected should be submitted to the executive committee before the annual desilting work begins.

[This ended the general meeting.]

## MEETING IV: GENERAL ASSEMBLY (1989)

### Results of the General Meeting Held on 12 February 1989

A General Meeting was held on 12 February 1989. The main item on the agenda was to determine the date of the main canal desilting and to fix the date for the election of the executive committee. The majority of the farmers present at the general meeting wanted to hold the election before fixing the date of the main canal desilting. Eventually, it was decided to call for a General Assembly Meeting on 14 February 1989 to discuss the election agenda and to set 19 February 1989 as the date on which to start main canal desilting.

### Chhattis Mauja General Assembly Meeting (1989)

The General Assembly Meeting was held at 11:00 am on 14 February 1989 in the compound of the Jyoti Lower Secondary School located in Mauja Number Four. Among the total number of kulara (175), two-thirds (116) have to be present to conduct the meeting. About three hundred farmers were present.

Karna Bahadur Pun, the *pradhan pancha* (chairman) of Karaiya Village Panchayat presided. Bala Ram Kharel, secretary of the executive committee, started the meeting with a speech about the budget. Following are the details of the meeting.

### Secretary's Report

*Secretary:* Mr. Chairman and farmers, I am thankful to all of you for providing opportunities to present the budget in the past few years. We have almost completed work on the canal for this year. You all know what we have done to improve and maintain the irrigation system. First of all, I would like to thank the International Irrigation Management Institute for providing implements such as pickaxes, crowbars, and metal pans amounting to a total of NRs 2,714.

Now, I would like to present the income and expenditures for the past year (1988-89). These accounts have been approved by the three-member audit committee.

Income	NRs	83,738.28
Expenditure		57,278.50
Balance	NRs	26,459.78

Next, I submit to you the record of resource mobilization in the main canal and the record of fines charged to the villages absent from work during the past year. The total number of kulara is 175 this year. The work carried out was as follows:

#### Emergency maintenance:

Single maintenance: 78 days x 175 persons	13,650 person-days
Double work: 9 days x (175 x 2 persons)	3,150
Quadruple work: 3 days x (175 x 4 persons)	2,100
Regular maintenance (main canal desilting over a 12-day period)	31,500
Total assigned	50,400 person-days

The records of the absent villages and the fines imposed are as follows: [See Table A2.1. Fines for absenteeism during emergency maintenance.] The rate for fines was NRs 15 per person-day before and NRs 20 per person-day after last year's general assembly meeting.

I would therefore like to advise all the village-level mukhtiyars that they should collect the fines from the farmers and deliver them to the executive committee before the allocation of second phase work during the main canal desilting period. It is understood that the second phase work will not be carried out until the fines have been paid.

*Table A2.1. Fines for absenteeism during emergency maintenance.*

Village	Absent (person-days)	Fine <sup>a</sup> (NRs)
Semra	5	85
Darshantole	14	260
Haraiya	23	425
H. Bazaar	78	1,455
Sakhuwi	36	675
Beuri	7	105
Bishnupura	48	935
Makrahar	14	255
Tuktuke	28	535
Mainahawa	6	120
Budhabare	33	605
Jamuhani	79	1,455
Bargaduwa	30	595
Suryapura	110	2,095
Mahuwari	30	510
S. Jyotinagar	17	315
N. Jyotinagar	28	490
Lal Bdr Mohoda	53	970
Kumari	38	675
Mohonajot	35	670
Petrani	36	690
Mirgauli	6	115
Madrani	11	195
Yuba Raj Mohoda	76	1,395

Table A.2.1 (Continued)

Village	Absent (person-days)	Fine <sup>a</sup> (NRs)
Chiniya Bdr Mohoda	49	900
Mauja No. 4	24	440
Pradipnagar	44	815
Premnagar	41	775
Mauja No. 3	90	1,650
Mauja No. 2	87	1,620
Satghare Mohoda	34	630
Pandetole	35	645
Dev Narayan Mohoda	41	740
Navadurga Mohoda	7	120
Sarada Mohoda	2	30
Kapil Mohoda	5	85
Santingar	63	1,155
Naya Chaprahatti	28	530
E. Shankarnagar (No. 3)	2	40
Naya Shankarnagar	4	80
Sardarnagar	19	375
Tulsipur	38	685
Mangalapur	55	1,075
Shankarpur	10	195
Main Kulo	23	425
Ampchaur	34	635
Majh Gaon	32	605
Manigram	79	1,360
E. Shankarnagar (No. 1)	41	780
Majuwa Kulo	4	80
Total	1,732	32,095

<sup>a</sup> The fine was NRs 15/day until 12 June 1988 when it became NRs 20/day.

