PN-AAU-157

Rapid Appraisal of Nepal Irrigation Systems

WATER MANAGEMENT SYNTHESIS PROJECT

WMS REPORT 43

RAPID APPRAISAL OF NEPAL IRRIGATION SYSTEMS

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WMS Report 43

Prepared in cooperation with the United States Agency for International Development, Contract DAN-4127-C-00-2086-00.

WATER MANAGEMENT SYNTHESIS PROJECT
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in cooperation with the
Consortium for International Development

April 1986

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*Though Pithuwa is placed here as a DIHM-managed irrigation system, it is actually managed by both DIHM and farmers.

INTRODUCTION

To understand the status of different irrigation systems in Nepal, a series of rapid appraisals of irrigation systems was conducted from September 1985 to February 1986. These studies were done in cooperation with the Irrigation Management Project (IMP), a joint project of His Majesty's Government of Nepal (HMG) and USAID/Nepal. IMP will institute improved irrigation management procedures in selected government irrigation systems in the hills and Terai in an effort to improve the performance of these systems. Simultaneously, IMP personnel will conduct long-term studies of farmer-managed irrigation systems in Nepal, to try to determine what lessons could be learned from these systems that could be applied to government-managed systems.

The objective of the rapid appraisals was to provide USAID/Nepal and HMG officials with relevant information on potential project sites. Based on this information, USAID/Nepal and HMG officials could make informed decisions about where IMP should be implemented.

Rapid appraisal as a technique was developed in reaction to the biases of totally unstructured "windshield surveys," and very long, time-consuming detailed studies. Rapid appraisals attempt to find a middle ground between these two extremes. The studies explicitly consider that there are always limits to budgets, time, and personnel. Rapid appraisals are simply a technique to systematically gather and analyze relevant information quickly and in a cost-effective manner.

Researchers using rapid appraisals must define the level of optimal ignorance or appropriate imprecision that they are willing to tolerate. Sacrifices in precision and detail are openly made to meet the demands of decision-makers. Results of rapid appraisal reports, therefore, should not be taken as absolute truth. Researchers facing the constraints of time, money, and personnel must admit that not everything needs to be known about a particular irrigation system. In the case of these IMP rapid appraisals, the information gathered was focused and related to the objectives of IMP.

We did look at both problems and opportunities in all the systems studied, so that we could develop a list of strengths and weaknesses for each system. It is important, however, to realize that rapid appraisals are best seen as the starting point of future

studies. Rapid appraisals should not be viewed as ends in themselves. They are complements, not substitutes, for more detailed, long-range studies.

The rapid appraisal team did not draw conclusions, nor recommend specific sites. The team simply conducted the studies and presents the findings in these reports. Site selection will be done by AID/Nepal and HMG.

The rapid appraisal team members were as follows:

- Robby Laitos, social scientist,
  Water Management Synthesis Project
- Alan Early, agricultural engineer,
  Water Management Synthesis Project
- Moin Shah, irrigated agriculture specialist,
  Ministry of Water Resources, HMG
- Umesh Parajuli, Assistant Engineer,
  Department of Irrigation, Hydrology, and Meterology (DIHM)
- Prachandra Pradhan, social scientist,
  Tribhuvan University, private consultant

In February 1986, two new members joined the team when Alan Early and Prachandra Pradhan had to leave due to prior commitments. The two new members were:

- John Baxter, irrigation agronomist,
  Arizona State University
- Upendra Gautam, social scientist,
  Tribhuvan University

It is important to realize that rapid appraisals are more of an art, than a science. Nevertheless, there were some general principles which the rapid appraisal team did use. First, wee worked as an interdisciplinary team, and constant interaction among team members was stressed. Second, The duration of each rapid appraisal varied according to the size and complexity of the irrigation system. The shortest appraisal (on a 40 ha irrigation system) took from one-half to one day, and the longest appraisal (on a 4,000 ha system) took slightly more than a week. Third, we consciously tried to avoid the biases of looking only at main canals, head reaches, and villages near motorable roads. After a site was selected for study, the team made every effort to study the entire system from head to tail, and talk to as many different people as possible.

In addition to these general principles, we also used team members' past experiences, readings from rapid appraisal literature, and inductive learning to study the systems. We developed a five step method for conducting the rapid appraisals.

1. Entry: The team members gathered as much information as possible from written material, reports, and studies. They identified important government and farmer informants who are particularly knowledgeable about the system. They found out what other people have concluded about the site. (Unfortunately, there were usually no written reports on farmer-managed systems.)

2. Initial Walk-Through: The entire team usually walked together through the system from head to tail, exchanging observations and insights. Key informants also accompanied the team.

3. Individual Studies: Team members collected their disciplinary data through direct observations, field measurements, and informal interviews. Most of these studies were qualitative in nature. Where quantitative data were necessary (yields, landholding size), variations were stressed as much as mean figures. Particularly useful was purposively sampling all relevant socio-economic strata of the irrigation system: rich and poor, men and women, landlords and tenants, head and tail. Interviews were then conducted with both individual respondents and key informants. Proxy indicators were also used to study the system, i.e., housing standards serving as indicators for income levels.

4. Compare Findings: At the conclusion of individual data collection, the team members assembled to compare findings, correlate data, and draw tentative conclusions. This was done in both formal and informal meetings.

5. Strengths and Weaknesses: Finally, each team member reported his impressions of the system's strengths and weaknesses. To keep the data fresh in team members' minds, the first drafts of the reports were written in the field.

To locate appropriate sites for the rapid appraisals, a reconnaissance of irrigation systems was first carried out in late September 1985 going from far east to the far west of Nepal. The reconnaissance covered both DIHM and farmer-managed irrigation systems in the hills and the Terai.

After the reconnaissance, the rapid appraisal sites were selected using the following criteria:

1. Accessibility: As IMP is to generate "visible success stories," we felt it was important that potential sites be

accessible to outsiders. Because of Nepal's rugged country and the resulting logistical problems, we decided that potential sites must not be more than a half-day's walk from a motorable road.

2. Size: The IMP project paper gave general guidelines for system sizes.

DIHM Terai Systems	1,500 ha (one site) 2,000 ha (one site)
DIHM Hill Systems	500 ha (total)
Farmer-Managed Terai Systems	500 ha (total)
Farmer-Managed Hill Systems	500 ha (total)

3. Control of water source, including reliability: As most irrigation in Nepal is run-of-the-river, we felt that it was important that farmers at potential sites have control of the water source and that the source be reliable.

4. Minimum external conflict: This criterion relates to number three, as external conflict over water could seriously hamper the reliability of water supplies.

5. Potential for expanding command area and cropping intensity: We wanted to study sites that had irrigated area and cropping intensity which could be expanded using improved management procedures.

6. Potential for increased crop production: This could result from improved management procedures, as well as using more improved agricultural technologies.

7. Replicability - Finally, we wanted to study sites that were representative of Nepalese irrigation, so that lessons learned could be replicated in other Nepalese irrigation systems.

After setting these criteria, we realized that they were most applicable to DIHM-managed systems. We did not develop a separate set of criteria for farmer-managed systems, but did adapt the above criteria when necessary. We were most concerned that the farmer-managed systems in Nepal should teach us lessons about irrigation management.

During our initial planning meetings, we also began formulating a report format. For each rapid appraisal completed, we wanted a separate report which would give officials the information needed to

make site selection decisions. Each report includes a description of the system and discusses the characteristics and performance of the physical, social/institutional, operational, and agricultural aspects of the system. At the end of each report the strengths and weaknesses of the system are summarized.

The reader should realize that the studies presented here are not definitive. By the nature of rapid appraisal studies, the data must remain superficial. All of the sites included here deserve careful study over a longer period of time. It is quite possible that the rapid appraisal team could have made mistakes in data collection and analysis. Our findings should be verified by other studies. The results are best considered as hypotheses for future study.

By the end of the rapid appraisals, we had examined 17 irrigation systems: 10 farmer-managed sites, 6 DIHM sites, and 1 hybrid system (Pithuwa) which combined both DIHM and farmer-managed attributes. There are 9 sites from the Terai (we considered the Chitwan Valley as part of the Terai) and 8 sites from the hills (Figure 1). We hope that these studies contribute to a successful Irrigation Management Project, and that they also stimulate other researchers to continue studies of Nepalese irrigation systems.

We wish to thank Mr. C.D. Bhatt, Director General of DIHM, and Mr. Jack Pinney of USAID/Nepal for their help and encouragement throughout the rapid appraisals. We also thank all the DIHM and Department of Agriculture officials throughout Nepal who aided us in innumerable ways. Our greatest debt of gratitude, however, goes to the Nepalese farmers. We were always received with courtesy and a great deal of hospitality. It is to all of them that we dedicate this report.

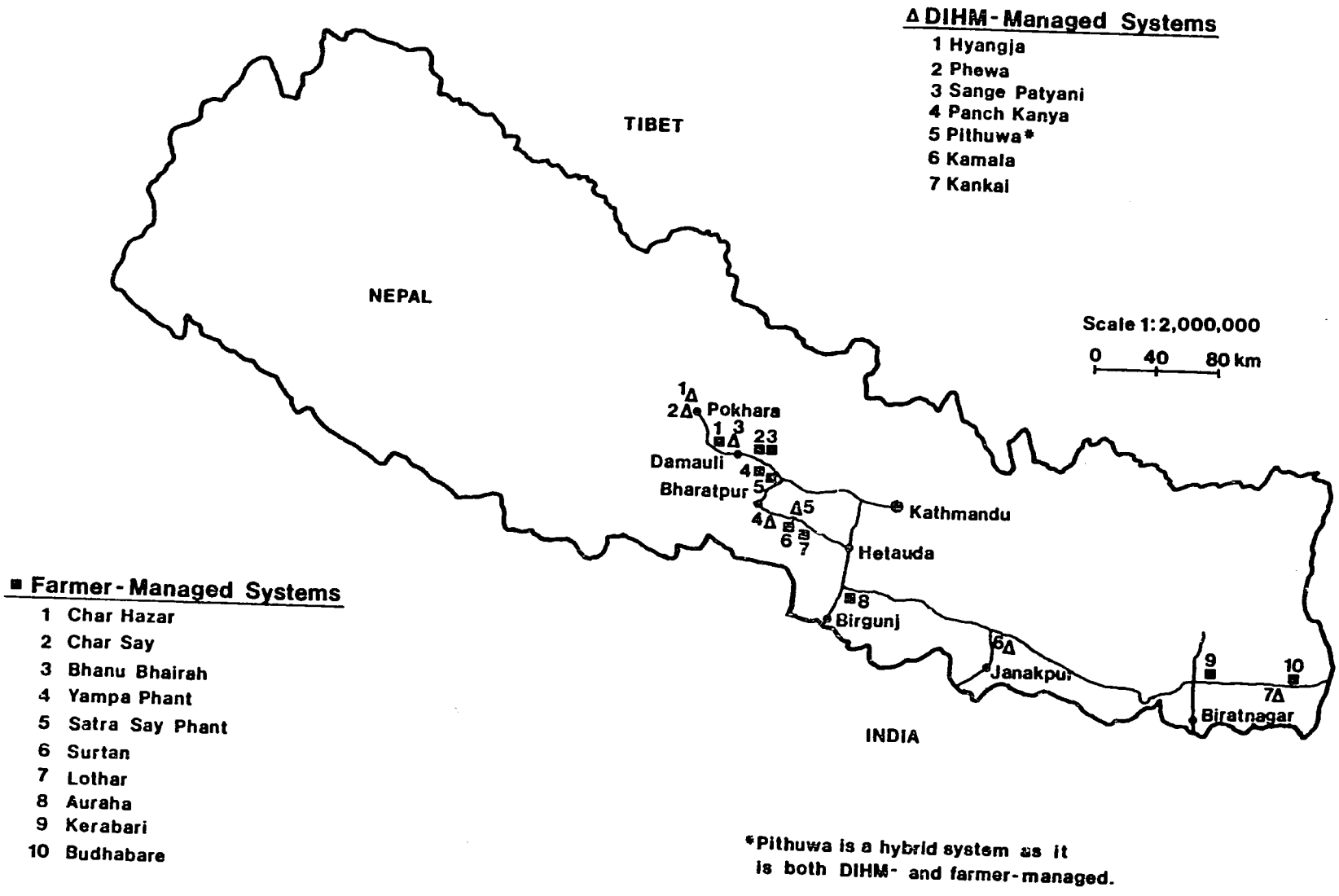

Figure 1. Farmer- and DIHM-Managed Irrigation Systems Appraised in Nepal

II. DIHM-MANAGED HILL SYSTEMS

1. PHEWA IRRIGATION PROJECT

A. INTRODUCTION

The Phewa Irrigation Project is a DIHM-managed system located in Pokhara in the Kaski District. The command area is about 320 ha: 298 ha on the left bank of the Phewa River and 22 ha on the right bank (Figure 2). The water tax records prepared to collect revenue show a total net irrigated area of 255 ha out of a potential 285 ha. The remaining 35 ha of the commmand area are upland and irrigation is not currently provided there.

Two of the most important characteristics of Phewa are that it must supply water to a nearby electrical power generating station, and the Phewa soils are such that massive quantities of water must be applied to the fields. First, the Phewa system is a multipurpose project, supplying water for both irrigation and power generation. The project can generate 1,000 kw of power using four 250 kw turbines. At times, water that might be used for irrigation must be diverted to generate electricity. Second, coarse, shallow soils contribute to a very high percolation rate at Phewa. This means that farmers must apply very large volumes of water to their paddy crop.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The Phewa Irrigation Project receives its water from the Phewa River. A dam impounds the water in Phewa Lake, the water supply for both irrigation and electricity generation. As described in Volume IV of the Nippon Koei Co. Ltd. report on the Phewa dam re-construction project, the monthly average stream flow of the Phewa River and the available water flow after regulation of the reservoir is as follows. Note that the available water is greatly reduced during the dry season months of December to May.

Since the Phewa Irrigation Project is multipurpose, water must be supplied for power as well as for irrigation. The water flow rate required to generate 1000 kw is about 2.0 m^3/sec. Currently, however, only about 750 kw of power are generated, and only at certain times of the day and year to meet the peak demand. Hence, the water flow required for power seems to be about 1.5 m^3/sec to 2.0 m^3/sec. Therefore, with the current operating water level of the reservoir and the continuous power generation requirement, it may be difficult to supply water for irrigation from December to May.

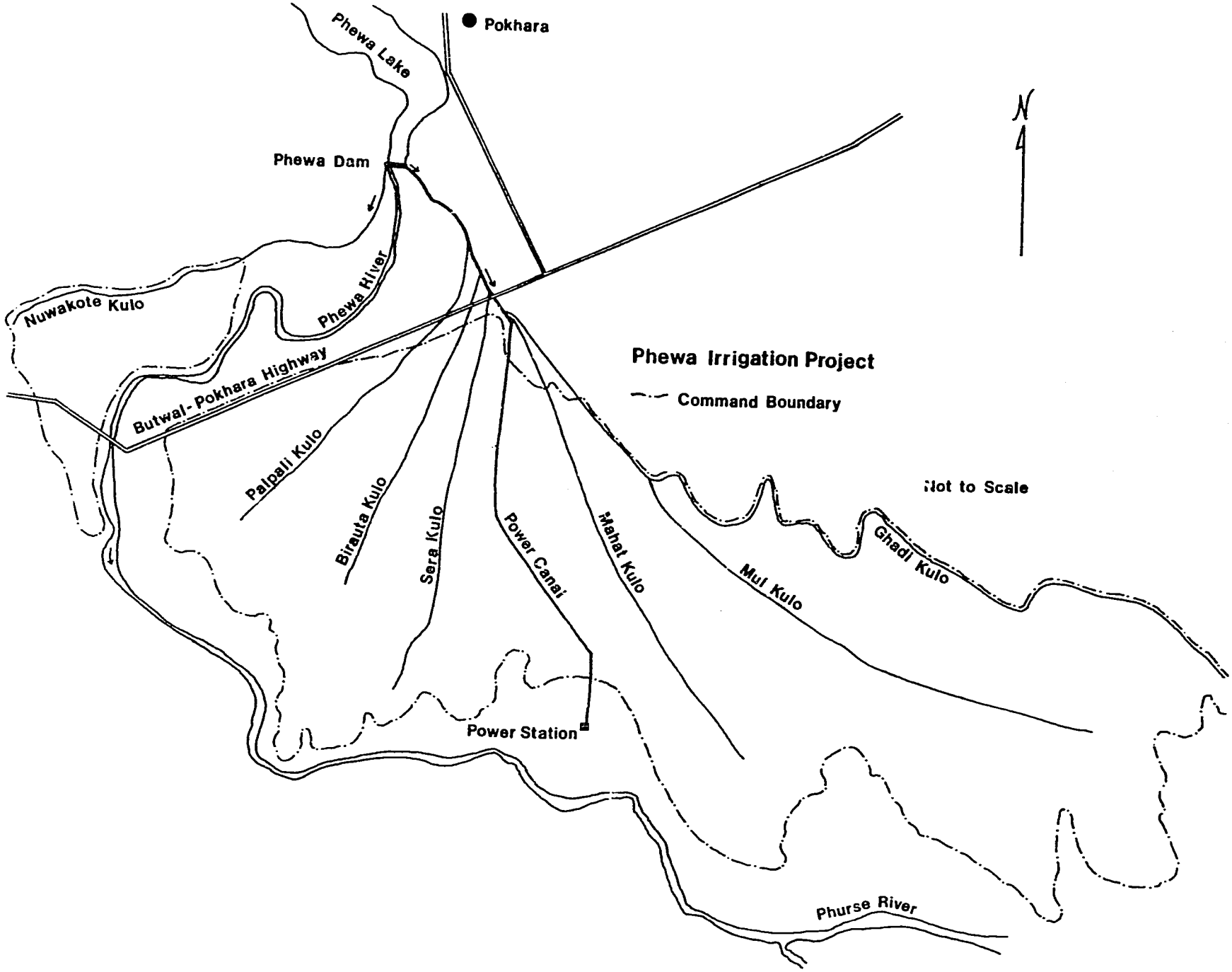

Figure 2. Phewa Irrigation Project

Average Flow Rates Before and After Reservoir Regulation

Month	Available water in Phewa River (m^3/sec)	Available water after reservoir regulation (m^3/sec)
January	1.43	2.09
February	1.23	2.04
March	1.04	1.97
April	1.03	1.92
May	1.43	1.93
June	11.00	8.62
July	26.10	25.86
August	34.00	33.72
September	19.40	16.59
October	8.80	8.61
November	3.09	2.09
December	1.88	2.09

The dam breached in 1975, and a new concrete dam was constructed and completed in 1982. The dam has been designed and constructed to increase the full reservoir level by 1.0 m, which would increase the net effective storage capacity from 7.6 million m^3 to 13.3 million m^3. The maximum water level of the reservoir is 794.7 m, but the water level in the reservoir has not reached that height. The maximum operating water level in the reservoir is about 793.7 m. By increasing the full reservoir level by 1.0 m to its designed value of 794.7 m, about 250 ha of land would be submerged on the upper side of the lake. The owners of that land have not yet received compensation.

DIHM officials at the Western Regional Directorate in Pokhara said that distribution of the reservoir water can be adjusted according to the cropping pattern and the power demand, and that about 1.0 m^3/sec of water can be added to Phewa Lake from the Seti River. If that is true, there may not be water supply problems for the winter crop.

The main canal of the Phewa irrigation system is about 650 m long. The flow capacity of the main canal during low water levels in the reservoir is about 2.8 m^3/sec. During the rapid appraisal, the amount of water in the system was greater than normal, partly due to the closure of the Pokhara power station. The flow in the main canal was estimated to be 2.5 to 2.8 m^3/sec, far in excess of the water required for the maturation or ripening stages of paddy growth.

2. Canals

All of the main canal is lined with stone masonry. For about 200 m, the canal lies in a deep cut about 4.5 m high, in which minor landslides sometimes occur. There are seven branch canals off the main canal including the canal that supplies water for power generation. The following table briefly describes the branch canals.

The flow observed at Palpali, Sera, Mahat, Mul and Ghadi Kulos was rushing at velocities greater than 1 m/s. Although water may not be flowing this rapidly all the time, at these velocities scouring could become a problem with the unlined channel sections eroding with time. Currently, the branch canals and their structures appear to function effectively. We did observe, however, a large amount of seepage from lined and unlined canals.