Notes: US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

## Preparation for Executive Committee Election

*Chairman:* I have served as committee chairman for the last two years. The term of office for this committee lasts until mid May. However, last year the main canal desilting work was started in February and we realized that the work is more easily completed at this time of the year. Therefore, I would like to form a new committee at this time so that it can start work in the main canal in February again. I don't need to mention what I have done during my term of office regarding irrigation management. If you provide me such an opportunity, I am willing to work for another two years. Now, I would like to dissolve the old committee and have the assembly elect a new one. Thank you very much.

*Chairman of the joint committee:* Is the list of voters prepared? What are the rules and regulations regarding the election procedure?

*Former chairman:* The list of voters is already prepared. It is the rule that only the 175 kulara are authorized to vote for executive committee members.

*Farmer:* The budget presented by the secretary is quite reasonable. I have also worked on this committee before. But there was no systematic financial management at that time. I have seen a lot of improvement. Also, the budget was audited. The old committee has been dissolved. However, as a beneficiary of the irrigation system, I would like to nominate Prem Bhandari to serve as committee chairman again. Thank you.

[A few farmers from the head reach area of the main system clapped their hands in agreement {Prem Bhandari, is from the head reach area}. However, some farmers, especially from the tail end area, rejected the proposal and whispered among themselves. One of the tail end farmers asked about the balance shown in the budget.]

*Farmer:* Mr. Chairman and Secretary, you have shown a balance of about NRs 26,000 in your record book. I went to see the balance record in the bank. But the money is not deposited there. Would you please therefore let us know where the money is kept?

*Former chairman:* The treasurer has NRs 6,000, the secretary has NRs 9,000, and I have NRs 3,000. The rest (NRs 8,000) is deposited in the bank.

*Same farmer:* This is a misuse of funds. As a rule, only NRs 2,000 can be kept by the treasurer at a time.

*Another farmer:* How much money can the treasurer keep at a time? What are the rules for it?

*Some farmers:* Only NRs 2,000 at a time.

*A young farmer addresses the former chairman:* How can your appointment be considered in this case? First, the problems must be solved.

*Another farmer:* The election can be held only after the money is deposited in the bank. These misdeeds must be corrected quickly before they have a chance to become even worse.

*Chief guest (Kabi Raj Pun, former chairman, Sorah-Chhattis Joint Committee):* Managing the budget for an irrigation system is difficult. At one time, under a different committee chairman,

the interest from the account was also collected from the misusers. However, the money must be deposited in the bank as soon as possible. It is communal property. Should we collect the interest from the users? If the money was deposited in the bank, a certain amount of money (interest) would be added. I wonder why such a big amount of money was misused. We should have hard and fast rules in order to avoid such problems. Due to this situation it is now difficult to simply re-elect last year's chairman. Now we have to form an election commission. Let us solve this problem with positive discussion.

*Former chairman:* I shall deposit the money in the bank right now. I am responsible because it was misused during my term as committee chairman.

*Another farmer:* I raised a similar financial question at last year's general assembly meeting as well. That year, about NRs 92,000 was raised from the farmers for improvement of the irrigation system. But no one paid attention to my question and as a result the money was misused. I wondered if the money would also be misused this year. It is an issue concerning illegal use of funds and therefore you should not be allowed to simply say that now the money will be deposited in the bank.

*Former chairman:* Last year, the executive committee paid NRs 118,000 to the joint committee by check. We have also paid some money to the joint committee by check this year. The amount of NRs 34,000 which was used for the bulldozer was also paid by check. So, most of our payments are made by check. However, this year, the money was kept by the committee members for paying the salary of the meth mukhtiyar and the messengers.

If we really wanted to misuse the money, we would not tell you the truth. I tell you frankly that only under my chairmanship have you been able to receive accounts as clear as these.

*Chief guest, speaking to the former chairman:* You are not supposed to play a dominant role in this meeting. Your duty is to satisfy the farmers in a peaceful manner.

*Former chairman:* I have already clarified the reasons for keeping the money (NRs 26,000). I gave the secretary permission to keep the money.

*Some farmers:* The election can be held only after the money is deposited in the bank.

*The joint committee chairman:* All the farmers are willing to hold the election only after the money is deposited. So, how long will it take the former chairman to deposit the money in the bank?

*Former chairman:* I shall deposit the money right now so that the election may be held today.

[The former chairman sent a person to his house who returned after half an hour and informed the farmers that the money had been deposited in the bank.]

*Presiding chairman:* Let us complete the meeting in a peaceful manner. The chairman of the joint committee is here to inform us of the work of the joint committee. We should proceed with the election now.

*A mukhtiyar:* I have been a mukhtiyar before. The work should be done carefully. I have a suggestion for those who will carry out work in the future: the banks of the main canal at the joint-system level have been destroyed. Who is going to control this? Unless the bunds are repaired,

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the canal may be lost. Where shall we go to report this? We have a problem: You have employed a clever way to ensure that the fines are collected<sup>10</sup> but then you misuse the money. The person we elect as chairman must take this situation into serious consideration. Furthermore, chairmen elected from the head reach area never consider the water scarcity problems of the tail end area. The chairman should perform his job impartially regarding water management issues.

*Former secretary:* We know that our canal bunds are used by farmers as well as by squatters. We shall try to control this in the following years if we are elected to the committee again.

*An area member:* It will be better to involve the respective local political units in controlling the use of the bunds. If the panchayat officials in these areas will ask the farmers who are using the bunds to utilize other land the management of the system will improve.

*Chief guest:* I appreciate your suggestion. I hope the local officials can play an effective role regarding this issue.

*Another former chairman:* During the time I was chairman of the committee, the tail end areas were dominated regarding irrigation management issues such as resource mobilization and water distribution by the four branches, Sukhanagar, East Kalikanagar, West Kalikanagar and Dada Kulo.<sup>11</sup> When we went to adjust their inlets to get more water during periods of water scarcity, we were often kept in the goat pen by the women of these villages. The joint committee was formed to resolve these kinds of problems. The role of the joint committee is of great importance. However, water distribution within the branch systems is not properly done. The Chhattis Mauja Executive Committee has not been helping the system to improve its performance. The head-reach farmers never contribute labor for main canal operation and maintenance. Nevertheless, they are not fined. They also use as much water as they want. It seems that our last chairman favors them so he can get their votes for election to the executive committee. It is therefore important to separate personal interests from irrigation management.

*Chief guest:* Let us forget all these things now and form an election commission to proceed with the election.

### **Election Commission**

An election commission consisting of five members was formed to supervise the election of the executive committee officers. The time and date for casting votes was fixed as from 12:00 to 3:00 pm on 15 February 1989. The committee chairman of the past two years was informed that he must submit the bank voucher verifying the deposit of the misused funds by 10:00 am that same day or he would be ineligible to run for re-election. The election commission formulated the following deadlines for the election:

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10 This mukhtiyar is referring to the rule that all irrigators in a village must pay fines before the assignment of second stage desiltation work or the entire village is denied the opportunity to work and receive irrigation water.

11 These four branch canals take water from the main canal upstream of the structure dividing water between the Sorah Mauja and Chhattis Mauja systems.



Nomination time	- 2:00-3:00 pm
Withdrawal of nomination	- 3:00-3:45 pm
Examination of nominees	- 3:45-4:00 pm
Declaration of eligible candidates	- 4:00-4:30 pm

The candidates were assigned colors for the ballot boxes as follows:

For chairman:

Prem Bahadur Bhandari (previous chairman)	blue
Khadka Bahadur Gurung (another former chairman)	red
Nara Bahadur Pun	withdrew

For vice-chairman:

Tara Prasad Pandey	red
Krishna Prasad Poudel	blue

For secretary:

Bala Ram Kharel (previous secretary)	blue
Hem Lal Dhakal	red

The election commission requested that all the village-level mukhtiyars register the voters from their villages. The number of registered voters from each village must equal the number of kulara assigned to each village. The commission also reiterated that only the registered kulara representatives would be allowed to vote. The deadline for voter registration was set as 10:00 am 15 February 1989. Because it was getting late, the meeting was adjourned, to resume the following day.

### **Election of the Executive Committee Members**

On 15 February 1989, the election was held at the Jyoti Lower Secondary School located in Mauja Number Four at the appointed time. Tin boxes with the open end covered with a cloth colored to correspond to the respective candidate's colors were used as ballot boxes. The boxes were placed in different rooms according to the position for which the candidates were running. The voting started at 12:00 am and finished at 2:00 pm, an hour before the closing time. It took about an hour to count the votes. Voters were given three pieces of paper upon which were written the different committee positions up for election. The voter was to put each slip of paper into the appropriate box of the color corresponding to the candidate for whom he wanted to vote. Agents were also assigned to act on behalf of the candidates during the vote counting period. A total of 175 votes were authorized for each position, but some ballots were not cast properly and were invalidated. The election results were as follows:

Chairman:

Prem Bahadur Bhandari - 132 votes (elected)  
 Khadka Bahadur Gurung - 41 votes

Vice-chairman:

Krishna Prasad Paudel - 114 votes (elected)

Tara Pst. Pandey - 56 votes

Secretary:

Bala Ram Kharel - 130 votes (elected)

Hem Lal Dhakal - 42 votes

The voters put *abir* (red powder) on the elected members as a gesture of felicitation. The newly elected members then spoke to the group.