3. Structures

There are regulator structures in all branch canals except for Nuwakot and Birauta Kulos. All of the locking arrangements on the spindle gate regulators are functioning well. Nuwakot Kulo and Birauta Kulo have hume pipe outlets without regulators.

The outlets from the branch canals to the field channels are in poor condition. There is no control at these outlets. Every year farmers make bigger and bigger holes in the canals, even in the lined sections, to get more water to their fields. This allows an uncontrolled amount of water to flow from the canals to the field.

4. Soils

The soil at Phewa Irrigation Project is mostly sandy loam to silty loam. The average depth of the top soil is about 5"-6". The subsoil is composed of granite and boulders, resulting in very high percolation, perhaps more than 50 mm/day. Farmers recognize the problem that coarse, shallow soils cause for excessive water use in the system. Excessive percolation is a major problem in the operation of the system.

The DIHM reported water duty for late paddy is 9 to 11 lps/ha (10 lps/ha average value), which represents 9 cm/day. Over an assumed 120-day paddy growing season, 1 ha would accumulate more than 10 m of water. Given that paddy consumptive use alone would not exceed 0.5 cm/day (or 60 cm over the 120-day season) great volumes of water are being wasted through seepage and percolation in the field, or as runoff out of the system.

The soil fertility is gradually decreasing due to flood alluvial deposits, the lack of manuring practices, and the loss of fertilizer due to the high rates of percolation.

Branch Canals in Phewa Irrigation System

Name of Branch Canal (Kulo)	Approx. Length (km)	Approx. Area to be Irrigated (ha)	Approx. Capacity (m^3/sec)	Chainage of Bifurcation from main canal (m)	Regulative Structure	Remarks
Nuwakote	1.0	22	0.30	(intake from reservoir)	Hume pipe outlet (250 and 300 mm without regulator)	Not lined
Palpali	1.0	30	0.04	250	Spindle gate	Lined up to 1 km
Birauta	0.70	17	0.10	310	Hume pipe (300 mm)	Not lined
Sera	1.50	50	0.50	620	Spindle gate	Not lined
Power	-	-	2.0	-	-	-
Mahat	3.0	61	0.50	650	Spindle gate	Partially lined
Mul	3.0	96	1.0	850	Temporary wooden plank	Partially lined
Ghadi	1.50	44	0.40	850	Temporary wooden plank	Partially lined

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

Landholdings are distributed fairly equitably at the Phewa Irrigation Project. The largest landowner possesses approximately 2.5 ha, though some of that land has been fragmented into smaller plots for family members. The average landholding per family is about 1.0 ha, with the smallest area held being one ropani (0.05 ha). There are only a few tenant farmers in the area, and many castes farm in the system. About 300 households are in the command area.

A significant characteristic of the Phewa irrigation system is the absence of established villages in the command area. Only the village of Mahat Gauda at the tail of the system is inhabited by full-time resident farmers. At least three-quarters of the land at Phewa is owned by farmers living in Pokhara. These farmers commute to their fields by bus when necessary. In addition to farming, these absentee farmers have pursued other employment opportunities in Pokhara.

2. Irrigation Organization

Phewa irrigation system was one of the old farmer-managed systems. At that time, farmers constructed a brush dam to direct water into canals to irrigate land through Nuwakote, Palpali, Birauta, Sera, Mul and Ghadi canals.

Until 1956 a chitaidar or ditha was appointed by the District Land Revenue Office to look after the irrigation system. The function of the chitaidar or ditha was to mobilize laborers from the landholders within the irrigation command area, who were to contribute one person from each household. He received renumeration from the Land Revenue Office. He was assisted by a katwal who would get renumeration in kind from the landholders within the area after paddy harvest.

After the construction of a permanent dam at Phewa, the Phewa irrigation system was brought under the supervision and control of the Irrigation Department. Gradually, the farmers' identification with the system decreased. Maintenance and operation was taken care of by the Irrigation Department. After the dam break in 1975, the farmers left their land barren until irrigation water was made available in 1982. Rainfall alone was not enough for paddy cultivation considering the high percolation rate in the soil.

After the construction of the new dam, an eleven-member irrigation cooperation committee was formed in 1982-83, but did not

last long. Currently, there is no formal or informal farmers' irrigation management committee.

The Agriculture Department has tried some organizational activities at Phewa. Last year an intensive production program in 35 ha was launched under the block system by organizing farmers into groups. Input, credit and technical services were also arranged. This year the area may be extended to 100 ha, provided timely water delivery is assured.

Under the block approach, 150 farmers in six groups were organized. Each group had a separate committee. Each group usually met before the cropping season and consulted with a technical group under the Agricultural Development Officer to determine the area, crop, varieties, and input deliveries.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

DIHM officials in charge of the Phewa system stated that the system runs continuously when sufficient water is available in the reservoir. When the water supply is insufficient, the officials attempt to distribute the water on rotation among the branch canals. DIHM dhalpas, who are also farmers, are supposed to open and close the gates on the branch canals on the request of the DIHM engineer.

Farmers reported that dhalpas control the main canal gates and distribute water to the head reaches of branch canals. Dhalpa influence was reported to end at that point. Their official presence along the branch canals was reported to be rare. The dhalpas appear to mainly communicate information between the farmers and DIHM and have little to do with system operation.

DIHM officials stated that at night, DIHM has little to no control of the water. These same officials reported that the tail portion of the system does not receive its fair share of water. They also stated that it would be feasible to supply additional water to the farmers for a winter wheat crop.

When there is adequate water in the canals, the farmers do not organize to distribute water. When there is a water shortage, the farmers organize themselves for two reasons: a) to demand more water in the system from DIHM officials (this type of organization is temporary); and b) to work out the schedule for water rotation.

The usual irrigation practice for the main paddy crop is to apply water continuously to the fields. Some farmers expressed the belief that paddy plants must live in running water. However, unless

water quality or some unforeseen soil quality problem is present, paddy cultivation does not require constant water flow through a field.

Many farmers prefer the running water (less labor intensive) to managing the water in the fields (more labor intensive). If farmers have other occupations that pay more than farming, then the decision to substitute excess water for labor may be economically justifiable to the farmers.

In numerous locations along the branch channels farmers had broken the pucca rock masonry and opened large holes in the channel. Thus, water discharges may have no relation to the area served or the need for water. The damage, along with the lack of turnouts and gates on the channels, indicates that the Phewa irrigation system lacks water control procedures and structures.

At numerous branch channel locations (Palpali, Sera, and Mahat kulos), water was observed falling into the Phewa and Phurse Rivers. The flow of this water was estimated to vary from 50 to 500 l/s. This waste occurs despite numerous tail farmers along Mul kulo who no longer are served by the system.

In one location commanded by Ghadi branch channel, water was observed overflowing the field bund at a rate exceeding 50 l/s into a sinkhole in the limestone. This sink hole has no surface outlet.

2. Maintenance

DIHM officials claimed that maintenance along the main system is performed between January and June. Phewa does not have a separate maintenance budget. Rather, the Western Regional Directorate of DIHM receives a lump sum for all their irrigation projects, and a certain portion of that is given to Phewa for maintenance.

Main canal maintenance is the responsibility of the District Irrigation Unit and is undertaken with a contractor. Farmers report that main and branch canal maintenance is done by the dhalpas. The farmers do not participate in main system maintenance, and there has been no attempt to establish farmer participation in maintenance activities.

The farmers maintain only the farm channels. Farmers report that the farmers who share a field channel organize for group maintenance once a year before the late paddy cropping season. Some farmers with farm channels across their own land report maintaining these individually once a year, before the late paddy water deliveries.

3. Conflict Management

Most of the farmers feel that there is an insufficient supply of water in the irrigation canals. As a result, conflicts have occurred between all farmers in the system and DIHM; and between head farmers and tail farmers. Virtually all farmers contacted complained of DIHM's inattention to their wants and needs.

The farmers sometimes file petitions to the Regional Directorate of Irrigation and sometimes even to the King. They frequently make presentations to the Gandaki Zonal Commissioner. There are also confrontations with the Chief District Officer. In the past, police have been used to control the farmers, and a few farmers have been arrested. This has led to a lack of farmer confidence in system management. The conflict between DIHM and farmers is prominent in the system.

Farmers at the tail often said that head farmers took too much water, leaving little water for the tail fields. Conflict was reported to commonly occur at the bifurcation points along the field channel where farmers alternate checking water for their farms at the expense of others irrigating at the same time.

It was reported that the intensity of conflict among farmers rarely exceeded quarreling and that water allocation conflicts were usually mutually resolved. Conflicts are generally settled in favor of the person still at the bifurcation point when the other person leaves the scene. Each farmer, however, has to watch his farm outlet and guard it regularly.

4. Water Adequacy, Reliability and Equity

Most farmers contacted, particularly at the tail village of Mahat Gauda, complained of the small size of the DIHM main canal. The farmers claimed that their old, farmer-built canal was much larger and could carry more water. They identified lack of an assured water supply as a large problem; and said that too much water is released into the river and not enough water is flowing in the "undersized" DIHM main canals.

Farmers generally reported insufficient water supply as the reason why early paddy was not cropped. Two tail farmers reported growing maize in the early paddy (spring) season. Farmers also generally reported inadequate water supply for the late paddy (summer) season. Farmers upstream from the power generator reported some wheat cultivation in the winter season. Some reports indicated that wheat received 2 to 3 irrigations in 10 to 12-day intervals.

Farmers plant paddy seedbeds 15 days prior to the expected date of water release. They reported no advance notice of water

releases, but usually they have been able to rely on water release in mid-June.

Farmers control water distribution along the branch channels, and they report the necessity of remaining at bifucation points along the field channels to keep water flowing to their fields. At night, water stealing appears to be prevalent.

The farmers at the tail of the Mul branch channel claim that land that was once irrigated by the old farmer-managed system does not receive water now. They feel they have been disenfranchised by the new system.

Other farmers stated that there has been unjust water allocation. They said that politically influential people receive water regularly because the canal was deliberately designed to benefit some influential farmers. They said the design has created inequality in water distribution.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

The Phewa area has been brought under the Department of Agriculture's intensive agricultural program, and the activities of FRIP (Fertilizer Response Integrated Project) are concentrated in the command area.

Monocropping is generally practiced, resulting in low cropping intensities. Paddy is the main season crop. In the tail village of Mahat Gauda the pattern of maize and paddy is followed. Since the last winter season, some farmers have started growing wheat and mustard. Very few farmers have adopted the pattern of paddy, wheat, maize. A few farmers have started growing early paddy, late paddy and lentils.

Farmers generally give two reasons for not growing more wheat. One, uncontrolled grazing of cattle takes place during the winter season, and two, severe hail storms in the winter could easily destroy an entire wheat crop. Farmers growing wheat, mustard, and lentils usually sow these crops early to use the moisture from the paddy crop and to avoid potential hail damage.

Farmers report that their annual crop calendar for late paddy is determined by the timing of water releases from Phewa Lake. Farmers report that they need to rotate their traditional crop varieties of paddy annually to maintain productivity.

If we assume a gradually increasing water demand from 1 mm per day at seeding to 3 mm per day at maturity, a water release of 1 m^3/sec used at 10 percent efficiency between the head gate of branch canal and the crop root zone should be sufficient to produce winter wheat throughout the area. If we assume a gradually increasing water demand from 1.5 mm per day to 5.0 mm per day, a water release of 1.5 m^3/sec used at 10 percent efficiency between the head gate of the branch canal and the crop root zone should be sufficient to achieve full maize production throughout the area in spring. Therefore, total water supply should not be a constraint to full cropping and intensive production in Phewa irrigation system. The maldistribution of water, the effects of animals grazing out of control during the winter, and the lack of economic incentives might be reasons for the low cropping intensity at Phewa.

2. Production Inputs

Farmers use improved plant varieties in an estimated 30 percent of the paddy crop, 100 percent of the much smaller wheat crop, and 70 percent of the also small maize crop. In paddy, while Masuli variety is commonly grown, varieties CH_{45} and K-39 are slowly increasing in the area. One variety named Kanchan has been introduced to some farmers due to hailstorm damage. RR21 wheat and Khumal yellow and Arun maize are popular improved varieties at Phewa. Paddy seed is usually preserved by the farmers from their own field. They usually are dependent on the Agriculture Inputs Corporation for maize and wheat seed.

Compared to tail farmers, farmers at the head use no manure and very little fertilizer. The average dose recommended is 30 N, 20 P, 10 K. Usually farmers use urea or ammonium sulphate as a top dressing. For wheat, 60 N, 40 P, 10 K is used after draining the water from the field for a short period. Plant protection practices are limited to stem borer and gundhi bug control.

One Phewa agriculture officer and one junior technical assistant are deputed in the command area. General extension methods rather than the training and visit extension system are applied in the area. The usual features are block demonstrations, fertilizer verification trials, fertilizer demonstrations, training farmers, and farmers' tours and field days in the block demonstrations. Although sajha (the cooperative) is ineffective in the command area, inputs and credits are within the reach of the farmers.

3. Yield

The density of the paddy plants and tillering per plant were very satisfactory in areas having continuous water as compared to those areas that receive less or no water. Paddy yield varied from 0.5 to 3.5 mt/ha depending on varieties, fertilizer used, and amount of water received during the growing period.

All farmers contacted reported late paddy production in the monsoon (summer) season. There was a very great variation in farmer reports of paddy, wheat, and maize yields. Farmers at the head of branch channels reported paddy yields of 3.6 to 7.2 mt/ha, while tail farmers reported 1.2 to 4.8 mt/ha. Head of branch farmers reported wheat yields of 1.0 to 1.8 mt/ha. Tail of branch farmers reported 0.4 to 2.4 mt/ha wheat yields. The few farmers reporting maize production in the spring season had yields ranging from 0.3 to 6.0 mt/ha on small plots of land.

The following table shows the official records of average crop yields, according to the District Agricultural Development Office.

There appears to be no problem in marketing the crops. Part of the produce is consumed by the farmers, and the remainder is sold in the Pokhara bazaar.

Average Crop Yields for Phewa Irrigation Project Supervised by Agricultural Extension.

Type	Yield Average Paddy (mt/ha)	Yield Average Maize (mt/ha)	Yield Average Wheat (mt/ha)
Result demonstration in farmer's fields	6.8	3.2	3.5
Improved practices in farmer's field	4.2	2.7	-
Improved variety by farmers	1.5	0.3	-
Local variety and improved practices	2.8	1.8	-
Local variety with no improved practice	0.4	0.9	

Agricultural officials reported that production and productivity at Phewa could be significantly increased by introducing improved varieties along with improved practices, introducing additional crops into the monoculture currently practiced, diversifying the cropping pattern (basing the pattern on paddy with more cash crops such as legumes), better managing irrigation water for paddy crops, providing winter season irrigation at least 2-3 times in the program launched area, and controlling animal grazing.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) Phewa possesses a good canal network, and the structures that do exist are in good condition.

b) Because the irrigation system's water source is Phewa Lake, silt is not a problem, maintenance costs are low, and there is little potential for damage. Also, water can be diverted from the Seti River to Phewa Lake, increasing the lake's capacity.

c) There is much potential for organization building, particularly at the tail of the system. The farmers at the tail village of Mahat Gauda have demonstrated much solidarity in adversity. Improvements in system performance at Phewa would benefit these farmers a great deal.

d) The soils are good for crops other than paddy, particularly vegetables. Cropping intensities can be increased greatly if there is an assured water supply. Some areas of Phewa currently grow 3 crops, and winter cropping is feasible.

e) Agricultural inputs, services and credit are readily available near the command area.

2. Weaknesses

a) The percolation rate in the soils is very high resulting in a high water demand and low fertilizer use.

b) The command area is inside the Pokhara Nager Panchayat and many farmers live in the bazaar and not near their land. Many of these farmers have developed side businesses in Pokhara and may view farming as only a sidelight.

c) Water flows uncontrolled from branch to field channels. DIHM management appears weak, and there is a lack of regulators or control gates throughout the system.

d) The outlets in the system are in very poor condition.

e) Agricultural production level is not up to expectation.

f) No effective farmer organizations are established in the area.

g) There is uncontrolled animal grazing in the winter. This practice has prevented many farmers from growing wheat. Farmers also report potential extensive hail damage in the winter. Agricultural officials confirm the hail danger.

3. Summary and Conclusions

The Phewa irrigation system must share its water with an electrical power-generating station. This could limit the water available for irrigation at times. The soils of the area are very porous and large quantities of water must be applied to the fields. Farmers at the tail of the system would receive great benefits from improved management of the system.

2. HYANGJA IRRIGATION PROJECT

A. INTRODUCTION

Hyangja irrigation system is managed by DIHM, and is still under construction. It is situated in Kaski District about 8.0 km northwest of Pokhara valley (Figure 3). It is accessible in fair weather by a jeep track from Pokhara. Hyangja irrigates Wards 1, 2, 3 and 4 of Hyangja Village Panchayat.

Farmers started digging a canal on their own to irrigate 300 ha in this area 18 years ago. In 1968, Rs. 15,000 were made available to this system, and the farmers cleaned gravel and boulders out of the canal. A 900 m canal was constructed in 1970, when Rs. 25,000 were made available to the system. A semi-permanent dam was constructed at that time to divert water from the Yamdi River to the canal. In 1974, Rs. 300,000 in cash and labor were made available through farmers' voluntary labor contribution and a government grant to extend the length of the canal from 900 m to 1500 m, but water did not flow in the canal. In 1982, DIHM undertook this project as the part of Hill Irrigation Development Program and received financial support from the Asian Development Bank in Manila. The construction of Hyangja irrigation system started in 1982 and is to be completed in June of 1986. Though the distribution system is not completed, the intake structure and the main canal are operating. Water was first released to the system June 15, 1985.

A unique feature of Hyangja is that a farmer-managed canal (Dhowan irrigation system) exists about 200 m upstream of Hyangja's main canal. These canals run parallel to each other. The Dhowan irrigation system has a brush dam on the Yamdi River and commands over 100 ha.

The Dhowan farmer-managed irrigation system overlaps with the command area of Hyangja. The head of Hyangja irrigation system used to be the tail commanded by the farmer-managed system, and this tail section received very little water. Field channels exist in this part of the new system.

According to the project document, the gross command area of Hyangja is about 300 ha, which extends from the left bank of the Yamdi River to the right bank of the Seti River. The people of the area are uncertain of the command boundaries.