### After-Election Discussion

*Newly elected chairman:* I am very happy that I have been re-elected as chairman of the executive committee for the following two years. I would like to convey my thanks to all of you. I promise to fulfill my duties during my tenure of office. I am very sorry for the mistake regarding the misuse of funds. I want to convey my thanks once more because you have re-elected me as chairman and forgiven my mistakes. I shall never repeat these mistakes. As a member of the joint committee, I would like to say that no one is faultless or perfect among us. If I had intended to be dishonest I would not have shown you the balance in the record book yesterday. If we were to examine the joint committee record book, we would see that the chairman of this committee used NRs 78,000 for two years without paying interest. Rupees 32,000 were also improperly used. I am pointing this out to you because the joint committee misused funds and although I am not in favor of this practice, the joint committee has blamed me of misusing funds as well.

The Department of Irrigation has granted about NRs 300,000 to the joint committee for the improvement of the system this year. I was able to purchase gabion wire for NRs 22 per kilogram (kg), but the joint committee chairman used the money to purchase gabion wire for NRs 23.75 per kg. I think that such transactions are not in the best interests of the farmers. You farmers need to understand the truth.

*Vice-chairman:* I am thankful to all of you for electing me as vice-chairman of the executive committee. I am anxious to fulfill my duties correctly. I shall always try to walk on the right path. No one should deceive others. Everyone should bear his responsibility. Now we all know how the funds were misused. I shall try to avoid such improper behavior during my term as vice-chairman. Thank you very much.

*Secretary:* I have already served as secretary of this committee for about five years. I had no interest to be secretary again, however, now that I have been elected I shall try to fulfill my duty with sincerity. We did not misuse the money. We showed the balance in the record book. We shall follow the rules in the following years.

I would also like to tell you something about the joint committee. Some joint committee members blamed us (Chhattis Mauja Executive Committee Members) for the misuse of funds even though we had shown the balance in our record book. Two other local community leaders and I wrote to the King asking for help during his last visit to the Western Development Region. As a result, NRs 416,000 was made available through the Lumbini Zonal Commissioner's Office for the improvement of the irrigation system in 1985. Out of that amount, some money was used for cement, some for the iron gate which was installed at Ittabhond to control excess water and about NRs 14,000 was not used for improvements to the system and is unaccounted for. The payment of the gate was made after one year of its delivery. The former joint committee chairperson, our chief guest today, was responsible for

all of these activities. The joint committee gave an advance to an agency for 1,000 bags of cement. But all the cement was not needed. Nevertheless, the money for 300 bags of cement was returned only after one year. The money made available from FIWUD [Farm Irrigation and Water Utilization Division] was also misused and the joint committee members told us that they had to give some money to the engineers illegally. The audit committee urged the joint committee to clear all the accounts at that time. About NRs 500 was used for a party in a hotel and this was not accepted by the audit committee. While the money was being used in this way, the executive committee had to collect money from farmers on the basis of the area irrigated for the construction work at Tara Prasad Bhond. Now, there are about NRs 300,000 worth of gabion wire in the joint committee store at Devasthan near Nayamill which was made available through the Department of Irrigation in June 1988. This has not been used yet. Who is keeping a record of all these things? I request that the joint committee members clarify all of these questions in the presence of all the farmers today.

*Farmer:* You ask us about collecting money but you spend it without consultation. If you continue this, no one from Chhattis Mauja will go to the main intake to fill the gabion wire with stones.

[Most of the farmers clapped their hands with enthusiasm.]

*Another Farmer:* First, I would like to thank the elected persons. It seems to me that the executive committee members have followed the example set by the joint committee members.

Why was this meeting called at the same time that the Lumbini Zonal Pancha Convention is being held? Why couldn't the election have been postponed until after the Pancha Convention when more of our local leaders could participate? I think there are political reasons behind this. I would like the persons concerned to clarify this point.

[Despite the farmer's question, no one addressed the issue and the matter was not mentioned again.]

*Joint committee chairman:* Thank you very much friends. I came to hear the Chhattis Mauja Executive Committee Members. During my term of office I had little opportunity to talk with you.

At present, I am unable to clear all my accounts because of the absence of the joint committee secretary. However, I shall try to explain how the budget was spent under my chairmanship. The NRs 416,000 made available through the zonal commissioner's office had to be used under the control of the zonal commissioner. I received an advance to deliver bricks at the rate of NRs 900 per 1,000 bricks. I was not able to supply the bricks in time because of the rainy season. In the next season the cost of the bricks increased to NRs 1,000 per 1,000 bricks. Nevertheless, I delivered the bricks at the old price and returned NRs 16,000 to the joint committee.

We also had a grant from the Department of Irrigation. All arrangements were made by the DOI and I was compelled to receive the material. I was told that if I did not receive the material in time the grant would lapse. Did I make a mistake in taking the material? Do we not need this material for the improvement of our system? The material is kept in our store. We can still use it can't we? Do you think this is corruption? If you need further clarification, I will come with the secretary next time. Thank you.

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*Chief guest:* The executive committee members blame the joint committee members for the misuse of funds. But first you must understand the facts. If we made mistakes why didn't your former executive committee member tell you at that time? After all, he is also one of the members of this committee. If you have any doubts about the money made available through the zonal commissioner's office in Butwal you are free to check the account in the zonal commissioner's office. Actually, that money was for the Marchawar Irrigation Project and it was made available to our system because of great effort on my part. We have to use the grant according to government policy. We did our best to improve the irrigation system during our terms of office. You should be grateful. If you think we made a mistake by receiving the material from the external agencies, let us give it back. I am an old farmer of this area. I know what can be done for the improvement of the irrigation system. I think it is reasonable to take advantage of external resources rather than collect money from the farmers for management of the system.

*Presiding chairman:* Congratulations to all the elected members. The farmers are also thankful that the election has been conducted in a peaceful manner. We were able to hear many things during the meeting. I think we were unable to fulfill all our duties during our terms of office. We should work for the sake of the farmers. I think the joint committee election should be held as soon as possible if all the members are not carrying out their duties properly. Let us try to improve our behavior rather than blaming others.

Now, I would like to close the general assembly meeting here. Thank you.

[The meeting ended at 5:00 pm.]

## Appendix 3

### EFFECTIVE RATE OF TAXATION

An effective rate of taxation is typically calculated as:

$$ERT = \frac{\text{Tax Paid}}{\text{Some Measure of Base}}$$

In this case the resources paid for irrigation are the tax. The base of interest is the increment of agricultural income attributable to irrigation. The income used is the gross margin. By definition, the gross margin is the difference between the gross product (gross income) and the direct costs of production. Subtracting the gross margin of unirrigated production from the gross margin of irrigated production gives the marginal income from irrigation. By this definition we have the effective rate of taxation as:

$$ERT = \frac{\text{Resources Paid for Irrigation}}{\text{Marginal Income from Irrigation}}$$

Information used to compute the total cost of irrigation operation and maintenance was presented in Table 6.3 and is summarized in Table A3.1. These are the "resources paid for irrigation" used in computing the ERT.

"Marginal income from irrigation" means the increment of income (due to the availability of irrigation) above what could be obtained from the same land if it were cultivated without irrigation. Thus, it is the observed value of irrigated production minus the hypothetically achievable value of unirrigated production on the same land. Net values (production minus costs) are used to represent both irrigated and unirrigated outputs.

The price of labor for field work and maintenance was determined through farmer interviews. The Farmgate financial prices and market rates used for computing the cost and value of production were taken from the Irrigation Master Plan document (Master Plan Cycle 2, Annexes B2-3, pages 5-27:1990). The Master Plan Preparation Exercise reviewed all available Farmgate economic and financial prices and crop production studies in Nepal. They prepared estimated average input and market prices and yields for irrigated and nonirrigated crops in each part of the country. The Farmgate input prices used in the analysis are summarized in Table A3.2. Table A3.3 summarizes the input levels used in crop production and the crop yields used to compute production. The rice, wheat, and maize yields are from the crop cut made in the sample branches. The level of inputs used, yield of mustard and pulse, and all rain-fed output values are from the estimates prepared by the Master Plan.

Table A3.4 presents the fraction of area cropped under irrigation for each crop in each season. This estimate was prepared by using the cropping intensity observed in the three sample branches to represent the geographical head, middle, and tail. Rain-fed conditions were assumed to follow the regional patterns documented in the Master Plan.