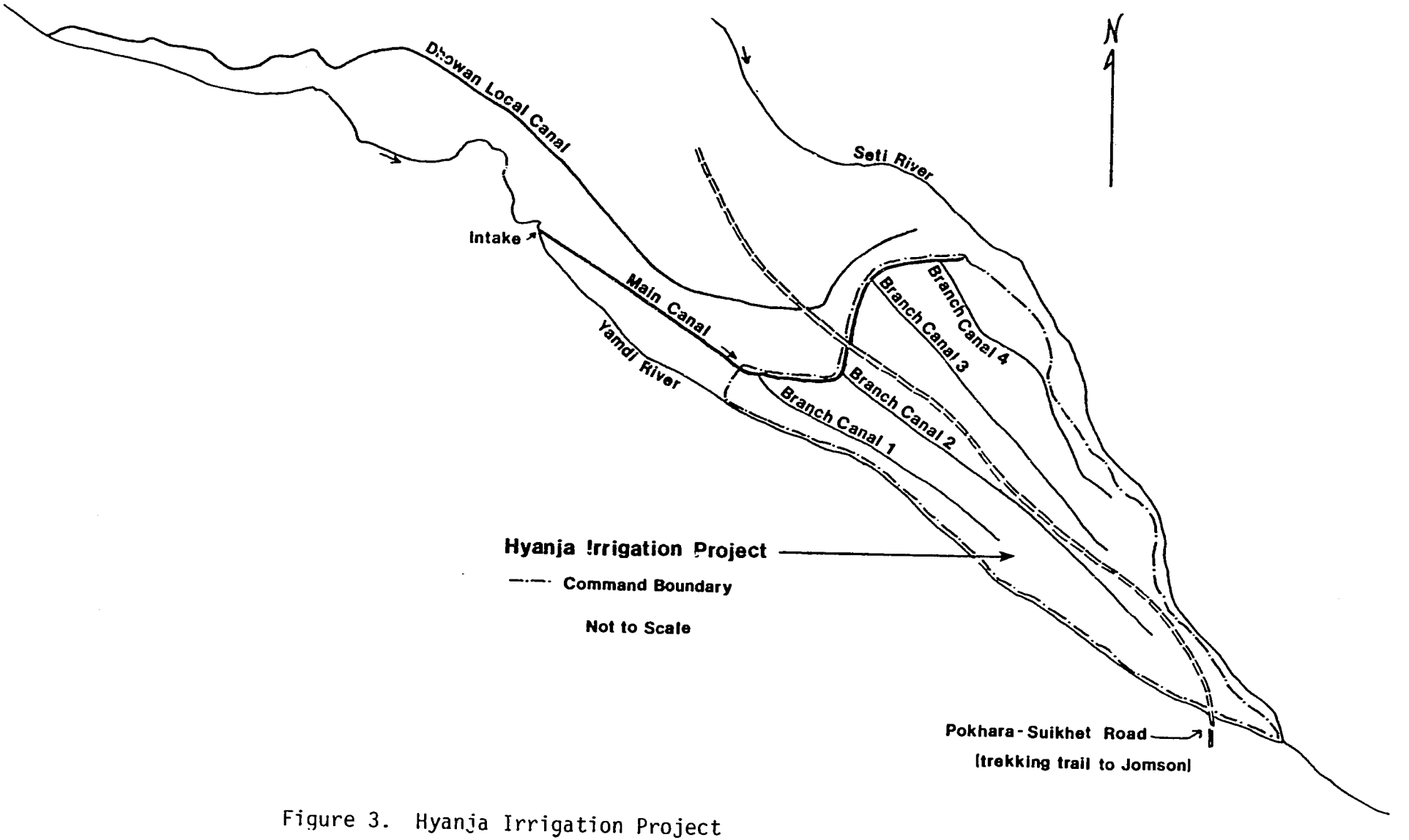

Figure 3. Hyanja Irrigation Project

The command area is divided into three parts: lowlands on the right bank of the Seti River, which lie almost within the floodplain; and terraced fields divided in two by the Pokhara-Suikhet jeep track (which is the proposed Pokhara-Baglung highway). The average slope of the terraced fields is four percent. Each strip of the command area is about 2.50 km long and 440 m wide.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The source of this run-of-the-river system is the Yamdi River, which is perennial. The maximum discharge of the Yamdi River is about 200 cumecs, and the minimum discharge is about 110 l/s. Although perennial, therefore, the water supply drops dramatically in the dry season.

2. Canals and Structures

The intake of the system is a permanent boulder-crated weir diversion structure with a masonry core wall and a concrete undersluice. This structure is 46 m long and 2.40 m high.

The main canal of Hyangja irrigation system is 1.94 km and follows the alignment of the old farmer constructed canal. The canal is completely lined with concrete on the bed and stone masonry on the sides. The first 23 m of the main canal are open, the next 892 m are covered, and the rest of the canal is open. The size of the main canal varies as shown in the following table.

Main Canal Discharge, Size and Slope at Hyangja Irrigation System

Chainage (km)	Bed Width (m)	Full Supply Depth (m)	Canal Slope (%)	Calculated Discharge (m^3)
0.00 to 1.395	2.00	0.85	1.00	1.598
1.395 to 1.515	2.00	0.85	0.05	1.120
1.515 to 1.635	1.00	0.85	0.20	0.870
1.635 to 1.875	1.10	0.80	0.05	0.464
1.875 to 1.940	0.80	0.80	0.05	0.295

There are four branch canals in Hyangja that will take off from the main canal as shown in the following table.

Branch Canals of Hyangja Irrigation System

Branch Canal	Chainage of Bifurcation (km)	Length (km)	Designated Capacity of Outlets (m^3/s)	Type of Outlets with Regulation (mm)
1	1.025	0.60	0.24	600 hume pipe
2	1.515	2.20	0.48	900 hume pipe
3	1.875	1.80	0.40	Rectangular 900 x 800
4	1.940	1.40	0.295	Rectangular 800 x 800

Currently, there are 10 outlets in the main canal to distribute water to the farmers' field channels. All of these outlets are made of hume pipe without regulators.

The main canal runs in a deep cut (3.104 m). Therefore, the area just to the side of the canal bank cannot be irrigated from the main canal. Nine super passages across the main canal have been constructed to bring water from the Dhowan farmer-managed canal above to these fields.

3. Soils

The soils are fine sandy loam to silt loam along branch canals 1 and 2. Medium-textured loams predominate in branch canals 3 and 4. The soils in Hyangja have inherently high percolation rates which substantially affect the water duty for paddy production. Several locations along branch canal 2 were observed to have soil subsidence. At these locations, subsurface pipe erosion along the major flow path had caused the soil surface to drop 1 to 1.5 m in an area 5 to 10 m^2. Some farmers reported that they are having problems with soil acidity.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

There are basically three socio-economic classes of farmers at Hyangja: large landowners, smaller landholders, and landless farmers who often work as agricultural laborers.

The large landowners are 5 or 6 families who own between 2.5 and 5.0 ha of land. These are Brahmin families, and their landholdings account for about 10 percent of the command area. They usually cultivate only small plots of land themselves, and employ agricultural laborers to farm the rest of their land. Their landholdings are not concentrated in one location, but are scattered throughout the command area.

The smaller landholders account for most of the land and population in Hyangja. These farmers own from 0.1 to 0.5 ha of land. Many castes own these smaller parcels of land, including Brahmins, Chettris, and even some Sarkis.

The landless people are also of many castes -- from Chettris to Sarkis. The landless people often work for the larger landowners as agricultural laborers. Many of the Sarkis have been in the area for generations and have provided agricultural labor for many years. The agricultural laborers are paid approximately Rs. 20/day and are given two meals. Women agricultural laborers are paid at half that rate.

In the 1950s and 60s tenant farming was fairly prevalent at Hyangja. Now, to avoid tenancy laws, many landowners employ agricultural laborers and pay them daily wages.

Currently, there is little sharecropping at Hyangja. We estimated that 95 percent of the farmland is owner-operated with the assistance of agricultural laborers. The little sharecropping that does exist is split 50:50 (half of the agricultural produce to the owner, half to the sharecropper). The sharecropper, however, must physically deliver the owners' share to the owners' house.

The different socio-economic classes of farmers do not appear to cooperate with one another, particularly the higher and lower caste farmers. One lower caste farmer reported that his small plot of land was sandwiched between a Brahmin's land and a Chettri's land. The farmer contended that his neighbors ignored his requests for water.

The power structure at Hyangja is somewhat feudal. A few older, larger farm families possess most of the power. These families

are very active in local affairs and are politically minded. Local DIHM officials reported that these farmers have a great deal of decision-making power regarding irrigation.

Almost all classes of farmers at Hyangja live along or close to the main road bisecting the system. This road is the main trekking route to Jomsom, and many foreigners pass through Hyangja. As a result, a great deal of foot and vehicular traffic pass through this village.

Farmers participated very little in planning and constructing the project. Farmers complain that their requests, ideas, and suggestions are not considered. For instance, farmer participation in selecting the canal alignment and outlets is not being sought by DIHM. Currently, technical considerations are the sole basis for decisions. DIHM officials contended that many of the farmers' suggestions are self-serving and politically motivated, but also said that DIHM/farmer relations are not good and need to be improved.

2. Irrigation Organization

Even though the system was not complete, farmers demanded in 1985 that water be released to the farms. The farmers formed branch canal water management committees to distribute the water after it was released through the gates of the branch canals. Farmers are also pressuring DIHM to finish constructing the branch canals and outlets. Opportunities for participatory planning between the farmers and DIHM to make the system functional exist, but are not being explored.

The farmer-managed Dhowan irrigation system above Hyangja does have an irrigation committee formed by the village panchayat. A katwal mobilizes the farmers for annual repairs and maintenance and also during emergencies. Dhowan's farmer organization does not seem strong. There are no specific regulations and the tradition of maintaining the canals is not taken seriously. Farmers do not contribute labor to system maintenance in proportion to the land irrigated. There is no provision for punishing farmers who do not fulfill their responsibilities.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

As the construction of the Hyangja Irrigation Project is not finished, comprehensive water allocation procedures have not yet been implemented. In 1985, when area farmers asked that DIHM release water into the main canal, each gate along the main canal was opened for 12 hours during the day and was closed for 12 hours during the night.

When Hyangja is complete, DIHM hopes to operate the main and branch canals with continuous flow, if the supply in the river is sufficient. Officials did say, however, that due to the high percolation rate in the command area soils, and due to the water flow in the river, it may be necessary to institute a rotation schedule along the main canal.

Officials would like to convince the farmers that they need not apply as much water to their paddy crops as they have in the past. DIHM anticipates rotating the water releases among the 4 gates every 24 hours with three gates opened and one gate closed. If farmers will use less water and if a rotation schedule can be successfully implemented along the main canal, DIHM expects to command all 300 ha. Without these preconditions, local officials said it may be difficult to irrigate the target command area. Rotation will have to be practiced in the winter season also.

If Hyangja is run with continuous flow, there may not be enough water for branch canals 3 and 4 because the main canal gets smaller after branch canal 2 and there are two small outlets without gates between branch canals 2 and 3.

If DIHM tries to maintain a rotation schedule, different durations of water release may have to be set for branch canals 3 and 4, which could create confusion about system operation among the farmers. Also conflict among farmers may arise over water shares because branch canals 3 and 4 have more potential command area compared to branch canals 1 and 2.

As there are no control or regulating gates planned for the outlets from the branch canals to field channels, DIHM anticipates having continuous flow along the four branch canals. Without gates, a rotation schedule along the branch canals will be difficult.

DIHM will employ four dhalpas for Hyangja. They will be from the local area, and each one will be responsible for a branch canal.

When DIHM released water into the system in 1985, water was distributed by dhalpas from the head to the tail of the system. The farmers received water from the main canal into the field channels that existed prior to the start of Hyangja Irrigation Project, where it was also distributed head to tail. The Hyangja farmer branch canal committees played a small role in water distribution.

2. Maintenance

As the system is not yet completed and has been only partially operated for one season, no extensive maintenance has been implemented. After the system is complete, DIHM will be responsible for all maintenance on the main and branch canals. So far, DIHM has made no plans to obtain farmer participation in main and branch canal maintenance.

Farm channel maintenance is considered the responsibility of the individual farmers and is to be done at least once per year. Field channel maintenance is a collective activity for all farmers whose land is served by the field channel, and is to be done once in a year. Group maintenance could be initiated by any person on the channel. No sanctions exist for non-participation.

3. Conflict Management

Head farmers at Hyangja reported no conflict in water distribution. Two tail farmers, however, reported that they had observed a conflict which was resolved by powerful men who discussed the problem with the conflicting parties.

Local DIHM officials reported that there have been many disputes between farmers and DIHM during project construction. The same officials said that they anticipate disputes with the farmers over placing the four branch canals. DIHM has already been accused of taking only the smaller farmers' land out of production for canal construction.

Detailed operational planning is not available in the project office and farmers' participation is not being sought. Mutual distrust between DIHM and the farmers could be a problem in Hyangja into the future.

4. Water Adequacy, Reliability, and Equity

Until branch canals are constructed, water cannot reach the middle and tail of the Hyangja command area. The water released in the canal has helped the head farmers (who are the tail farmers of the Dhowan irrigation system). According to farmers, the summer releases in 1985 irrigated only one-fourth of the Hyangja command area, whereas the project personnel estimated that the water released was enough to irrigate three-fourths of the command area. The head farmers are happy about the new system, but others feel the main canal is too small to make water available to all of the targeted command area.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Currently, farmers in the command area predominantly practice traditional subsistance agriculture. Usually, monocropping of late paddy dominates most of the command area. With irrigation, land preparation is done mostly by draft animals with some manual labor. Paddy seed bed is prepared in the pulverised soil rather than in wet seed beds due to the unavailability of water during this period. Wheat and other crops are generally broadcast and depend on rain for water. Farmers adhere to traditional farm practices.

The main crop grown in the area is paddy followed by wheat, small millet, corn and mustard. Potatos are grown year around exclusively in nearby Chapaghat Panchayat where farmers use better cultivation practices.

The recently harvested paddy crop that the rapid appraisal team observed appeared to be poor when judged by counting the number of tillers.

The usual cropping patterns adopted by farmers are as follows:

a) Late paddy - rainfed wheat - rainfed maize

b) Late paddy - rainfed wheat

c) Late paddy - potatos

d) Late paddy - mustard - wheat

e) Millet - mustard - maize

Most farmers reported that they used a traditional calendar to determine cropping pattern and dates.

2. Production Inputs

Farmers maintain their own local seed. The use of improved varieties for crops except for wheat and maize, is practically nil. Even for wheat, the farmers' usual practice is to replace seed after 4-5 years. Seed usage is high as farmers usually broadcast seed, except for paddy.

Fertilizer use is extremely low, and fertilizers are used by those farmers who grow more than one crop and do not leave land fallow. No pesticides are used. Agricultural extension services

appear extremely poor as farmers still practice traditional methods of cultivation. Farmors appear to be aware of improved varieties and times for sowing wheat and maize, but they have not adopted them. No farmer's training or production programs have been launched so far. Also, farmers use very little or no credit to purchase material from the agricultural cooperative.

3. Yield

The yield of paddy varies from 1.0 to 2.0 mt/ha, which is low compared to the Dhowan farmer-managed irrigation system. Early maturing local varieties like Tauli, Katha Marsi and Jadam Kargi yield less than late maturing varieties like Gorkhali and Bizim Phool. The maximum yield was reported to be about 2.5 mt/ha.

Wheat yield is extremely variable -- 0.05 to 1.0 mt/ha -- as wheat depends on rainwater and less interculturing due to the broadcast sowing. The average yield for wheat was reported to be 0.75 mt/ha.

Farmers grow an improved variety of maize called Khumal yellow, which yields about 1.5 mt/ha. Even though cropping intensity appears high, the total yearly crop yield does not exceed more than 3.0 mt/ha. Cropping intensity varies from 150 percent at the head to 120 percent at the tail of the system. Farmers reported no problems with pricing and marketing.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) The system is new and, managed properly, has a great deal of potential for improving irrigated agriculture in the area. Currently, there is little improved agricultural technology in the area. Intensified agriculture is possible.

b) If managed properly, the system can expand the present irrigated area of the old farmer system and provide assured water to the tail farmers. Many tail farmers currently receive no irrigation.

c) The area possesses good soil for diversified cropping, primarily rabi crops and vegetables.

d) The main canal is pucca and the construction quality appears to be good.

e) The slope of the land is suitable for irrigated agriculture.

2. Weaknesses

a) There is little effective DIHM and farmer interaction. Future system operation plans have no farmer involvement component, and communication between farmers and irrigation officials seems to be absent. There is little organized farmer participation in construction decision-making. The social aspects of irrigation have been neglected at Hyangja.

b) The system design may be faulty. The system does not appear able to provide water to the entire command area. The capacity of the main canal at the tail (serving branch canals 3 and 4) has too little discharge with respect to the command area.

c) The soils in the area are not conducive to good system management for paddy, as farmers will have to apply much water to grow the paddy crop. Additionally, if water in the main canal ever flows over the top of the pucca structure, it could easily wash away the loose canal banks.

d) Considering the command area and soils, the water duty provided by DIHM may be inaccurate and too low.

e) Only traditional, rainfed agriculture exists in much of the system now, which inhibits the adoption of new agricultural technologies.

3. Summary and Conclusions

Hyangja irrigation system has a permanent intake structure, and the main canal has been lined completely. The system has not yet started to function properly, as the operators are still learning. The water source for Hyangja seems to be a major problem, since only 110 l/s flow in the Yamdi River during dry season. How much area can be irrigated in the winter is yet to be ascertained. It seems that the capacity of the main canal from chainage 1.395 km to the tail may be too small to meet the requirements of branch canals 3 and 4, but discharge can be increased by increasing freeboard.

Hyangja possesses an almost feudal power structure with a few large landowners holding a great deal of power. Smaller farmers and agricultural laborers seem to depend on the larger farmers' decisions. These larger landowners are very active in local affairs and in irrigation activities.

All classes of farmers, however, complain that DIHM planners o not listen to farmers' suggestions. DIHM officials said that these uggestions are often politically motivated. Many farmers in the roposed command area are entirely ignorant of the plans for the yangja project.

There is a weak, indigeneous farmer irrigation organization in ıe area, and the Hyangja project will overlay much of its command rea. Most farmers appear to welcome the addition of a new irrigation ystem.

The current pattern of agricultural practices and production ›pears to directly reflect the unavailability of irrigation water for ırly paddy and winter crops. Since availability of irrigation water ›termines not only the type of crops to be grown, but also the crop-ng intensity per unit of area and the yield, Hyangja Irrigation ·oject's success depends largely on making irrigation water available › the command area during all three cropping seasons.

3. SANGE PATYANI IRRIGATION SYSTEM

A. INTRODUCTION

The Sange Patyani irrigation system is situated in Wards 6 and 8 of Damauli Village Panchayat of Tanahu District, about 65 km east of Pokhara along the Kathmandu-Pokhara highway. The intake for the system is about 10.5 km from Damauli headquarters, and the tail of the command area is about 1 km from Damauli. There is no motorable road to the project site. A foot trail from the Kathmandu-Pokhara highway leads to the command area in a one and a half hour walk (Figure 4).

Sange Patyani is a DIHM-operated irrigation system. It was constructed in 1965. Water was first released in 1966 before any permanent structures were built. Most of the structures were completed in 1970, and then the system started functioning more efficiently. From the intake to approximately halfway down the system, improvements were made on the canal supplying a farmer-managed irrigation system. From there to Patayani village at the tail of Sange Patyani irrigation system, a new canal was constructed.

The gross command area of the system is 208 ha, which lies in a long, narrow strip that is about 8 km east to west. In width, the command area varies from 40 m at the head to about 750 m at the tail. In most places, the width of the command area is about 200 m. Sange Patyani is divided into 13 tars (small plateaus) by natural drains flowing from north to south. These 13 tars include Nepal Tar, Panitguna, Sora Tar, Thulo Tar, and Patyani Tar. More than 50 percent of the command area lies in Thulo Tar and Patyani Tar at the tail end of the system.

The majority of land in Sange Patyani irrigation system lies in high, man-made terraces situated below the main canal. Nearly 20 small kholas drain small catchments above the main canal. The slope ranges from less than 1 percent to more than 20 percent in several isolated, small blocks of land close to the margin of the system near the farmer-managed Char Hazar system. Char Hazar Kulo starts approximately 1.5 km downstream from the DIHM headworks and follows a contour 10-40 m below the DIHM canal.

There is a large amount of leakage in the main canal: about 50 percent at the head end and about 20 percent at the tail end. Farmers at the nearby farmer-managed Char Hazar irrigation system use this leakage water for their irrigation. Since the canal is not lined and the canal gradient is low, most of the leakage takes place through the earthen canal. There is also a large amount of leakage from almost all structures through its connection with the earthen canal. Silt deposited in the main canal has never been completely removed within the last 20 years.

Even though the canal runs along the foot of the hills, landslides are not a problem because the hill slopes along most of the canal are mild. In some portions the canal banks are weak and canal breaching is frequent. Farmers attribute some canal bank problems to burrowing crabs. The total length of weak canal banks through the alignment is about 400 to 500 m.

3. Structures

The diversion structure is a rock-fill weir that is 31.0 m long with an undersluice of 1.8 m and an intake regulator. It is constructed of boulder masonry with a manually operated, spindle steel gate.

Altogether, there are 12 aqueducts, 10 super passages (structures that carry water over a canal), 9 footbridges, and a locally constructed tunnel of irregular shape and size about 40 m long along the main canal. The materials used in most of the above structures are boulder masonry and reinforced concrete. One aqueduct is made of brick masonry and one super passage is made of wood. There are all together 5 escape structures with manually operated spindle steel gates.

There are 50 outlets in the main canal to feed the field channels. All of these outlets are made of hume pipe (100 mm to 150 mm in diameter) without any regulating structures. The size of the outlets is not based on the land area to be cultivated. There are no measuring structures anywhere in the system. All the structures, including the intake, are performing well except for the spindle gate regulator. The diameter of the spindle rod was too small, and the spindle rod has already deformed. The hume pipe outlets are also functioning well.