Tables A3.4 through A3.7 present the cost of production and gross value of production for the three main crop seasons. Table A3.8 is the financial budget summary. It shows the

gross value of production and the cost of production for each crop. These are used to compute the marginal income from irrigation. The final section of Table A3.8 shows the ERT for the conditions observed in the 1988/89 crop year.

*Table A3.1. Operation and maintenance cost for the Chhattis Mauja Irrigation System with labor rates at NRs 20/day.*

Item	Head Sample	Middle Sample	Tail Sample	System
Main canal desilting	3,720	3,480	1,480	151,980
Main canal emergency maintenance				
Labor	8,860	6,780	3,160	299,091
Fine for absent labor	540	500	320	21,636
Messenger (NRs 55/kulara)	275	220	110	9,625
Main canal irrigation expense	13,395	10,980	5,070	482,332
Irrigation expense (NRs/ha)	268	157	55	138
Irrigation expense (NRs/kulara)	2,679	2,745	2,635	2,756
Branch canal irrigation expense				
Cash in lieu of labor	4,600	9,800	6,200	370,800
Labor for desilting/cleaning	2,760	4,200	3,480	153,120
Total irrigation expense	20,480	24,760	14,640	996,627
Irrigation expense (NRs/ha)	410	354	159	285
Irrigation expense (NRs/kulara)	4,096	6,190	7,320	5,695

*Source:* Field observation and system records 1988/89.

*Notes:* For details of the three sample branches, see pages 21-22.

US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

Table A3.2. *Farmgate financial prices in 1988.*

Medium grain rough rice	NRs/t	3,925
Wheat		3,725
Maize		3,425
Pulses		12,750
Mustard		11,925
Crop by-products		700
Nitrogen	NRs/kg	8.67
Phosphorous	NRs/kg	8.67
Potassium	NRs/kg	3.33
Manure	NRs/t	160
Seed		
Medium grain rough rice	NRs/kg	8.1
Wheat	NRs/kg	6.4
Maize	NRs/kg	8.5
Pulses	NRs/kg	16.5
Mustard	NRs/kg	15.5
Hired Labor (without food/8-hr day)	NRs	16
Bullock labor/8-hr day	NRs	20

Sources: Field observations and Master Plan Cycle 2, Annexes B2-3.

Notes: US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

Table A3.3. Rate for inputs and outputs of all crops per hectare.

Item	Unit	Monsoon rice		Wheat		Maize		Pulse		Mustard		Mustard of M+P		Pulse of M+P	
		Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
INPUT															
Seed	kg	50.00	45.00	120.00	100.00	25.00	20.00	45.00	40.00	15.00	15.00	0.00	0.00	45.00	0.00
Fertilizer	kg														
N		10.00	30.00	0.00	30.00	10.00	25.00	0.00	15.00	0.00	20.00	0.00	0.00	0.00	0.00
P		0.00	15.00	0.00	15.00	0.00	20.00	0.00	20.00	0.00	10.00	0.00	0.00	0.00	0.00
K		0.00	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00
Manure	Tons	1.50	0.00	2.50	1.00	3.00	1.00	2.00	1.00	2.00	1.00	0.00	0.00	0.00	0.00
Plnt. Pro.	NRs	0.00	125.00	0.00	50.00	0.00	60.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Labour	MD	130.00	163.00	75.00	94.00	100.00	125.00	30.00	37.00	60.00	75.00	45.00	0.00	22.00	0.00
Draft Ani. per day		45.00	52.00	30.00	35.00	30.00	35.00	20.00	22.00	20.00	23.00	0.00	0.00	0.00	0.00
OUTPUT															
Crop	Tons														
Head		1.50	3.75	0.90	3.69	1.20	2.20	0.35	1.27	0.40	0.75	0.25	0.00	0.20	0.00
Middle		1.50	4.00	0.90	3.10	1.20	2.19	0.35	0.91	0.40	0.81	0.25	0.00	0.20	0.00
Tail		1.50	2.88	0.90	2.07	1.20	1.20	0.35	0.98	0.40	0.95	0.25	0.00	0.20	0.00
System		1.50	3.71	0.90	2.95	1.20	1.86	0.35	1.05	0.40	0.84	0.25	0.00	0.20	0.00
By-product	Tons	1.30	2.10	0.90	2.20	1.10	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Sources: Field observations and sample crop cuts (1988/90).

Master Plan Cycle 2, Annexes B2-3, pages 5-27.

Notes:

Irr. = Irrigated.

M+P = Mustard and Pulse.

Plnt. Pro. = Plant Protection.