4. Soils

The soils observed in the upper terraces are a medium-textured, brown to reddish material derived from residual upland parent soils. These soils are not inherently productive. Farmers at the head of the system reported that soil fertility is declining and

It was found that for paddy and wheat the water available in the river is sufficient, but for early paddy, the water available in the river is not sufficient for the whole Sange Patyani area.

Sange Patyani is characterized by an important physical feature and an important socio-economic feature. Physically, the system is hydrologically linked to the nearby Char Hazar farmer system, as Char Hazar farmers have become dependent upon leakage water from the Sange Patyani system. Any changes or improvements in Sange Patyani, therefore, will directly affect Char Hazar. Socio-economically, most of the farm land at Sange Patyani is owned by absentee landlords. Major benefits from improved irrigation management procedures may be skewed to people not living directly on the land.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The source of water for the Sange Patyani Irrigation System is the Sange Khola, which is a tributary of the Madi River. Since no gauging station exists on the river, monthly river flow is not available. It was found that the minimum discharge is 200 to 250 l/s in May and the maximum discharge is about 100 cumecs in July.

2. Canals

The main canal runs parallel to the command area along the foothills from northwest to southeast. The main canal is 8.4 km long, with a designed discharge of 1275 l/s. The following table shows how capacity varies along the main canal.

Variations in Capacity Along Sange Patyani Main Canal

Chainage (km)	Full Supply Capacity (l/s)	Bed Width (m)	Water Depth (m)	Grade
0 to 2.0	1275	2.3	0.75	1/1000
2.0 to 3.0	800	1.8	0.90	1/3000
3.0 to 6.5	600	1.5	0.75	1/3000
6.5 to 8.4	330	1.2	0.60	1/2000

There are no branch canals. Water is distributed to field channels directly from the main canal.

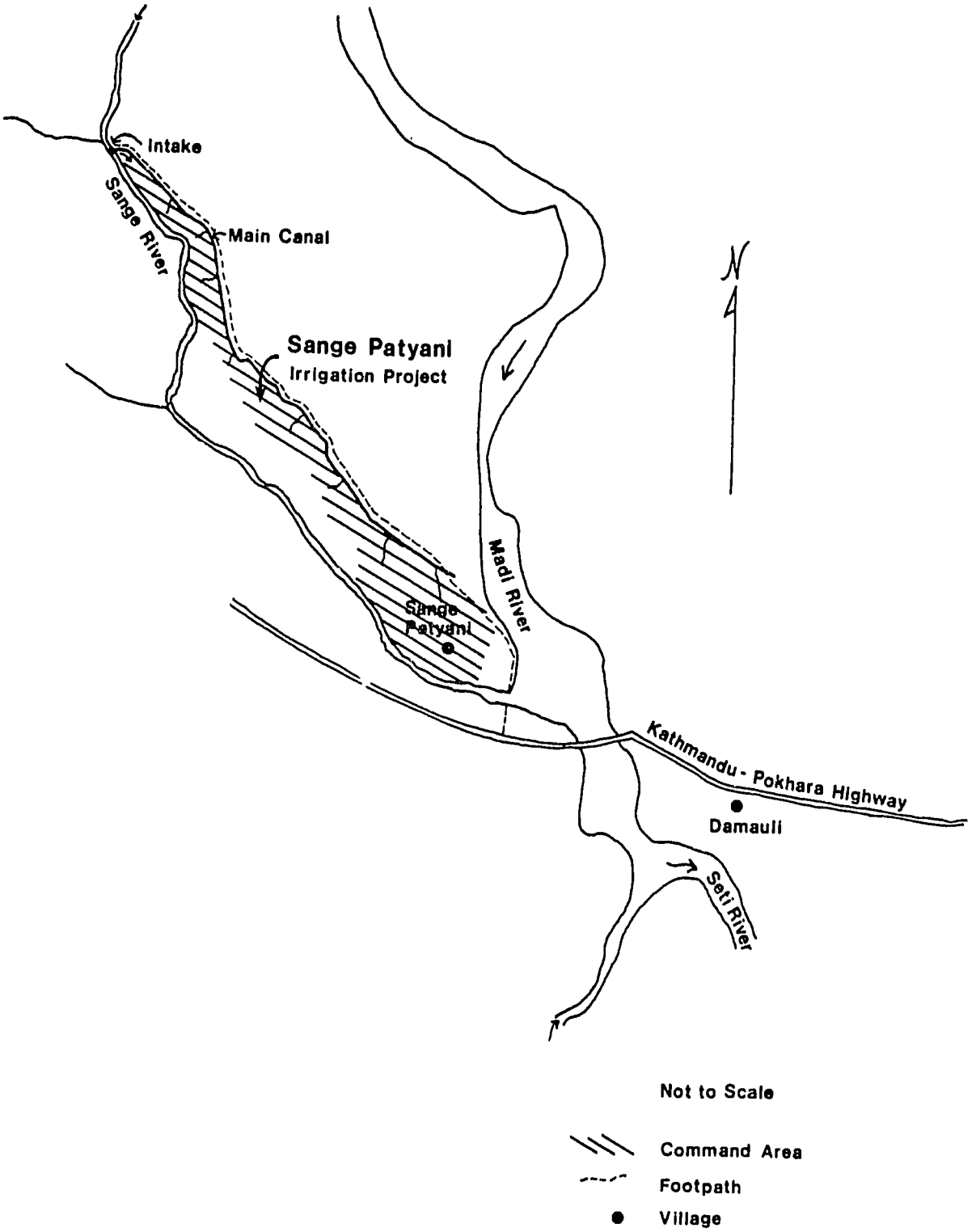

Figure 4. Sange Patyani Irrigation Project

is becoming a major problem. Farmers said that prior to the DIHM system's operation, silt replenished the fields annually.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

Brahmin, Kumale, and Darai castes are predominant in the Sange Patyani area. Brahmins appear to own most of the land. In the tail reach of the command area, the majority of the households are Darai and Kumale. In the head reach, Kumale and Brahmin are the majority. These different groups are separate and there are no inter-marriages among these groups. However, they have a labor exchange system for cultivation activities.

There seem to be four classes of farmers: (1) absentee landlords who own large amounts of land and rent land out to others; (2) owners with large amounts of land who farm some of the land and rent the rest out to others; (3) owners with small amounts of land who farm their own land and also rent land from other farmers; and (4) landless farmers and agricultural laborers. Some of the "landless farmers," however, may own unirrigated farmland outside the command area. Most farmers at Sange Patyani are owners-cum-tenants, and most of the cultivated land is under some form of tenancy or contract farming. About 50 percent of the land is owned by absentee landlords who live outside the command area in nearby villages and towns. As river valleys were considered a poor place to live until malaria was eradicated, most absentee landlords have their houses on the upper ridges of the hills and mountains.

The average landholding at Sange Patyani is about 0.5 to 1.0 ha. A large farm is 3 to 6 ha. The largest landowner contacted reported that his father owned 15 ha, but had divided the land equally into 5-hectare parcels, one for each of his three sons.

The farmers who rent land technically are not tenants, and they are not protected by tenant rights under Nepal's Tenancy Act. The landowners contract with different farmers from year to year and sometimes leave their land fallow to avoid provisions of the Tenancy Act. Due to extensive land fragmentation and laws governing tenants' rights, landlords are beginning to farm more of their own land themselves.

In the past, the usual rental agreement for paddy was a 50:50 crop share, with the contract farmer supplying all the inputs. Currently, the contract farmer still supplies all the inputs, but the owner receives 3 units of paddy to the contract farmer's 2 units. Where it is difficult to get water and the land is rented from relatives, the 50:50 crop share is still practiced. The arrangement for early paddy is also 50:50.

Fertilizer and seed are sometimes difficult to obtain for winter wheat, making the 3:2 crop sharing disadvantageous to the contract farmers. Overall costs of cultivation are high and leave little financial return. Because of the complicated tenancy situation, uncertain water delivery, and the high cost for winter crop production, winter crop cultivation is done only at the head of the system. Few contract farmers grow wheat and larger landowners do not feel the need to grow wheat.

2. Irrigation Organization

In 1983, influential farmers organized a committee that had representatives from the head, middle and tail of the system. According to a committee member, the committee was initiated for the following reasons: (a) to properly utilize the maintenance budget allocated to the system by the government, (b) to set the maintenance priority in consultation with DIHM officials, and (c) to set the water rotation so that the tail of the system also gets water for cultivation.

According to interviews with members of the irrigation committee, Sange Patyani has one main irrigation committee of 22 members which is headed by the pradhan panch of Damauli Panchayat. The pradhan panch is the chairman of the irrigation committee. The present pradhan panch does not have land in Sange Patyani irrigation system.

To have regular meetings and to supervise the system, a sub-committee was also formed under the chairmanship of a member of the main committee. The current chairman of the sub-committee lives at the tail of the system. During times of water stress, the sub-committee is active. This year, water supplies were low, and the sub-committee decided to ration the water supplies. The decision was carried out by DIHM dhalpas.

The status of the irrigation committee is not clear, and the relationship between the committee and the irrigation unit is not well established. Throughout the system, many farmers did not know about the irrigation committee or the sub-committee, or said they were ineffective. Some farmers said that head farmers do not cooperate with the committee or the sub-committee, and that DIHM has never supplied maintenance expenditure figures when requested.

The pradhan panch has verbally expressed commitment to revitalizing the Sange Pityani irrigation committee. He has proposed meeting with other committee members and decentralizing decision-making -- giving that power to turnout groups. The members of the committee said they would like to be informed about maintenance activities and the maintenance budget. The irrigation committee has even petitioned the King requesting that the local DIHM office be required to consult with the farmers' irrigation committee about maintenance.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

Tahanu District is a sub-division of the Western Regional Irrigation Directorate. Tahanu District manages Sange Patyani system along with several other systems.

One supervisor and 9 dhalpas are assigned to Sange Patyani irrigation system. Of the 9 dhalpas, 7 are assigned in the system and 2 are deputed in the subdivisional office at Damauli. In addition to the regular dhalpas, temporary workers are recruited for 3 months during paddy cultivation season.

Works valued under Rs. 1,000 must be bid out and assigned to contractors. Larger contracts have to be approved through the Regional Directorate at Pokhara.

DIHM officials at Sange Patyani stated that their main responsibility was to capture water from the Sange River, deliver and distribute that water along the main canal, and maintain the main canal. The water is primarily used for paddy irrigation, though water is distributed for winter crops, too.

When the water supply is sufficient, the canal runs continuously and all outlets are open. During periods of water shortage, DIHM officials attempt to give water to the top half of the system for 24 hours, and then to the bottom half of the system for 48 hours. During this rotation period, field DIHM officials place rocks and straw in the hume pipe outlets to close portions of the main canal. Officials reported that there is minor tampering with the closings but nothing serious.

Head farmers reported that water was distributed turn by turn in the early paddy season, continuously in late paddy season, and on demand during winter season (for wheat). Priority in water distribution followed the location of the land relative to the turnout, with closer farms having higher priority. Head farmers reported no excessive water use in the system, and said that they exerted great care in their water use. Leakage from the main canal and excessive deep percolation at specific fields were recognized as water use problems by head and tail farmers.

DIHM officials estimated that 75 percent of the Sange Patyani farmers are paying the water charge (Rs. 60/ha) for operation and maintenance. This is an extremely high rate of collection for a DIHM system, and both farmers and DIHM officials said that only one request needs to be made of the farmers to secure payment. Such a high rate

of collection may indicate that farmers are willing to cooperate with DIHM.

In addition, the rapid appraisal team observed that there were few unauthorized outlets along the main canal and that current outlets did not show evidence of tampering. This also may indicate that farmers are cooperating with DIHM officials and are at least partially satisfied with the main system operation.

DIHM officials reported that their biggest problems were the excessive leakage and seepage from the main canal, and the lack of control structures in the system. The lack of measuring devices also makes it difficult for DIHM officials to determine how much water is delivered to different parts of the system.

2. Maintenance

Maintaining the main system is done by a site office headed by an overseer in the district headquarters of Tanahu under the Western Regional Irrigation Directorate. At the end of the monsoon, a maintenance survey is done, and the amount needed for maintenance is forwarded to the director at regional headquarters for approval. On the basis of a survey report, the regional director approves the money for maintenance. Most of the time, the money approved for maintenance is less than the money requested. Hence, the subdivision ranks the maintenance jobs according to their importance.

At Sange Patyani, canal lining to minimize leakage is the most important maintenance task, then canal bank strengthening, and then desilting. A contractor does the maintenance during March and May. Most of the time, the money allocated for maintenance does not reach the project on time, which delays maintenance and leaves less time to do quality work.

Farmers do not participate in the annual maintenance of the main canal. Since they pay their water charges, they are not willing to contribute their labor to irrigation maintenance. Some farmers reported that they have internal farm channels that they maintain themselves, usually once a year just before late paddy season begins.

Field channels shared by a number of farmers were reported to be cleaned at least once a year for one day by the farmers. The field channels were cleaned with greater frequency if the monsoon resulted in flooding and siltation. Any farmer sharing a field channel could initiate the channel maintenance, except at the tail of the system where it is usually a landowner who initiates the maintenance. Sanctions for non-participation were reported to amount to a charge of one day's labor (Rs. 7 to 8 when demand for labor is low and up to Rs. 10 when the demand for labor is high). The sanction was usually

enforced unless the absent farmer was not informed of the planned group activity in advance.

3. Conflict Management

Conflict over water distribution was reported in early paddy season. The conflict usually was a question of priority. Farmers reported that such conflicts were solved among themselves through discussion, usually resulting in a turn-by-turn agreement. Conflict was not reported to occur in the late paddy or winter wheat seasons.

4. Water Adequacy, Reliability and Equity

Farmers reported that water releases in the main canal did not necessarily coincide with the needs of the farmers. The late arrival of DIHM funds for maintenance (in June, at the end of the fiscal year) often means that water releases for paddy cultivation are late.

Farmers at the head of the system who were both owners and operators reported receiving water in all three cropping seasons (early and late paddy and winter), but that in the early paddy season, water was inadequate in quantity and not delivered on time. Other head farmers reported that water was adequate and timely in late paddy season and adequate in winter season where water was available.

Tail farmers report that they usually do not have the right amount of water to cultivate early paddy and winter crops. One farmer at the tail of the system who was a sharecropper on two plots of land could to cultivate only late paddy. Other tail farmers were allowed to crop early paddy and winter wheat where water was received.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

A large number of crops can be grown in the command area including wheat, maize, mustard, lentils, soybeans, potatos and peas. However, due to the availability of water, the tenancy system, and market prices, paddy is the crop grown most extensively.

Cropping patterns and cropping intensity vary greatly in the command area. No one cropping pattern is recommended or practiced in the area. According to the availability of water, a farmer follows one of the following patterns:

a) early paddy-late paddy-wheat

b) paddy-wheat

c) paddy-mustard-wheat

d) paddy-maize

Cropping intensity varies from 100 to 300 percent. We estimated that 25 to 66 percent of the total irrigable area is planted in early paddy, and 25 to 33 percent of the land is planted in wheat. However, the area under 3, or even 2, crops is small.

Farmers reported various methods for determining their cropping calendar. In early paddy season, the cropping time is determined individually. In late paddy season, cropping time is determined by the DIHM date of water release or by the calendar date. For winter wheat, cropping is done at the advice of a junior technical assistant or by the calendar date.

2. Production Inputs

Agricultural extension services are provided by a junior technical assistant stationed at the headquarters in Damauli. The general extension approach and methodology, rather than the Training and Visit Extension system, are used. The service appears to be inadequate, as most of the farmers complained about receiving poor or no services.

Farmers have not received any agricultural training, nor have they been organized to visit programs elsewhere to look at improved agricultural practices. The farmers receive some incentives from result demonstrations, minikit programs (small package of seeds, fertilizer, and pesticides), and seed multiplication activities. Recently, farmers were organized to take part in a paddy production program (about 40 ha) using the block system.

The cooperative appears to be ineffective. Inputs and credits are controlled through Damauli except in the production block system, where a committee provides the needed inputs and credits. Farmers seldom apply for credit because of the nature of the tenancy system in the command area and because of the conditions the small landholder/tenants must fulfill to get the credit.

We observed no improved agricultural practices except the adoption of improved varieties. About 25 percent of the command area is covered with the improved paddy variety, Masuli. More than 90 percent of the area is covered with improved wheat. Maize, mustard, lentils, soybeans, and potatos are of local types. Farmers usually use some of their own paddy, maize, lentil, soybean and pea seeds for cropping. Potatos and wheat seeds are purchased in Damauli, either through extension or through the Agricultural Input Corporation.

Usually no fertilizer is used for paddy. Wheat receives some fertilizer (60:40:20, 60 kg of nitrogen; 40 kg of phosphorus; 20 kg potash). Manure is used to some extent in paddy and corn. Very little pesticide is used. The fertilizer and pesticides that are used are not obtained locally; farmers purchase them in Damauli.

3. Yields

Different yield levels are achieved in the command area. Farmers reported that the average yield variation in local paddy is 1.0 to 1.5 mt/ha, and for Masuli, improved variety, 2.0 to 5.0 mt/ha. Head farmers contacted at Sange Patyani reported late paddy yields of 1.7 to 1.9 mt/ha, and tail farmers reported yield variations from 1.5 to 2.3 mt/ha. Early paddy average yields were reported to be 1.5 to 1.7 mt/ha, though sometimes early paddy yields more than late paddy. Wheat yield varies from 1.5 to 2.0 mt/ha. Farmers are reluctant to cultivate wheat extensively and choose to grow vegetables due to price and market factors.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) Farmers appear very cooperative on this system, and there do not appear to be large conflicts. Farmers actively inquire of DIHM officials where maintenance money is spent, and an estimated 75 percent of the farmers are voluntarily paying their water charge. There appears to be little unauthorized cutting of the canal banks.

b) Tail end farmers, in particular, are very active in trying to get water to their fields. They appear receptive to establishing new water users' associations or strengthening old associations.

c) DIHM management is fairly good at Sange Pityani. Officials watch the canal closely, and the supervisor is well trained and has been at the system for 20 years.

d) Even though the main canal is 8.4 km long (a long distance in the hills), the canal is stable as a whole. In addition, no landslide problems were observed at Sange Pityani. The main canal is functioning well, compared to other DIHM hill systems.

e) There is high potential for increased agricultural production. The land has been cultivated relatively recently, and new agricultural technology can have a significant impact.

2. Weaknesses

a) Much of the land at Sange Pityani is owned by absentee landlords. Many of the primary beneficiaries of improved system performance, therefore, may not live in the area.

b) The prevalence of sharecropping in the area has accelerated mono-cropping and inhibited winter wheat cultivation.

c) Coordination between DIHM and local farmers and also between DIHM and DOA appears to be poor.

d) The Sange-Pityani DIHM irrigation system is hydrologically linked to the Char Hazar farmer-managed system. Any improvement made on Sange Pityani will greatly affect Char Hazar. This complicates potential improved management procedures.

e) There is a great deal of leakage and seepage throughout the system. This is due partly to the system being so high on the hillside, and partly due to the numerous crabs in the main canal. Some farmers reported that the crabs could eat through the concrete structures.

f) Relatively poor maintenance, partly due to a low budget, also contributes to the excessive leakage and seepage.

g) The system has a poor distribution system with excess water at the head, and too little water at the tail. Additionally, the system is located so high on the hillside that it cannot catch the cross-drainage.

h) There are very few control structures in the system.

i) The system design is more appropriate for a Terai irrigation system, where slopes are gentle. The resulting water flow is very slow.

j) The agricultural system is not as productive as it should be. Fertilizer use and yields are relatively low.

3. Summary and Conclusions

The command area of the Sange Patyani irrigation system is served by a long (8.4 km) canal, which is plagued by excessive leakage. There are also no control structures along the canal. Absentee landlords and a complicated tenancy system leads to a great deal of monocropping. All these factors hinder effective system performance.

Nevertheless, Sange Pityani is not plagued by serious conflicts, and farmers seem willing to work with DIHM officials. The potential for system improvement exists.

III. FARMER-MANAGED HILL SYSTEMS

1. CHAR HAZAR IRRIGATION SYSTEM

A. INTRODUCTION

Char Hazar is situated in Damauli Village Panchayat in Tanahu District about 65 km east of Pokhara. The intake for the system is about 10 km from Damauli headquarters and the tail of the command area is about 6 km from Damauli (Figure 5). There are no motorable roads to Char Hazar, but there is a foot trail from Damauli which leads to both Char Hazar and the nearby Sange Patyani DIHM irrigation system.

The gross command area of the system is about 200 ha. The command area extends from northwest to southeast and lies just below DIHM-operated Sange Patyani Irrigation System. One of the most important features of Char Hazar is its physical and hydrological relationship to Sange Pityani. The Char Hazar farmers depend on leakage water from Sange Patyani.

Char Hazar is one of the oldest farmer-managed irrigation systems along Sange Khola. Even the old farmers do not know when this system was constructed. There are two explanations for the name of the system. One is that Char Hazar (four thousand) irrigation system cost Rs. 4,000 when it was constructed. The other explanation is that it used to irrigate 4,000 mato muri (an old unit for measuring land; 1 hectare = 78.6 mato muri; 4,000 mato muri = 50 ha).

The Char Hazar Irrigation System begins at a brush weir approximately 1.5 km downstream from the DIHM Sange Patyani system headworks. The command area proceeds approximately 3.5 km and is bordered by the Sange Khola. Another farmer-managed system bounds Char Hazar on the south (downstream) side. Char Hazar irrigation system starts at 477 m above mean sea level and drops to 440 m in a distance of 3.5 km. The slope is approximately 1 percent.

The land is shaped into terraces and is bunded. Most of the command area lies within 5 to 10 m of the same elevation as the Sange Khola, which means 80 percent of the command area is subject to annual flooding from the khola.

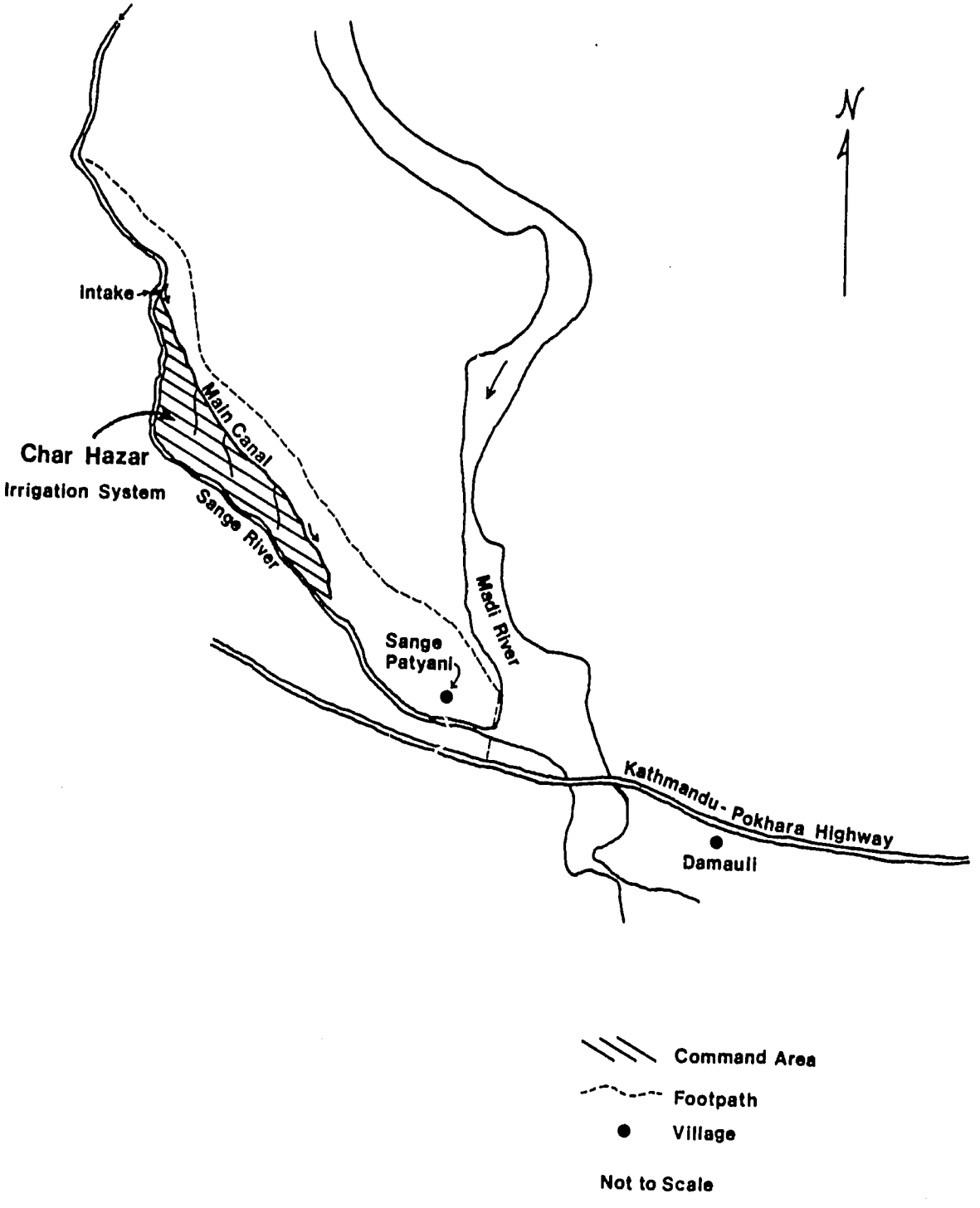

Figure 5. Char Hazar Irrigation System

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The primary water source for Char Hazar is Sange Khola, which is a tributary of the Madi River. At the intake for Char Hazar, farmers have constructed a brush dam across Sange Khola. This dam needs repair every year. The minimum discharge of the river is about 200 to 250 l/s. In addition to the river water, the main canal of Char Hazar also receives leakage and drainage water from the Sange Patyani main canal. Currently, there is sufficient water for late paddy and wheat cultivation, but not enough water to irrigate the entire command area for early paddy. Better management could make sufficient water available for early paddy.

2. Canals

The Char Hazar main canal runs parallel at a lower elevation to the main canal of the DIHM Sange Patyani irrigation system. The Char Hazar main canal is about 2.5 km long with a capacity of about 1200 l/s. The canal banks are in good shape. However, some leakage does occur due to construction defects. Farmers report no other water or soil problems.

Seven branch canals divert water from the main canal. Most of the branch canals run from north to south. The following table shows the length and location of the branch canals.

Branch Canals in Char Hazar Irrigation System

Branch Canal (Kulo)	Approximate Length (m)	Distance from Intake (km)
Kadme Ko	100	1.00
Aargakhe	400	1.20
Bhena Ko	300	1.35
Shale Ko	300	1.60
Rampure Ko	400	1.70
Thado	300	2.50
Therso	1500	2.50

3. Structures

There are no permanent structures and no regulating structures in Char Hazar. The dam at the intake is also a temporary structure. At about 1.6 km and 2.5 km there are two small drains crossing the main canal. These two drains are functioning as branch canals. There are 23 turnouts on the main canal.

4. Soils

The soils are a mixture of medium to fine alluvial materials. Micro-relief from terrace to terrace is often as much as one meter and the presence of old river meander scars is often seen on the land surface.

The soils of the upper lands in the DIHM system are derived from stream deposits. More fertile soils are in the flat land of the farmer system which are flooded annually during monsoon. This ultimately affects the texture as well as the fertility status of the flat land.

Because the rate of water percolation through the soil is less in the Char Hazar command area than in the nearby Sange Patyani irrigation system, the Char Hazar system will likely require less water.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

Brahmin, Kumale and Darai castes are predominant in the Char Hazar farmer-managed system. Most of the landowners are Brahmins, while other castes often rent land from the Brahmins.

The landholding patterns for Char Hazar appear similar to the nearby Sange Patyani system. Absentee landlords, owners-cum-tenants, and landless farmers and laborers are present. It appears that most of the farmland is rented. Land fragmentation among family members has reduced large landholdings (up to 15 ha) to smaller plots (1 ha). Most land is rented on a one-year contract to avoid the provisions of Nepal's Tenancy Act.

Over 50 percent of the land within the system is owned by absentee landlords who stay in the villages of Manung, Sange Patyani, Dagun, Gunadi, Harkapur, Tilahar, Pohare Pani, Kunu Chuder, and Archeli. Share cropping is the most prevalent system of cultivation at Char Hazar. The crops are shared 60:40; i.e., 60 percent of

produce goes to the owner and 40 percent goes to the cultivator. The cost of the production is the responsibility of the cultivator.

2. Irrigation Organization

Two jimawals are assigned to manage the system. The responsibilities of the jimawals are to inform the members about meetings, keep a membership record, and plan the schedule for desilting and maintenance. Currently, one jimawal is from the Kumale ethnic group.

Previously, the jimawal was a hereditary position confined to a certain family, and age was not a consideration. For example, a 9-year-old boy was once appointed as jimawal by the farmers after the death of his father, who was the previous jimawal. Currently, jimawals are elected annually by the farmers. A jimawal gets Rs. 25 as annual renumeration.

Each year, during the time of seedbed preparation, a general meeting is called at Barahabot (a place at the center of the command area). At the meeting, the following issues are usually discussed:

a. the schedule for desilting the canal and constructing the brush dam at the intake;

b. who will do the desilting: the farmers, wage laborers, or a contractor; and

c. the settlement of accounts.

There is also a cultivation committee for farmers growing winter crops. Only winter crop cultivators participate in this committee's meetings.

Some farmers stated that the farmer organization is not as effective as it has been in the past. It was reported that in the past, farmers would spend up to 29 days working together to clean the main canal. Now farmers clean for only 2 days. The following may be reasons for the organizational degeneration:

a) Farmers feel they do not need to work hard because of the supply of leakage and seepage water coming from the Sange Patyani main canal.

b) Authority relationships have changed, and leaders who have little knowledge and command have been elected each year.

c) Young men are leaving the area to search for new jobs or higher education.

d) Politics have polarized the irrigation group.

e) Landowners are away from the farm.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE AND WATER DELIVERY

1. Water Allocation and Distribution

Water distribution at the head and tail of the system during both paddy seasons was reported to be continuous. No priority system for distributing water is present in Char Hazar. Farmers share water delivery turn by turn, according to the location of the land along the length of the field channel.

2. Maintenance

Once the farmers agree on a schedule for maintenance, and a method of labor mobilization is chosen, the canal is desilted and cleaned. For maintenance and cleaning, the sharecropper, not the landlord, contributes his labor. Char Hazar farmers reported many different ways of maintaining their system.

The farmers at the tailend outlet start the canal cleaning. When they reach the next outlet toward the head of the system, all the farmers on that outlet join in cleaning and repairing the canal up to the next outlet.

Farmers are required to work to a designated point in the system depending on the amount of land they are cropping. Small farmers having only 5 mato muri (0.06 ha) of land are required to clean the canal up to Barahabot, near the middle of the command area, or they can be exempted by paying 75 paise (100 paise = Rs. 1) per mato muri. Farmers having up to 10 mato muri (0.13 ha) participate in canal cleaning up to Agrakhe (1.2 km from intake). Farmers having 15 mato muri (0.19 ha) participate up to Bahatar Dam. Farmers having more than 15 mato muri (0.19 ha) must participate up to the main intake.

According to the jimawal, those having 5-10 mato muri (0.06 - 0.13 ha) must contribute 2 days of voluntary labor. Those having up to 15 mato muri (0.19 ha) must contribute 3-4 days of labor. Those having between 15 and 30 mato muri (0.38 ha) can either contribute labor or cash. However, farmers with over 30 mato muri cannot get an exemption and must contribute labor. When it is time to construct the brush dam, everybody must contribute voluntary labor. There are no exceptions.

For regular maintenance, farmers can contribute voluntary labor or cash. The cash contribution system is called theka. This year, 1 out of 5 farmers contributed labor and the rest made a cash contribution. Forty-three farmers took responsibility for maintenance. During maintenance, there are weekly meetings near the dam. Those who are absent have to pay Rs. 5. Last year, each farmer who participated in regular maintenance received Rs. 22.

The maintenance group decides the form of punishment for defaulters. If a farmer does not pay the fine or the cash contribution, the members may go to his house and get some of his utensils equal to the value of the fine. If this cannot be done, paddy equal to the value of the fine is cut from his farm. While we were surveying this system, we saw people on similar farmer-managed systems who were cutting paddy on a defaulter's farm. This sanction seems prevalent in this area.

It was reported that field channels are cleaned once or twice a year as needed. Cleaning can be initiated by any of the farmers served by a channel. Maintenance is done from the tail of a channel to the head. The tail farmer starts the maintenance and is joined by other farmers as he works toward the head of the channel. In the last reach before the turnout, all the farmers on the field channel should be working together. Farmers stated that sanctions for nonattendance (Rs. 10 for heavy work and Rs. 5 for lighter, routine work) are enforced.

3. Conflict

Conflict over water within the upper reaches of the system is infrequent. But conflicts between farmers on the upper and lower reaches of Char Hazar were mentioned frequently.

4. Water Adequacy, Reliability, and Equity

The size and shape of the main canal below the brush weir led us to estimate a maximum discharge of 1,200 l/s. Assuming that the main canal loses 40 percent of its water, but that it regains the loss from the leakage from the DIHM Sange Patyani system and the small kholas above the DIHM system, 1,000 l/s should serve the nominal 200 ha of land in the command area with a duty of 5 lps/ha. However, the system greatly depends on the runoff and drainage water it receives in addition to water from Sange Khola. Without the supplemental sources, much more careful management would be required to effectively use an approximate duty of 3 lps/ha.

Head farmers reported that water was both adequate and timely in the early and late paddy seasons. Head farmers also stated that excess water use was not a problem because of the jimawal's supervision of the system. Tail farmers reported cropping only during late

paddy season. Tail farmers said that there was not enough water available to crop early paddy or winter wheat.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Farmers determine their cropping calendar by the calendar date or by the date of water release in the system. Farmers rotate varieties to maintain the productivity of the soil, but no priority is attached to the order of the crop rotation.

All farmers receive enough water to grow late paddy, but not all farmers are able to grow crops during early paddy and winter wheat seasons. Winter cropping is practical only at the head of the system. Those farmers at the head of the system who could grow wheat but do not, may choose to do so for the following reasons: loan terms for crop production, lack of manpower, threat of hailstorms, and low financial returns.

Compared to the DIHM Sange Patyani irrigation system, Char Hazar farmers have more area under early paddy (about half the command area) and more wheat. Farmers at Char Hazar sow their seeds earlier and harvest earlier than the farmers at Sange Patyani. Also, farmers at Char Hazar are using the improved variety, Masuli, on 70-75 percent of the command area as compared to 25-30 percent at Sange Patyani.

2. Inputs

The production inputs at Char Hazar are similar to the ones at Sange Patyani. Agricultural extension services are available, but farmers complain about the lack of services. The agricultural cooperative is the same one that serves Sange Patyani, and appears to be ineffective. The tenancy system at Char Hazar usually discourages farmers from applying for credit.

There were few improved agricultural practices observed at Char Hazar, except for the adoption of improved paddy varieties. Fertilizer is usually not used for paddy, though farmers growing wheat sometimes apply fertilizer.

3. Yields

Farmers reported early paddy production of 1.9 to 2.2 mt/ha. Late paddy cultivation provided production of 2.2 to 2.4 mt/ha. One farmer who was sharecropping 3:2 reported harvesting 2.3 mt/ha. Another farmer who was an owner-operator, said he used one bag of

ammonium sulfate on inferior land with an inadequate water supply and obtained a yield of only 1.5 mt/ha.

Milling recovery is greater at Char Hazar since the husk is thinner and the grain is more plump compared to the harvest of the upper terrace of Sange Patyani system. Compared to Sange Patyani, the yield level is expected to be higher (10-15 percent) in Char Hazar.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) The system is located on relatively flat land that receives a significant amount of flood water, which adds fertile soil to the command area. Because of this flood plain, Char Hazar has better soils than the neaar-by Sange Patyani irrigation system.

b) Because of the flatland soils, the porcolation rate at Char Hazar is less than the DIHM Sange Patyani system.

c) The system captures a great deal of leakage water from the DIHM system above; thus using otherwise wasted water.

d) The main canal is very stable.

e) An indigenous farmers' irrigation organization exists at Char Hazar.

2. Weaknesses

a) The farmers of Char Hazar are dependent on the leakage water of DIHM's Sange Patyani system. Most of their irrigation operations assume that this leakage water will be available to them.

b) Absentee landlords are prevalent and generally hold the greater share of power in the area. Sharecropping is common.

c) As the farmers have come to rely on the DIHM leakage water, the indigenous farmers' irrigation organization has begun to deteriorate. Traditional rules and regulations are no longer followed, and maintenance tasks are not performed as well as in previous years.

d) There are no pucca structures or measuring devices in the system, and no permanent intake structure exists.

e) Agricultural services are poor and farmer agricultural practices are not improved.

3. Summary and Conclusions

The Char Hazar farmer-managed system has to be studied in relation to the nearby Sange Patyani DIHM system. They are in close physical proximity to one another, and Char hazar farmers rely on leakage and drainage water from Sange Patyani. Additionally, fertile soil is often washed down to the Char Hazar flatlands from Sange Patyani during floods.

As a result of this dependence, the Char Hazar farmers' irrigation committee has degenerated during the past few years. Farmers have lost some of their initiative and drive. If the organizational structure could be revitalized, Char Hazar could become a very efficient irrigation system.

2. BHANU BHAIRAH IRRIGATION SYSTEM

A. INTRODUCTION

Bhanu Bhairah is a farmer-managed irrigation system in Tanahu District about 80 km east of Pokhara. The irrigation system is accessible by a fair weather jeep road from Dumre on the Kathmandu-Pokhara highway (Figure 6). In the rainy season, a two-hour walk is necessary to reach the command area. Bhanu Bhairah irrigates Wards 2 and 3 of Bhanu Panchayat.

Bhanu Bhairah is an old system. It was constructed by farmers about 175 years ago, and in 1955, farmers renovated and extended the system. Since then, the system seems to have functioned quite well.

The gross command area of the system is about 120 ha. The command area is flat and extends from the left bank of Chundi Khola to the right bank of Bhaguwa Khola. It is located directly below the Char Say Phant farmer-managed irrigation system.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The water source for Bhanu Bhairah is Chundi Khola, which is a tributary of Marsyangdi River. Bhanu Bhairah is a run-of-the-river system. The maximum discharge of the river is about 100 cumecs. The minimum discharge seems to be about 200 l/s.

About 400 m upstream of the intake, another intake exists for the Char Say Phant farmer-managed irrigation system. Hence, Bhanu Bhairu system gets only the leakage water from the upstream intake for winter crops. The leakage may be about 50 l/s. Therefore, water is available for only about 50 ha of wheat and only 10 to 20 ha of early paddy.