Draft Ani. per Day = Draft Animals per Day.

US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.



**Table A3.4. Chhattis Mauja cropping pattern and area cropped in each season:**  
 1. Under present irrigated conditions, and 2. Without irrigation conditions (assumed).

Crop area, head branch (ha)	50							
Crop area, middle branch (ha)	70							
Crop area, tail branch (ha)	92							
Crop area, total system (ha)	3,500							
Monsoon season (fraction of command area with crop)								
	Head Sample		Middle Sample		Tail Sample		System	
	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
Rice	0.98	1.00	0.98	1.00	1.00	1.00	0.9	1.00
Maize	0.02	0.00	0.02	0.00	0.00	0.00	0.0	0.00
Winter season (fraction of command area with crop)								
	Head		Middle		Tail		System	
	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
Wheat	0.15	0.35	0.15	0.24	0.12	0.12	0.14	0.24
Pulse	0.15	0.31	0.15	0.53	0.17	0.17	0.16	0.34
Mustard	0.10	0.24	0.10	0.05	0.05	0.05	0.08	0.11
Mustard+Pulse	0.10	0.00	0.10	0.00	0.06	0.00	0.09	0.00
Fallow	0.50	0.10	0.50	0.18	0.60	0.66	0.53	0.31
	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Spring (dry) season (fraction of command area with crop)								
	Head		Middle		Tail		System	
	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
Maize	0.00	0.34	0.00	0.15	0.00	0.00	0.00	0.16
Fallow	0.00	1.66	0.00	0.85	0.00	1.00	0.00	0.84
	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00

Sources: Irrigated condition observed in sample branches 1988/89.

Unirrigated condition from Master Plan and field observation.

Note: For details of the three sample branches, see pages 21-22.

Table A3.5. Chhattis Mauja monsoon financial crop budget (1988/89) with present irrigated and hypothetical rain-fed conditions (NRs).

Item	Head Sample		Middle Sample		Tail Sample		System	
	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
COST OF PRODUCTION	184,853	226,383	258,794	316,936	341,476	416,544	12,956,767	15,846,775
Seed	20,058	18,225	28,081	25,515	37,260	33,534	1,408,517	1,275,750
N	4,335	13,005	6,069	18,207	7,976	23,929	303,450	910,350
P	0	6,503	0	9,104	0	11,965	0	455,175
K	0	0	0	0	0	0	0	0
Manure	12,240	0	17,136	0	22,080	0	851,200	0
Plant Protection	0	6,250	0	8,750	0	11,500	0	437,500
Labor	103,520	130,400	144,928	182,560	191,360	239,936	7,257,600	9,128,000
Draft Animals	44,700	52,000	62,580	72,800	82,800	95,680	3,136,000	3,640,000
GROSS VALUE OF PRODUCTION	337,958	809,438	473,141	1,201,900	625,370	1,175,208	23,701,767	56,111,125
Crop	292,598	735,938	409,637	1,099,000	541,650	1,039,968	20,523,300	50,966,125
By-product	45,360	73,500	63,504	102,900	83,720	135,240	3,178,467	5,145,000
NET VALUE OF PRODUCTION	153,105	583,055	214,347	884,965	283,894	758,664	10,745,000	40,264,350

Notes: For details of the three sample branches, see pages 21-22.

Irr. = Irrigated

US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

Table A3.6. *Chhattis Mauja winter season financial crop budget (1988/89) with present irrigated and hypothetical rain-fed conditions (NRs).*

Item	Head Sample		Middle Sample		Tail Sample		System	
	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
<b>COST OF PRODUCTION</b>								
Seed	56,626	121,833	79,277	146,040	83,244	82,526	3,698,193	6,323,283
N	17,366	24,220	24,313	36,052	26,543	18,458	1,147,020	1,400,058
P	0	8,648	0	9,801	0	5,703	0	437,474
K	0	6,004	0	8,921	0	4,547	0	346,439
Manure	0	400	0	117	0	153	0	13,209
Plant Protection	7,000	7,200	9,800	9,184	10,893	5,005	464,800	384,533
Labor	0	875	0	840	0	552	0	41,417
Draft Animals	22,760	49,896	31,864	51,430	31,089	31,383	1,456,373	2,419,387
<b>GROSS VALUE OF PRODUCTION</b>	9,500	24,590	13,300	29,694	14,720	16,726	63,000	1,280,767
Crop	114,844	625,801	160,781	888,837	166,235	463,141	7,467,425	35,289,132
By-product	110,119	598,851	154,166	862,965	159,280	446,140	7,158,725	34,013,499
<b>NET VALUE OF PRODUCTION</b>	4,725	26,950	6,615	25,872	6,955	17,002	308,700	1,275,633
	58,218	503,968	81,505	742,798	82,990	380,615	3,769,232	28,965,849

Notes: For details of the three sample branches, see pages 21-22.