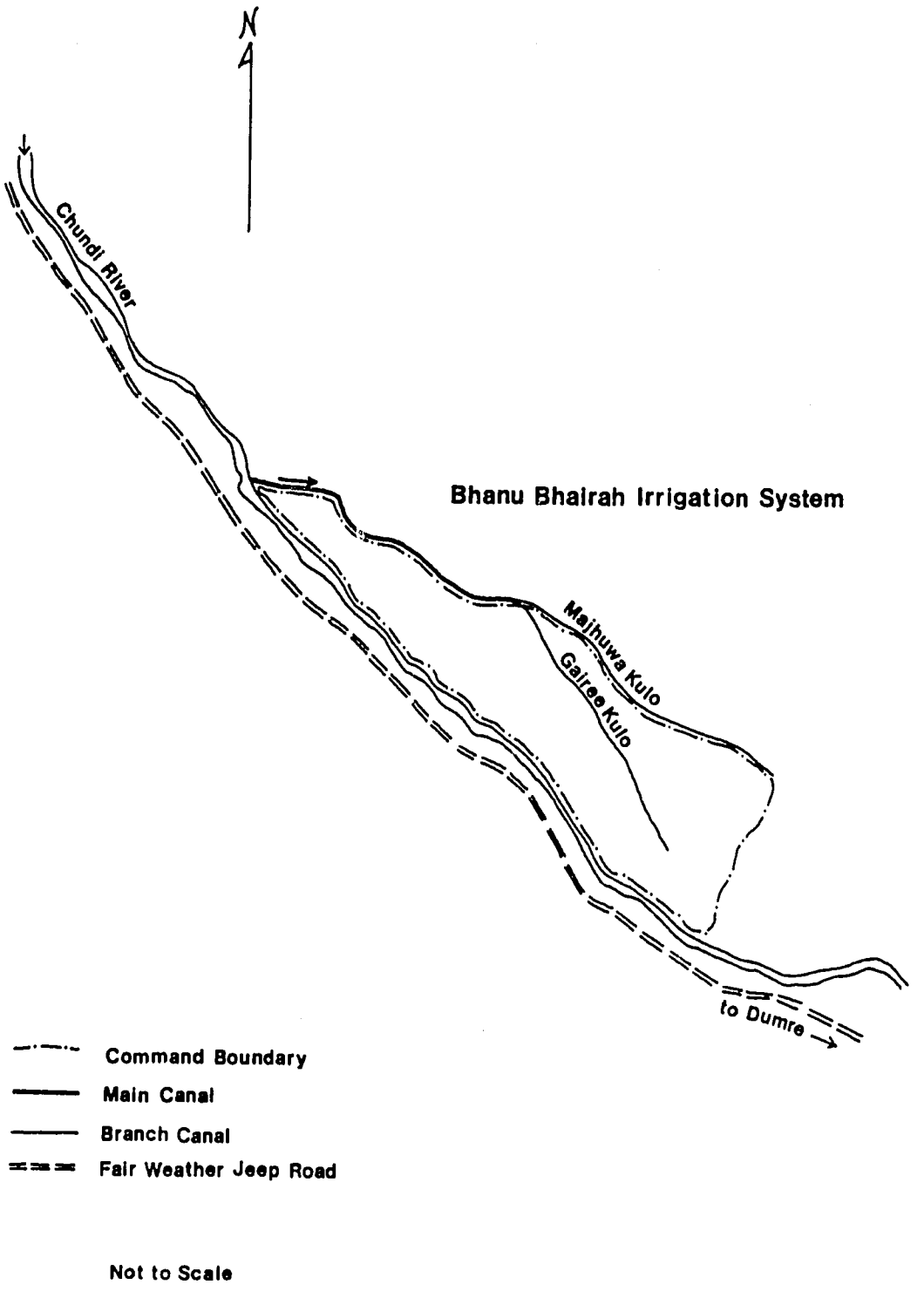

Figure 6. Bhanu Bhairah Irrigation System

2. Canals and Structures

The intake of Bhanu Bhairah irrigation system is located at the concave side of the river. There is no obstruction, so flood water enters the canal directly causing much damage and erosion. The width of the canal at the intake is about 100 m, which gradually decreases to about 2.5 m within 50 m of the intake. During low flow, the diversion structure across the river is generally made of boulders and brush.

The main canal of Bhanu Bhairah is about 1.5 km long with a bed width of about 2 m and a maximum depth of water in the canal of about 0.5 m. The cross section of the main canal intake and the corresponding channel slope indicate that the full supply capacity in late paddy season is 600 l/s. For a cultivated service area of 120 ha, 600 l/s provides a duty of approximately 5 lps/ha, which is considered normal for hill irrigation systems.

Certain sections of the canal are in very poor condition, and in some places, the bank width is only about 30 cm. Because of the poor condition of the canal banks, extensive seepage causes the canal to breach frequently. Due to the seepage and leakage, it was found that the farmers shift the canal alignment. The seepage problem exists in about 500 m of the canal. The rest of the main canal seems to be in good condition.

Bhanu Bhairah has two branch canals bifurcating from the same point at the tail of the main canal. These branch canals are named Majhuwa Kulo and Gairee Kulo. The Gairee and Majhuwa Kulos are 1.0 km and 1.5 km long, respectively. Both of the branch canals discharge approximately 350 l/s, and command approximately equal areas. No pucca structures, measuring devices, or regulating structures exist on Bhanu Bhairah irrigation system.

The main canal crosses two drainages at about 300 m and 700 m. The drainage at 300 m carries much debris and silt, which frequently damages the canal. This drainage is a major problem in the system. Since there is no structure to carry the drainage water, the drainage water flows along the main canal. Farmers have constructed a vertical trap of bamboo to filter out vegetation and other floating material in the main canal. The drain at 700 m is small. The farmers have constructed check dams of bamboo across the drain to stop the flow of silt into the main canal.

3. Soils

The soils are young alluvial deposits on the floodplain and the low terraces. Loam to sandy loam soils are present in the command area in varying depths. The soil of the upper terraces appears to be less fertile than that in the lower terraces. Areas receiving floodwater in the lower terraces appear to be more fertile.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

There are several comparatively large landowners in the Bhanu Bhairah irrigation system. Some landholders in this area own up to 7.5 ha, though most appear to own much less, perhaps 0.5 ha. Large parcels of land are under sharecropping; we estimated about 50 percent of the irrigated area. The most prevalent sharecropping arrangement seems to be 50:50; 50 percent of the agricultural output goes to the sharecropper and 50 percent goes to the landowner. The sharecroppers are not tenants, per se, and are not protected by Nepal's Tenancy Act. The larger landholders in the area cultivate only small parcels of their land themselves and allow sharecroppers to farm the remainder of their land. Seasonal labor shortages and tenancy laws contribute to landowners leaving some land fallow in the dry season.

Brahmins are predominant in this system in terms of population and the amount of land owned. Some Chettris and Newars also farm here with fewer numbers of Magars and Gurungs. The Magars and Gurungs have moved out of the valley and onto the hillsides. The larger landowners who are Brahmins are active in the system and very involved in the irrigation committee. The most powerful farmers in the system appear to take a keen interest in all irrigation activity.

We were told that there are 92 families in the system and that almost all of them live in nearby settlements in the valley and on the hillsides. The settlements seem prosperous as they contain large, well-maintained, three-story houses. The high educational level of the farmers and Bhanu Bhairah's proximity to main roads contributes to the farmers' apparent economic well-being.

2. Irrigation Organization

The local people associate Bhanu Bhairah with Bhanu Bhakta Acharya, a classical Nepalese poet, for his contribution to constructing the irrigation canal that feeds the plains of Chundi River valley, including Bhanu Bhairah. Over time, the Bhanu Bhairah areas under

irrigation expanded. Currently, the command area is estimated to be about 120 ha.

Until 1961, the system was managed by the family of Bhanu Bhakta. In 1961, rules and regulations were codefied. The preamble of the regulation book mentions that over four generations of the Bhanu family have looked after the system, but that the time had come for all farmers in the system to participate in managing the system.

A committee of seven members elected from among the farmers of the system was formed in 1961. These members have terms of one year which are subject to renewal based on job performance. The committee consists of a chairman, a vice-chairman, a secretary, a treasurer, and three other members. They meet once every fortnight.

There are currently 92 farmers in the system. Thirty years ago, only 12 farmers were members of the system. The irrigation command area is divided into five regions. Five of the committee members are responsible for communicating with the farmers in each region, each member represents one region.

The written regulations of Bhanu Bhairah irrigation system mention the work division of the members, facilities for the committee members, resource mobilization, water distribution in normal times, water distribution during stress times, and punishment and fines. The irrigation organization has the following duties:

a) Conduct a meeting of all the farmers in March to decide the methods and modes for repairing and desilting the dam and canal.

b) Conduct a meeting of all farmers in July to settle accounts.

c) Assess the condition of the canal and realign it if necessary.

d) Enforce the decisions made during the farmers' meetings.

e) Reinvest the savings of the system. Currently, Bhanu Bhairah has Rs. 800 in savings which has been invested on loan at 10 percent interest.

In addition, the chairman is responsible for conducting meetings, looking after the system, and leading the farmers in maintenance work; the secretary keeps records and accounts. The meeting place and time is fixed, and if someone comes late, he is fined.

The Bhanu Bhairah irrigation organization seems to have effectively made the transition from a family-managed system to farmer-managed system. Bhanu Bhairah is quite effective in implementing the decisions reached during the general farmers' meetings. Since Bhanu Bhairah has only one source of water to irrigate 120 ha, strict discipline is imposed and maintained for repair and maintenance. The brush dam and mud bunds have dictated that the organization be effective to compensate for structural deficiencies in the system.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

During the paddy season, the water in the river is sufficient to supply a continuous flow of water throughout the system. The farmers make outlets on the main canal to get water, and during the monsoon season, farmers take water as they need it. Water is not allocated in proportion to cropped land.

However, if there is a shortage of water during the paddy season (or during the wheat and early paddy season), a rotation system is introduced throughout the system. The irrigation committee meets at these times and decides the rotation schedule. During times of water stress, each outlet has only a specified amount of water flow in proportion to the land to be irrigated. Therefore, the type of water allocation system depends on the availability of water.

Some tail farmers on the system reported that they did not receive water in the dry season, despite having a rotation system. Other tail farmers complained that during floods, head farmers sometimes destroy the intake on the river to protect their fields from excessive water flow. While justified from the head farmers' point of view, this prevents water from flowing to the tail. No report of excessive water use was made.

2. Maintenance

Maintenance is divided into dam construction and main canal repair. The farmers have to contribute to both activities separately. Those who fail to participate are fined. The fine is fixed at 50 percent more than the current wage rate in the area. Committee members are exempt from contributing labor for their land up to 20 mato muri (0.25 ha). In addition to maintenance, labor is mobilized during crises (i.e., if a bund breaches or the brush dam washes out).

The main canal is cleaned at least once a year, before the paddy season. At this time, all farmers are responsible for

maintenance. The main canal is cleaned first, and then the farmers on the separate field channels clean those channels. The irrigation committee supervises the maintenance on the main system.

Each year, the canal is strengthened and enlarged to bring more area under irrigation. Bringing more area under irrigation means increasing labor mobilization for repair and maintenance. Landowners are not compensated for the land used to realign the canal.

Maintenance during the wheat or early paddy season is not considered a group activity. The farmers who grow crops during these seasons are responsible for system maintenance.

Even though the rapid appraisal team observed the system at the end of the paddy season when maintenance would be expected to be poor, the condition of the main canal was good. It appeared to have been cleaned recently.

Field channel maintenance was reported to take place once a year unless more maintenance is needed to clear a blockage on a channel. Maintenance begins at the tail and moves toward the head. Farmers who do not participate are fined Rs. 10 to 12/day. Farm channels are maintained individually once or twice in a year.

3. Conflict Management

When conflict arises during the alignment of the canal, the committee settles such issues with the landowner. To avoid conflict over water distribution during early paddy season, a rotation system is followed. While the committee is responsible for most conflict resolution, at the farm level the farmers settle water conflicts among themselves.

Conflicts in water distribution were reported to occur often, but are usually not serious. Such conflicts are generally started by downstream farmers who need water. Resolution was reported to occur through discussion among the parties involved; often with the help of that region's committee member.

4. Water Adequacy, Reliability, and Equity

Some farmers at Bhanu Bhairah reported that even in the dry season there is adequate water available in the system. Tail farmers, however, reported that during water stress, sufficient water would not reach the tail. When sufficient water is available, however, it does appear to be delivered reliably.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Current agricultural practices appear to be traditional with the exception that some farmers use improved crop varieties. Land preparation is done using draft animals and human labor to some degree. Water availability determines whether to grow early paddy or rabi crops like wheat in addition to the paddy crop.

The major crops grown in the command area are early and late paddy, wheat, mustard, maize, potatos, linseed, and small peas. Livestock is usually raised and integrated into the production system as draft power, as suppliers of manure, and, to a lesser extent, as suppliers of milk.

The general conditions needed to grow the main paddy crop appeared satisfactory, except for the tendency of the local varieties to lodge. Lodging is a problem especially in areas having more flooding and fertile soil. Little difference was observed in crop appearance between the head and tail end of the canals.

All of the command area is cropped in paddy during the main growing season. In spring, about 20 to 25 percent of the area of the head of the system is planted with early paddy. In winter, about 50-60 percent of the area at the head is reported to be cropped with wheat. The other crops have smaller land, except for small pea which is increasing in area.

The following cropping patterns have been adopted by the farmers:

a) Early Paddy-Late Paddy-Wheat

b) Late Paddy-Lentil-Wheat

c) Late Paddy-Wheat-Potato

d) Late Paddy-Wheat/Mustard/Lentil

Mixed cropping of wheat and small pea is also practiced.

The cropping intensity varies from 125 to 250 percent in the command area. Cropping intensity is higher at the head of the system than at the tail.

Farmers reported that they determined their own cropping calendar within traditional limits. Water to prepare land is supplied from the head of the system to the tail. No other priorities were reported either for water distribution or crop choice. No cropping rotation was reported.

2. Production Inputs

More than 75 percent of the command area is cropped with improved paddy variety Masuli. During early paddy season, farmers use CH45 or Himalee improved varieties. An improved variety of wheat covers 100 percent of the command area. Other crops appear to be local varieties. Farmers use their own seeds for paddy, lentil, and peas, whereas they depend on the agricultural cooperative for wheat seed.

The little fertilizer used is primarily spread by farmers at the head of the system, where 2 or 3 crops are reported to be grown annually. Very little fertilizer has been issued for early paddy. The agricultural cooperative sold about 2.5 lakh rupees (Rs. 250,000) worth of fertilizer last year to farmers in the command area. In addition, very little pesticide is used (mainly to control gundhi bug).

Agricultural extension, cooperative and credit services are available at branch offices operating in the village of Sepa Bagaicha. However, in view of the command area's potential and the availability of better technology, the services, especially agricultural extension, appear to be inadequate.

3. Yields

Farmers reported that paddy crop yields varied from 2.0 to 3.0 mt/ha. It was also reported that early paddy yields more than the main crop of paddy per hectare. The wheat crop yield was reported to be an average of 2.0 mt/ha, while the yield for maize was reported to be an average of 3.0 mt/ha. The crop cutting report of Bhanu Panchayat shows the average paddy yield to be 2.1 mt/ha. Judging by the appearance of the paddy crop, the average yield is probably not more than 3 mt/ha.

Usually three crops a year are grown in a small area at the head end. The total annual yield of the three crops averages between 7.0 and 8.0 mt/ha. The rest of Bhanu Bhairah is covered by two crops a year, with a total average annual yield of about 5.0 mt/ha.

There does not appear to be any problems with marketing surplus production at Bhanu Bhairah. Ready markets are available in nearby hill villages. A summary of statistics for crop production is presented in the following table.

Average Crop Production Statistics for Bhanu Bhairah

Source	Early Paddy Head (mt/ha)	Early Paddy Tail (mt/ha)	Late Paddy Head (mt/ha)	Late Paddy Tail (mt/ha)	Wheat Head (mt/ha)	Wheat Tail (mt/ha)	Maize (mt/ha)
Farmers' report	3.4	-	3.2	3.1	2.1	1.5	3.5
Crop cutting report	2.92	-	(2.13)*		(1.62)*		2.92
Area cultivated (%)	50	-	100	100	100	33	10

* Material in parentheses are an average of the head and tail of the system.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) The farmers have developed an effective irrigation organization with enforceable rules that farmers appear to obey. The management is rational and pragmatic. The management of the command area is divided into five geographic regions. The committee member from each region is responsible for that region's irrigation activities.

b) Cooperation among farmers seems good, and water conflicts are resolved quickly and effectively.

c) Physically, the system is in good shape and is functioning well. Soils in the area are suited for irrigated agriculture.

d) The farmers keep expanding the irrigable area. Additionally, the area under early paddy could be increased by taking water from the nearby Gaundi Khola. Cash crops could also be introduced into the area.

2. Weaknesses

a) Currently there is not sufficient water available to grow a great deal of early paddy.

b) Much land in the area is owned by a few large farmers, and many sharecroppers who farm in the area have no tenancy rights. Benefits of system improvement, therefore, may not go to many Bhanu Bhairah farmers.

c) Because of the main canal's location on the river, floodwaters often enter the canal. Under these conditions, head farmers will destroy the intake structure to save their fields, but by doing so, prevent the tail farmers from receiving water.

d) There are no control or other structures in the system.

e) Agricultural services are not adequate.

3. Summary and Conclusions

Bhanu Bhairah covers about 120 ha. The system sits on a floodplain and low terraces. The flood water enters directly into the canal without any obstruction causing much damage and side erosion of the main canal. The length of the main canal is about 1.5 km, and the lengths of the two branch canals totals about 2.5 km. Because of the narrow bank widths in the main canal, large amounts of water seep through the banks, causing the banks to breach frequently. There are two cross-drainages dissecting the main canal with no structures on them. There seems to be enough water available for late paddy, but not for wheat and early paddy. A problem in Bhanu Bhairah seems to be the lack of flood control at the intake and seepage in the main canal.

The Bhanu Bhairah farmer-managed system is a small, stratified society with strict rules for irrigation behavior. Most farmers are conservative Brahmins who have codified a set of rules which are widely accepted and followed. There are a few large landowners in the system, but most of the area is owned by smallholders. Sharecropping is prevalent. A devolution of power has taken place over the past few years, which has increased the irrigation organization's effectiveness.

The area appears to have much agricultural potential in view of recent improvements in agricultural practices and technology, especially if cash crops can be incorporated into the existing cropping patterns.

3. CHAR SAY PHANT IRRIGATION SYSTEM

A. INTRODUCTION

Char Say Phant is a farmer-managed irrigation system situated in Tanahu District about 80 km east of Pokhara. The command area is accessible by a fair weather jeep road from Dumre on the Kathmandu-Pokhara highway (Figure 7). During the rainy season, there is a two-hour walk to the irrigation system. Char Say Phant irrigates Ward 8 of Bharbhangyang Panchayat.

Char Say Phant was constructed by farmers more than 100 years ago. The gross command area of the system seems to be about 50 ha. The command area extends from the right bank of Chundi Khola to the left bank of Gaudi Khola. The command area is flat, very similar to the Terai. The system is located directly above the Bhanu Bhairah farmer-managed irrigation system. Char Say Phant irrigation system seems to function well.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The source of water for Char Say Phant is the Chundi Khola, which is a perennial source. Char Say Phant is a run-of-the-river system. The maximum discharge of the river is about 100 cumecs, and the minimum discharge of the system is about 200 l/s.

It was found that the system gets enough water from the river for late paddy and a winter crop, but a rotation system has been adopted for early paddy because there is usually not enough water in that season.

2. Canals and Structures

The diversion structure is temporary and usually washes out during floods. The main canal takes off from the left bank of Chundi River. For about 130 m, the main canal runs parallel to the river.

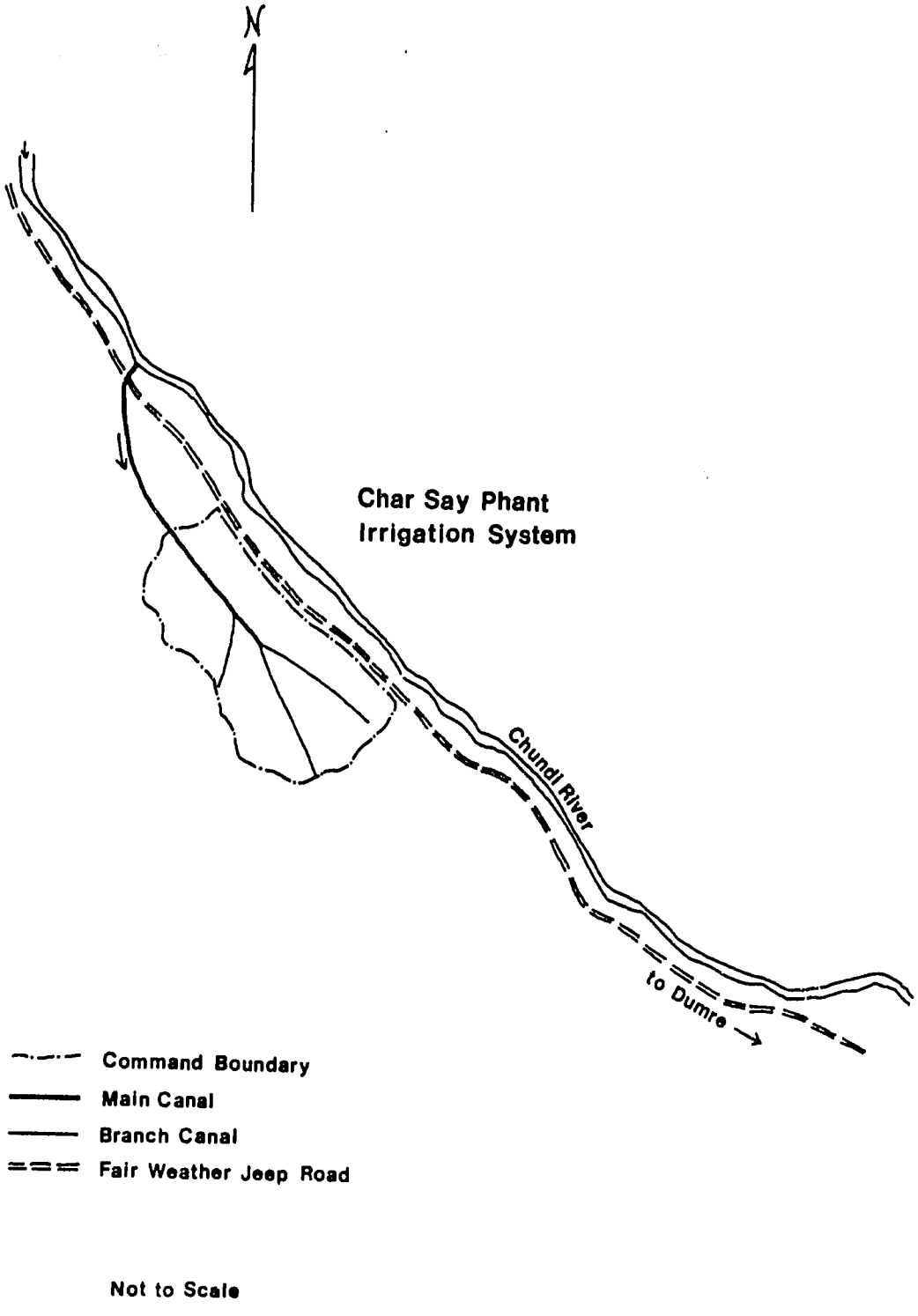

Figure 7. Char Say Phant Irrigation System

Some flood protection has been built by the Western Regional Irrigation Directorate at the intake of this system, where they have constructed six gabion spurs (structures across the river banks made of boulders covered by wire nets). The intake width of Char Say Phant is restricted to 2.0 m by the gabion spurs. There are no regulating or measuring structures in the system.

The main canal of Char Say Phant is about 450 m long with a bed width of 2.20 m and a maximum depth of water in the canal of about 40 cm. The cross section of the main canal varies from place to place. The full supply capacity of the main canal seems to be about 500 l/s. Farmers have irrigation outlets right after the intake on both banks of the main canal.

There are four branch canals that are about 200 to 300 m long, and there are many field channels. The current condition of the main, branch, and field channels is very good. Water is always released from a fixed point. There are no cross drainage, seepage, or canal breach problems. Except for the intake which usually has to be repaired every year, the system is functioning fine.

3. Soils

The soils are young alluvial deposits on the floodplain and low terraces, which range from loam to sandy loam and lie in varying depths. The soil of the upper terraces appears to be less fertile than that in the lower terraces. Areas receiving floodwater in the lower terraces appear to be more fertile.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

Almost all of the land in the Char Say Phant farmer-managed system is owner-operated with little or no tenancy or sharecropping. As landowners are not leaving land fallow to avoid tenancy laws, cropping intensities are high. The largest landholder in the area owns approximately 1 ha. The smallest landholding is approximately 0.2 ha.

The Ranabhats, a Chettri caste, are dominant in the system as they own about 90 percent of the land. Most of the Ranabhats live on the north side of the valley in Bhanu Panchayat. A few farmers live on the south side in Barbhyangjang Panchayat. The houses of the north side of the valley are large, well-kept, 3-story structures.

2. Irrigation Organization

Char Say Phant is a farmer-managed system with 65 members who are the beneficiaries of the system. To manage the system, a five-member committee (a chairman and four members) has been formed. The members are elected from among the beneficiary farmers each year at the annual meeting. The chairman of the committee leads the farmers in the activities relating to irrigation water management and the maintenance of the system.

The irrigation organization looks after the annual repair and maintenance of the canal and the brush dam; sets the water rotation schedule for the early paddy crop; keeps a record of the members who have participated in canal cleaning and brush dam construction; and resolves conflicts resulting from water sharing and water allocation.

The amount of labor farmers contribute toward branch canal and main canal cleaning and dam construction is determined as follows:

Land Owned	Labor Contribution
20 mato muri (0.25 ha)	1 laborer for 1 day
10 mato muri (0.13 ha)	1 laborer for 1/2 day
5 mato muri (0.06 ha)	1 laborer for 1/4 day

If the labor required is not contributed, a fine is imposed based on Rs. 10 per laborer per day.

At the end of the monsoon season, the irrigation organization members settle their accounts. The remaining balance is used to buy a goat, which is slaughtered and distributed to each member of the irrigation system. The irrigation organization of Char Say Phant does not have a system for using the balance for future capital investment in system improvements.

The management of the system is dominated by Ranabhats. According to one informant, only six members of the irrigation system are not members of this major ethnic group.

The system works well; in part because all except six farmers live close to the farms. Also, the Char Say Phant irrigation system has elaborate farm channels and individual outlets to each farm, which has reduced the potential for conflict in water sharing.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

During the paddy season, there is sufficient water in the system to provide continuous flow in the main canal. Farmers are permitted to divert water to their fields through the numerous field channels in the system.

During times of water stress, or during the wheat and early paddy seasons, the irrigation committee meets and decides upon a rotation schedule. Water is rotated hourly turn by turn. Despite the rotation schedule, some farmers claimed that there is an inequitable distribution of water.

Head farmers reported that strict management was not implemented on the main canal daily. One farmer reported a "might is right" system of water priority. Tail farmers reported no priority system. One tail farmer reported that he had no canal service and received water only through seepage and runoff from higher fields. Individual initiative seems to prevail.

2. Maintenance

Maintenance is performed along the main canal at least once a year before the paddy season. Maintenance is performed under the supervision of the irrigation committee. During winter and spring seasons, the farmers who grow wheat or early paddy are responsible for maintaining the main canal.

In June, the farmers have to clean, desilt and repair the canal and dam. The cleaning and desilting start from the individual outlets and farm channels, where the work is done by the individual farmers. Then, all the farmers on the branch canals clear their own branch canals and later join to clean the main canal. Finally, all of the farmers participate in constructing the brush dam.

3. Conflict Management

Most conflicts are mutually settled. Once in a while, conflicts over water distribution arise that are resolved by the committee. To avoid conflict in water division, Char Say Phant has elaborate farm channels so that each farm has an independent outlet on the main canal.

4. Water Adequacy, Reliability, and Equity

There is sufficient water for all 50 ha during the late paddy season. In the winter and early paddy seasons, water flow is significantly reduced. During these seasons, the water distribution system sometimes deteriorates and head farmers receive more reliable water than tail farmers.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Char Say Phant is close to the Bhanu Bhairah irrigation system, and they share water from the Chundi Khola. The agricultural system and the production pattern at Char Say Phant are similar to those reported for the Bhanu Bhairah system. However, there are some differences between the two systems.

The Char Say Phant command area is flat and receives little or no floodwater compared to Bhanu Bhairah. Most of Char Say Phant is cropped with local varieties of paddy rather than Masuli; and more than 75 percent of the command area is cropped in early paddy, whereas the early paddy crop is negligible in Bhanu Bhairah.

2. Production Inputs

Since more than 95 percent of the owners till their land themselves in Char Say Phant, the farmers of Char Say Phant have adopted intensified agriculture. Rabi cultivation is reported to be extensive and no areas are left fallow. Farmers of Char Say Phant use more fertilizer and obtain greater yields than the farmers do in Bhanu Bhairah.

3. Yields

The following table summarizes crop yields in Char Say Phant.

Cropping Intensity and Crop Yields in Char Say Phant

Source	Early Paddy		Late Paddy		Wheat		Corn
	Head	Tail	Head	Tail	Head	Tail	
	(mt/ha)						
Farmer's report	3.5	3.4	2.2	2.5	1.1	1.8	
Crop cutting report	(3.1)*		(2.0)*		(1.5)*		(2.15)*
Area Cultivated (%)	100	100	100	100	60	50	
Cropping Intensity (%) Head - 260 Tail - 250							

* material in parentheses are an average of the head and the tail of the system

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) There is an elaborate network of branch, field and tertiary canals, and there are separate outlets to each farm.

b) The branch and field channels are functional and well-maintained. There do not appear to be any leakage or seepage problems, and the system is not threatened by landslides.

c) There are no cross-drainage structures, so no canals are adversely affected.

d) The system receives so much water that management tasks are relatively minor.

e) Most of the land is owner-operated and equitably distributed. There is little tenancy or sharecropping.

f) Due to the social and agricultural system, many farmers grow three crops, including early paddy.

g) Most farmers live in settlements close to the command area, so more intensive cultivation is possible.

h) The command area is on flat lands, which are suitable for intensive agriculture.

2. Weaknesses

a) One particular caste, the Ranabhat Chettris, is predominant and has power over all decision-making. "Might is right" characterizes some aspects of system operation.

b) Farmers are not using improved agricultural practices, and the government is not extending these services.

c) The intake on the river has no regulator and is uncontrolled. During floods, excessive water can damage the system.

d) In the irrigation organization, only the chairman is active. If he is not present, there is little communication among farmers.

e) The water fees collected by the organization are not used for capital improvements in the system, but for celebrations and feasts.

3. Summary and Conclusions

Char Say Phant is a very small system of 50 ha located on a floodplain and on low terraces. With the construction of six gabion spurs across the Chundi River, flood problems have been reduced. There is enough water in the river to command the above area. All the canals seem to be functioning well.

The Char Say Phant farmer-managed system is almost entirely populated by one caste, the Ranabhat Chettris. Land distribution is relatively equitable, and almost all of the farmers are owner-operators. The farmers' organizational structure is relatively loose because of their source of water is secure. Rules are somewhat lax and the more powerful farmers sometimes manipulate the system to their advantage. No serious social or organizational problems were found at Char Say Phant. Elaborate individual outlets and farm channels are typical features of this system, and the owner-operated farm management has made three-crop cultivation possible, which has increased agricultural productivity.

Char Say Phant irrigation system farmers appear to use the land very efficiently and are intensifying agriculture to its maximum. Char Say has a very good indigenous agricultural system.

4. SATRA SAY PHANT IRRIGATION SYSTEM

A. INTRODUCTION

Satra Say Phant is a farmer-managed irrigation system situated in Tanahu District about 80 km east of Pokhara. The Kathmandu-Pokhara highway crosses the command area of Satra Say Phant (Figure 8). Satra Say Phant irrigates Ward 1 of Abu Village Panchayat.

Satra Say Phant is an old system built by farmers that is so old that nobody knows when it was constructed. The command area seems to be about 40 ha of flat, terraced land. The average slope of the land seems to be about 10 percent at the head and 1 to 3 percent at the middle and tail of the system.

Satra Say Phant is best understood in relation to the nearby Yampa Phant farmer-managed system. Both systems share a water source, and there is a long-term dispute over control of that source.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The water source for Satra Say Phant is Aadi Mul, which is a spring located in the hills above the command area. The intake of the system is situated about 500 m downstream of the spring. The maximum discharge of Aadi Mul spring at the intake seems to be about 1000 l/s with a minimum discharge of about 300 l/s.

2. Canals and Structures

The intake of Satra Say Phant is small, and the stream bed is about 10 m wide. The diversion is temporary but requires few repairs because of relatively low discharge during floods. There is a locally constructed tunnel that is 0.75 m wide and 0.75 m high on the canal. The temporary diversion weir has been constructed across the river just below the tunnel so that the water flows directly into the tunnel. The length of the tunnel is about 30 m. The length of the main canal is about 4.0 km.

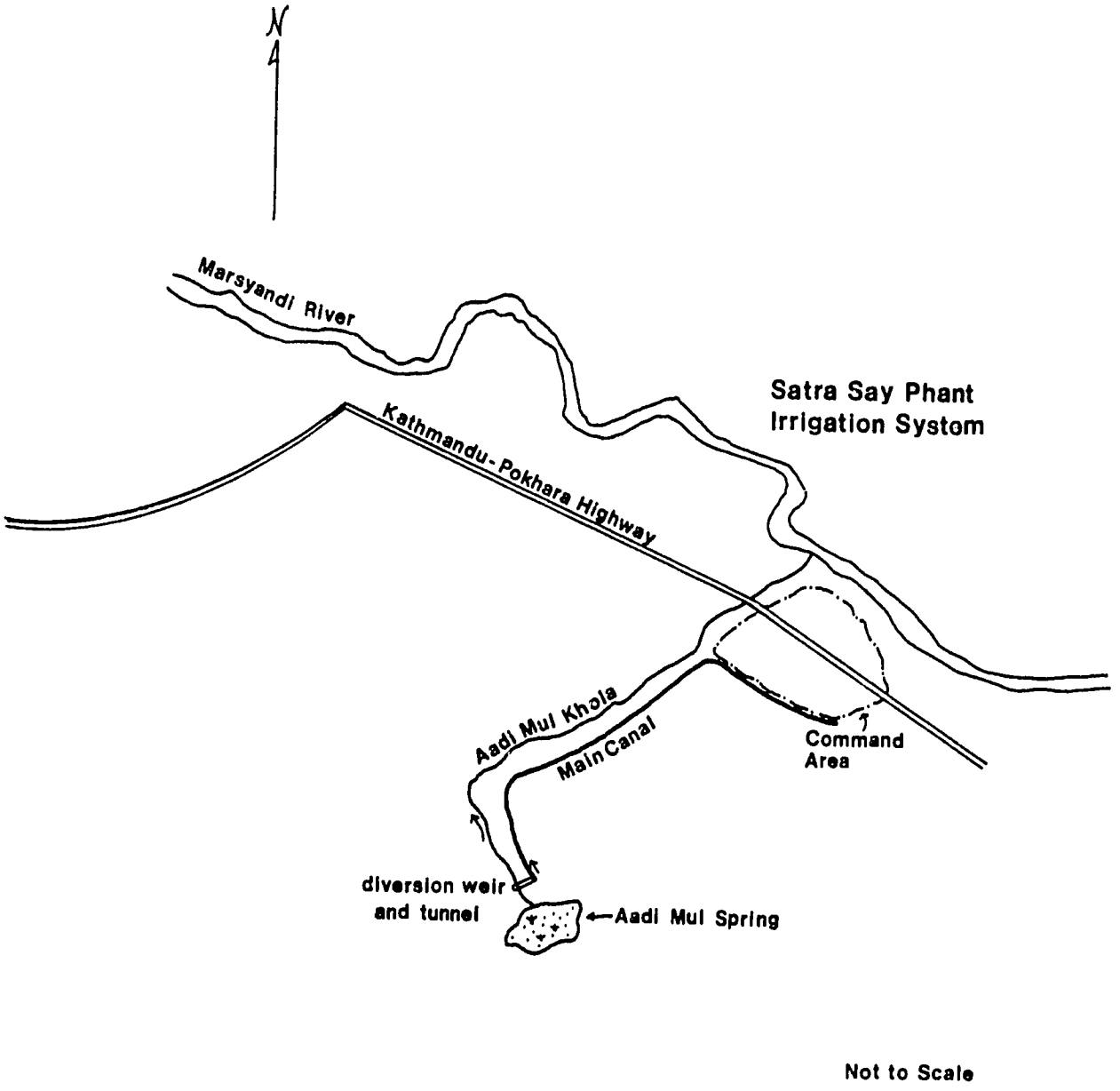

Figure 8. Satra Say Phant Irrigation System

The upper reach of the main canal for about 1.3 km is in very difficult alignment. The canal bed is rocky with good rock banks. This portion of the canal is very steep: an average of four percent or even steeper. There are two vertical drops of more than 5.0 m each over rock. The canal and banks are completely covered by vegetation. In some places, the canal cannot even be seen because of the thick vegetation, and it is very difficult to work along the canal. At some places, hand-over-hand climbing is required to reach the canal. However, because of the steep slope, the canal needs a minimum of cleaning.

The rest of the main canal has seepage problems. At about 1.3 km, the canal bifurcates into two branches which run parallel along the same hill for about 1.5 km before rejoining into a single canal. It appears that the purpose of the lower canal is to trap the seepage water from the upper canal. The lower canal was constructed later. The branched portion of the canal is steep, but less so than the head reach of the canal.

The remaining portion of the main canal (1.2 km) also has major seepage problems. In this portion, the soil in the canal banks is loose, and big cavities were observed in many places along the canal. Leakage may be as much as 40 percent in this portion of the canal.

The cross sections of the canal vary from place to place. Some portions of the canal are about 30 cm wide, but other portions are about 2.50 m wide, depending upon the slope. The full supply capacity of the canal seems to be about 500 l/s.

At 4.0 km the command area starts. Satra Say Phant does not have any branch canals but it does have 23 field channels to irrigate the 40 ha in the system. The system has no structures except for some dry masonry retaining wall along the banks of the main canal. There are no cross drainages, no regulating structures, and no measuring structures. Water distribution is approximate.

3. Soils

The terraces have mostly loam soil with good depth and texture, as it contains much humus. Below the terraces, the flatter land is sandy loam with little humus. The waterholding capacity of the area appears to be satisfactory. The soil is fertile, and fertility is maintained with adequate applications of manure and other fertilizers.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

A few large landowners, perhaps 7 or 8, hold large parcels of land (2.0 to 2.5 ha) compared to other hill sites. The smallest landholder identified owned 0.05 ha. We estimated the average landholding at approximately 0.5 ha. Approximately 70 percent of the cropland is owner-operated. The other 30 percent is sharecropped 50:50 -- half of the agricultural output goes to the landowner and half to the sharecropper.

Almost all the farmers in the area are Brahmins and perhaps 10 percent of the Satra Say Phant farmers are Magars. The pradhan panch for nearby Bandipur Panchayat, however, is Magar. Brahmins, however, seem to dominate the irrigation committee and all irrigated agricultural activities.

A major feature of Satra Say Phant is the Kathmandu-Pokhara highway, which bisects the command area. A high volume of commercial traffic and public transportation pass over this road. Access to Pokhara and Kathmandu, therefore, is relatively easy for Satra Say Phant farmers.

2. Irrigation Organization

The local people believe that Satra Say Phant is 200 years old. Before the land survey in 1968, this area was known as Adhikary Phant. After the survey, the area was named Satra Say Phant, because the land measurement came out to be 1699 mato muri (21.6 ha). The local people added one more and made it 1700 (Satra Say). The command area today is larger.

Until 1979, the irrigation system was looked after by a jimawal. A jimawal is a government agent who is responsible for collecting land revenue on behalf of the government. If the revenue collection falls short of the quota for the area, he must pay the revenue difference himself. Since irrigation contributes to productivity in the land, the jimawal looks after irrigation as well. When the harvest is not good, revenues fall short, so the jimawal is active in order to maintain the productivity of land within his assigned area. Since he is the government agent in the village, he is respected by the farmers and his orders are carried out.

After the jimawal system was discontinued in Satra Say Phant in 1979, a seven-member committee was formed to look after the irrigation system. Currently, they have a 10-member committee with a chairman, vice chairman, secretary, treasurer, and six other members. The secretary has been the same person since the committee was formed.

The committee has written rules which are updated each year after discussion. There were 45 irrigators registered as members in 1979 and 1980. Currently, there are still 45 members according to the record of the committee.

The tasks of the committee are to maintain the system and repair the dam annually, guard the dam during main crop cultivation (paddy); and allocate water to each farm within the command area. The irrigation organization is kept alive and active because Satra Say Phant has a serious water rights conflict with Yampa Phant, another farmer-managed irrigation system, at the source of the spring.

D. CHARACTERISTICS AND PERFORMANCE OF THE SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

Sharing the Aadi Mul Spring with Yampa Phant irrigation system has been an issue for generations. The Satra Say Phant irrigation system attempts to direct all of the spring's water into their main canal. When Satra Say Phant farmers divert the spring water into their canal, the lower sections of Yampa Phant are deprived of water. Therefore, the farmers of Yampa Phant frequently break the Satra Say Phant brush dam to feed water to the canals going to Yampa Phant. For this reason, protecting the dam in order to secure a steady flow of water is a prominant task of Satra Say Phant's irrigation committee.

The committee assigns six different persons for each night to guard the dam. Each group reports any activity to the chairman the next morning when they return from the dam.