Irr. = Irrigated

US\$1.00 = NRs 25.10. in 1988.

US\$1.00 = NRs 28.10. in 1989.

Table A3.7. Chhattis Mauja spring (dry season) financial crop budget (1988/89) with present irrigated and hypothetical rain-fed conditions (NRs).

Item	Head Sample		Middle Sample		Tail Sample		System	
	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
COST OF PRODUCTION								
Seed	0	59,729	0	36,891	0	0	0	2,008,522
N	0	2,890	0	1,785	0	0	0	97,183
P	0	3,685	0	2,276	0	0	0	123,909
K	0	2,948	0	1,821	0	0	0	99,127
Manure	0	566	0	350	0	0	0	19,037
Plant Protection	0	2,720	0	1,680	0	0	0	91,467
Labor	0	1,020	0	630	0	0	0	34,300
Draft Animals	0	34,000	0	21,000	0	0	0	1,143,333
GROSS VALUE OF PRODUCTION	0	11,900	0	7,350	0	0	0	400,167
Crop	0	147,135	0	90,878	0	0	0	4,947,775
By-product	0	128,095	0	79,118	0	0	0	4,307,508
NET VALUE OF PRODUCTION	0	19,040	0	11,760	0	0	0	640,267
	0	87,406	0	53,986	0	0	0	2,939,253

Notes: For details of the three sample branches, see pages 21-22.

Irr. = Irrigated

US\$1.00 = NRs 25.10 in 1988.

US\$1.00 = NRs 28.10 in 1989.

	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.	Rain-fed	Irr.
<b>MONSOON SEASON</b>								
Gross value of production	337,958	809,438	473,141	1,201,900	625,370	1,175,208	23,701,767	56,111,125
Cost of production	184,853	226,383	258,794	316,936	341,476	416,544	12,956,767	15,846,775
Net value of production	153,105	583,055	214,347	884,965	283,894	758,664	10,745,000	40,264,350
<b>WINTER SEASON</b>								
Gross value of production	114,844	625,801	160,781	888,837	166,235	463,141	7,467,425	35,289,132
Cost of production	56,626	121,833	79,277	146,040	83,244	82,526	3,698,193	6,323,283
Net value of production	58,218	503,968	81,505	742,798	82,990	380,615	3,769,232	28,965,849
<b>SPRING SEASON</b>								
Gross value of production	0	147,135	0	90,878	0	0	0	4,947,775
Cost of production	0	59,729	0	36,891	0	0	0	2,008,522
Net value of production	0	87,406	0	53,986	0	0	0	2,939,253
<b>TOTAL NET VALUE OF PRODUCTION (NRs)</b>	211,323	1,174,429	295,852	1,681,748	366,884	1,139,280	14,514,232	72,169,452
<b>MARGINAL INCOME DUE TO IRRIGATION (NRs)</b>		963,107		1,385,897		772,395		57,655,220

Note: Cost of production excludes cost of irrigation operation and maintenance. All above values are in NRs

#### TOTAL NET VALUE OF PRODUCTION

NRs	211,323	1,174,429	295,852	1,681,748	366,884	1,139,280	14,514,232	72,169,452
NRs/ha	4,226	23,489	4,226	24,025	3,988	12,383	4,147	20,620
US\$/ha	150	386	150	855	142	441	148	734

#### EFFECTIVE IRRIGATION TAX RATE

	Head Sample	Middle Sample	Tail Sample	System
Marginal income due to irrigation	963,107	1,385,897	772,395	57,655,220
Total cost of operation and maintenance	20,480	24,760	14,640	996,627
Net marginal income after deducting cost of irrigation (NRs)	942,627	1,361,137	757,755	56,658,593
Net marginal income after deducting cost of irrigation (NRs/ha)	18,853	19,445	8,236	16,188
Net marginal income after deducting cost of irrigation (US\$/ha)	671	692	293	576
Effective irr. tax rate (Total cost irr./marginal income irr. x 100%)	2.13	1.79	1.90	1.73

Notes: For details of the three sample branches, see pages 21-22.

Irr. = Irrigated/irrigation

US\$1.00 = NRs 25.10 in 1988. US\$1.00 = NRs 28.10 in 1989.