After the irrigation committee took over water distribution from the jimawal, the farmers found that they could not do the job satisfactorily as a group. The committee then contracted the responsibility for water allocation and distribution to a person called a water supervisor. The contract is reviewed each year, and the water supervisor's performance is evaluated.

During the summer paddy season, water is allocated along the main canal by the supervisor. The farmers have used the same allocation procedures for many years. Though there are no pucca outlets along the main canal, the size of the outlets is fixed according to tradition. When someone needs water, they give the water supervisor four to five days advance notice. The water supervisor allows water to flow into the first outlet until all the lands there are wet. He then rotates water from outlet to outlet from head to tail along the main canal until all the fields are wet. This procedure is repeated throughout the season.

When the rains are late or do not come during summer paddy season, the water supervisor divides Satra Say Phant into four blocks and allocates water for 24 hours to each block. For his work, the water supervisor receives from each farmer 2 kg of paddy per ropani (0.05 ha). Farmer responsibility for delivery begins at the individual field channels.

Those farmers who do not conform to the water distribution system, are fined. The first violation fine is Rs. 5, the second violation fine is Rs. 50, and the third violation fine is Rs. 100. If a farmer neglects to pay the fine, water is not given to his farm.

The water supervisor is responsible for keeping the water flowing in the canal. If the water supervisor shows partiality in distributing the water, he is fined Rs. 5 the first time and Rs. 10 the second time.

Unauthorized water use is prohibited. The first violation fine is Rs. 50; the second violation fine is Rs. 100. Besides the fine, offenders are required to compensate for any damages.

If someone damages the dam, he is fined Rs. 100. This rule applies to irrigators and non-irrigators and is directed against the Yampa Phant farmers.

During the winter and early paddy seasons, the water supervisor does not allocate the water. It is the farmers who plant crops in those seasons who are responsible for allocating water along the main canal. When a water shortage is severe, the committee determines the rotation for water distribution.

2. Maintenance

When the jimawal managed Satra Say Phant, 128 men were mobilized for main canal maintenance each day until the work was completed. The command area was divided into 4 blocks; 32 men from each block contributed their labor. Today, these blocks are the basis for the rotation system for water distribution during stress periods.

After the irrigation committee was formed, they locally contracted for the annual maintenance of the main canal. The lowest bidder for the job is given the contract for the year. In 1985, the contract amount for the maintenance work was Rs. 1000. The vice-chairman of the committee supervises the contractor. Dam repair is also done through a contractor. To construct the brush dam is not difficult and does not take many laborers.

The maintenance supervisor for Satra Say Phant is responsible for beginning maintenance in June or earlier. The maintenance supervisor receives a lump sum of money from the irrigation committee, and

he must perform all of the main system maintenance using that money. The farmers contribute Rs. 5/ropani (0.05 ha) for maintenance. However, if there is a large breach in the canal, all members must contribute labor for the repair.

In the winter and early paddy seasons, only the farmers planting crops are responsible for main system maintenance. They must clean and maintain the system using their own resources.

3. Conflict Management

The major source of conflict for Satra Say Phant farmers is the disagreement with Yampa Phant farmers over water rights on the Aadi Mul Spring. This is a perennial conflict and has never been satisfactorily resolved. Internal conflicts at the farm level are settled by the individuals involved. Other conflicts are settled by the committee. Farmers reported that they had no conflicts in the system over water distribution.

4. Water Adequacy, Reliability and Equity

All of the sampled farmers of Satra Say Phant reported that water was inadequate and untimely in the winter and spring seasons. Sometimes shortages of short duration were reported in the summer (monsoon) season as well. Water shortages, sometimes due to leakage in the main canal, are a critical element in Satra Say Phant irrigation system performance.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

The agriculture of this area is predominantly subsistance. Paddy is the main crop, followed by wheat, maize, lentils, peas, potatos, and some vegetable crops. Ginger is being introduced as a cash crop. A few farmers have started growing vegetables to supply to a nearby market.

The area under different crops varies greatly from year to year depending on the availability of irrigation water. All farmers grow late paddy. Farmers expressed a preference for early paddy crop. At Satra Say Phant, 30 to 35 percent of the total command area is cropped with early paddy. Wheat is cropped in 55 percent of the area, followed by peas, maize, lentils, and other crops.

Different cropping patterns have been adopted by the farmer. The predominant patterns are:

a) Early paddy - late paddy - wheat

b) Early paddy - late paddy - lentil/pea

c) Maize - late paddy - wheat/lentil/pea.

Some winter cropping of wheat and mustard is also practiced.

Cropping intensity varies from place to place depending on water availability. Usually three crops are grown at the head of the system. Cropping intensity is higher at the head (185%) than at the tail (160%) (lentils, maize, and peas not included).

2. Production Inputs

The farmers' use of improved varieties is limited to early paddy followed by wheat, maize and late paddy. The area under different improved varieties of paddy is about 25 to 30 percent.

Farmers purchase 10 to 15 percent of their wheat seed through the agricultural cooperative. Seeds of other crops, including wheat, are either produced by the farmers themselves or are exchanged among farmers. Timing, availability, and the high price of seeds are the contributing factors to poor seed sales.

The use of inputs like fertilizers and pesticides is limited, which is understandable in view of the small holdings and poor economic status of the farmers. Manure is used extensively for early paddy, wheat and maize. Areas growing three crops (early paddy - late paddy - wheat) usually receive some fertilizer as a top dressing.

The extension service is available, and a production campaign by blocks was recently organized. Some minikits containing a package of inputs such as fertilizer and pesticides have been given out and some demonstrations have been done, but without followup. Production credits are available through local cooperatives.

In view of the ease of transport to market and the existence of subsistence agriculture, marketing presents no problems.

3. Yield

The average yields from the crop cutting reports are presented in the following table.

Average Crops Yields for Satra Say Phant Irrigation System

Crop	Average Yield (mt/ha)
Early Paddy	3.12
Late Paddy	2.70
Wheat	1.65
Maize	2.50

An improved variety of paddy (Savitri) has yielded more than 4.5 mt/ha. Total crop yield per year for three crops varies from 6.3 to 7.5 mt/ha.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) There is a great deal of organizational solidarity at Satra Say Phant. There are extensive written records and accounts, and all members collectively protect the system's water right from the Yampa Phant farmers.

b) The organization is responsive and able to react to changing situations. As many Satra Say Phant farmers have found additional employment elsewhere, the organization has contracted people to perform essential irrigation tasks. Members know who is responsible for these tasks.

c) The steep slope in the upper half of the main canal over a small area means that there is less chance of leakage and/or seepage.

d) There is a good intake structure (the brush dam and rock tunnel) at the water source.

2. Weaknesses

a) There is usually insufficient water at the source.

b) There is considerable leakage and seepage along the lower half of the main canal. The contractors do not appear to maintain the system adequately.

3. Summary and Conclusions

The main canal of Satra Say Phant is about 4.0 km with a very difficult alignment, and slopes of about four percent. The entire length of the main canal before it reaches the command area is in thick forest. The last third of the main canal has very serious seepage and canal breach problems.

The source of the system is a spring. Since the high flood discharge of the system is only about 1000 l/s, there are no problems at the intake.

This system was originally managed by a jimawal and is now managed by an irrigator's committee. The Satra Say Phant farmer-managed system has a formal organizational structure with written regulations. Over the years, the organization has adapted to changing circumstances; i.e., the construction of the Kathmandu-Pokhara highway, increased employment opportunities outside of agricultural sector, and hiring contractors to carry out specific irrigation tasks. About one-fourth to one-third of the land is sharecropped, as farmers have begun leaving agriculture. Because of the external threat to their water source and the single caste area, the Satra Say Phant farmers possess a great deal of group solidarity.

Specialization of work is prevalent in the system. Water management and allocation is carried out by a person assigned to these duties. Maintenance through a contract paid by financial contributions from irrigators are examples of job specialization induced by internal and external economic and social factors in this area.

The command area, while producing more than double the national average in crops per unit of land, is still of subsistance nature, as is indicated by the limited use of inputs and new irrigated agriculture techniques. Growing more cash earning crops and adopting high-production strategies are needed.

5. YAMPA PHANT IRRIGATION SYSTEM

A. INTRODUCTION

Yampa Phant is a farmer-managed irrigation system situated in Tanahu District about 80 km east of Pokhara. It is located on the north side of the Kathmandu-Pokhara highway across the Aadi Mul Khola Valley from the Satra Say Phant farmer-managed irrigation system (Figure 9). Yampa Phant irrigates Ward 8 of Bandipur Village Panchayat. Yampa Phant is an old system constructed by farmers. Nobody knows when it was constructed.

The gross command area of Yampa Phant seems to be about 40 ha. The average land slope of the command area is about four percent.

Yampa Phant is divided into three subsystems, each having its own canal. The canals are called the Jaise (the upper canal), Baraha (middle level), and Kukhure (lower canal). For the purposes of the rapid appraisal, the team looked at Baraha canal in detail. The specific information given here for Baraha canal may or may not apply to the other two canal subsystems in Yampa Phant.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

Baraha Canal in the Yampa Phant irrigation system is supplied by the significant amount of leakage that comes through Santra Say Phant's dam on the upper Aadi Mul Spring, and by Jaise Kulo, which is also fed by a spring (Sano Aadi Mul) and irrigates the upper terraces of Yampa Phant. The Sano Aadi Mul Spring is roughly half the size of the Aadi Mul Spring, according to the farmers of Yampa Phant. The farmers at Yampa Phant do not have an agreement with the Satra Say Phant farmers for sharing the water of Aadi Mul Spring. Hence, during water shortages, farmers from Yampa Phant frequently destroy the Satra Say Phant dam on Aadi Mul.

The maximum discharge of the Aadi Mul at the intake point in combination with the Sano Aadi Mul Spring seems to be about 1.5 cumecs and the minimum about 100 l/s.

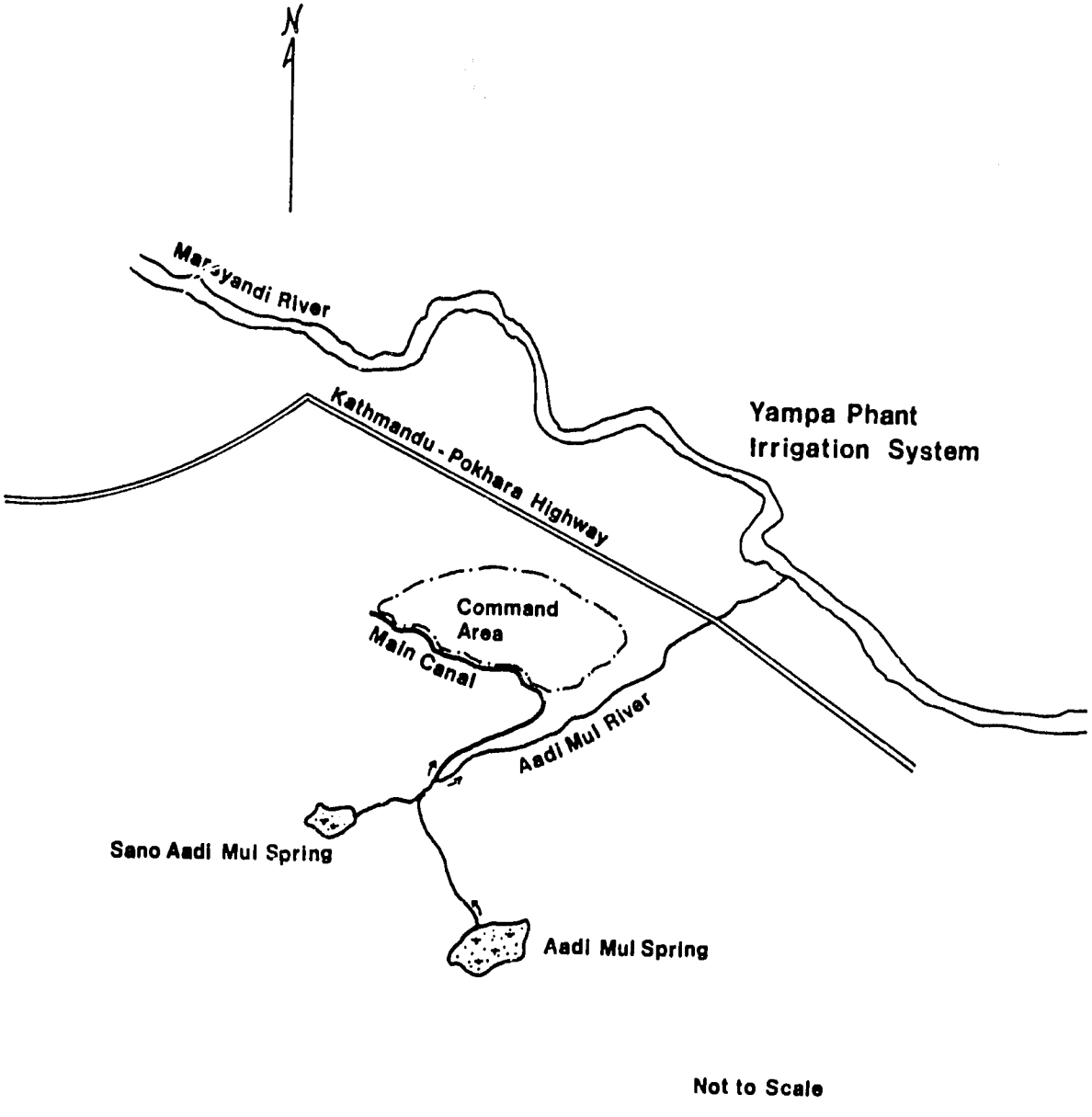

Figure 9. Yampa Phant Irrigation System

2. Canals and Structures

The intake structure for Yampa Phant is quite stable. It is a rock-fill weir about 2 m high and 15 m long. There are no regulating structures at the intake. As maximum discharge is relatively low, flooding is not a problem at the intake.

The main canal runs for about 2 km. There are no drainages that cross the main canal. The average width of the main canal is about 1.5 m and the maximum depth of water in the canal is about 0.3 m. The full supply capacity of the main canal seems to be about 200 l/s.

The condition of the main canal seems quite good along the first 1.5 km. The bank width for that distance is about 1.5 m. Farmers irrigate from the main canal starting at about 1.5 km. There are no branch canals. Instead, the water goes directly from the main canal to field channels. There are 12 outlets on Baraha Canal. There are no measuring structures in Yampa Phant, and the only other structure is a dry-stone masonry retaining wall on the valley side of the main canal to prevent canal breach.

3. Soils

The terrace fields have mostly loam soil with good depth and texture as they contain much humus. Below the terraces, the flatter lands have soil that is sandy loam with little humus. The waterholding capacity of the area appears to be quite satisfactory. The soil is fertile and the farmers maintain the fertility by applying manure and some fertilizer.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

The Yampa Phant farmers appear to have slightly smaller landholdings than their neighbors in Satra Say Phant. The largest landholding in Yampa Phant may be about 1.5 ha with the average landholding under 0.5 ha. Most of the farming is done by owner-operators.

Brahmins are the predominant caste in the area, but a Kulmi settlement is also present. The Kulmi provide some agricultural labor on the Brahmin farms.

As in Satra Say Phant, the Kathmandu-Pokhara highway bisects the small command area. Access to these urban centers is easy for the Yampa Phant farmers.

2. Irrigation Organization

According to an informant in the village, the main canal of Yampa Phant is older than that at Satra Say Phant. Originally, Baraha Kulo was constructed to irrigate the trust land (guthi land) of the Baraha temple. The produce of the guthi land was used to manage the Baraha temple, which is located at the source of the irrigation water. The goddess of the temple is considered a protector by the people of Satra Say Phant and Yampa Phant.

Disputes over water rights between the people of Yampa Phant and Satra Say Phant have occurred frequently. In the early 1950's Satra Say Phant farmers filed a case in court to establish their water rights. The case reached Pradhan Nyayalaya (supreme court) in 1953, and the court decided that the water should continue to be divided in half between Yampa Phant and Satra Say Phant as was traditional. (The Nepali word "aadi," in Aadi Mul Spring, means half.) This left the issue unresolved, as farmers from each system claimed rights to the water. Satra Say Phant farmers built a dam on Aadi Mul to protect and ensure a steady water flow. The continued dispute, however, has strengthened their respective irrigation organizations as farmers have fought to maintain water rights.

According to the secretary of Yampa Phant's irrigation organization (who also manages the Baraha canal), the objective of Yampa Phant's informal irrigation organization is to get the water supply in the canal by any means.

The Yampa Phant irrigation system does not have a formal committee: one man is responsible for system operation. There are 40 members in the system. When problems arise, 5 to 6 members of the irrigation system get together and decide what to do.

The man given responsibility for system operation inspects the dam and canal each day and measures the water flow in the canal. If necessary, he breaks the Satra Say Phant diversion dam to get water to Baraha. This man also organizes canal maintenance every year.

As there is no formal committee, there are no written regulations. However, traditions have been established, and the members of the system know the informal rules and their obligations. Hence, the system functions well.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE AND WATER DELIVERY

1. Water Allocation and Distribution

If there is no water shortage during the summer paddy season, the main canal runs continuously. When water flows continuously, farmers take water from the main canal as they wish. However, when there is a water shortage, the Baraha canal is divided into half: the upper 6 outlets and the lower 6 outlets. Water is then rotated every 24 hours between the upper and lower outlets. For winter crops and early paddy, there are no set rules. Farmers who plant during these seasons are responsible for allocating water among themselves.

Each group of farmers sharing a field channel is responsible for water delivery to individual farmers, who in turn apply the water to their fields. Those farmers interviewed reported no knowledge of a priority system.

2. Maintenance

The farmers at Yampa Phant are very concerned about main system maintenance. They have devised a rotation system to mobilize labor for maintenance. During the summer paddy season, maintenance responsibility is rotated among the 12 outlets daily. One laborer per day per outlet is required. After 12 days, responsibility shifts back to the farmers served by the first outlet. Within each field channel served by an outlet, farmers also rotate the responsibility for main system maintenance. Each farmer takes a turn inspecting the main canal and making necessary repairs. Everyone participates during an emergency. If a farmer does not show up during his maintenance turn, he is fined the daily wage rate during that period. If he neglects to come on the day of his assignment, he is imposed with a double fine. If his absence is unavoidable, he is allowed to contribute his labor at a later date instead of paying the fine.

3. Conflict Management

The conflict with Satra Say Phant over water rights has not been resolved. For conflicts within Yampa Phant, four to five members of the irrigation system meet informally to resolve the conflict. Conflicts over water distribution are usually settled in favor of the farmer who needs water most urgently.

4. Water Adequacy, Reliability, and Equity

All of the farmers interviewed at Bahara Kulo reported that water is inadequate and untimely at the head and tail of the system during the winter and early paddy seasons. Occasional shortages in the summer paddy season were reported as well.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Agricultural practices are more or less traditional except for the adoption of improved varieties and the use of fertilizer. The small holdings and terraces limit the use of draft animals, and so farmers depend more on manual labor in most of the command area. The cultivation of paddy, wheat, corn, lentils, peas and other crops depends largely on the availability of water in each season. A few head of cattle for draft power, manure, and milk and a few citrus plants are found at the households of the command area.

The general condition of the paddy crop, especially the Savitri variety, is impressive. More than half the command area is under early paddy and wheat; about 10 percent is in lentils and peas and 5-10 percent is under maize. Most farmers follow the cropping pattern of early paddy - late paddy - wheat. Most of the command area grows these crops year-round, making cropping intensity more than 275 percent.

2. Production Inputs

More than 85 percent of the area cropped in late paddy is covered with Masuli and Savitri improved varieties, whereas early paddy occupies 100 percent of the area in improved varieties. Seventy percent of the corn grown is improved and 100 percent of the wheat is improved. Lentils, peas, and beans are local varieties. Fertilizers are used on Savitri late paddy, early paddy and wheat. Extension and cooperative services are available, and farmers depend on the agricultural cooperative to supply wheat and corn seed.

3. Yields

High crop yields are reported from this area. The crop cutting data collaborates the high yield reports. The average crop yields as reported by farmers is presented in the following table.

Average Crops Yields on Baraha Canal,
Yampa Phant Irrigation System

	Head (mt/ha)	Tail (mt/ha)
Early paddy	3.6	2.3
Late paddy	3.5	2.3
Wheat	2.0	1.8
Maize	3.5	2.6

The high cropping intensity at Yampa Phant helps the farmers produce an annual average total yield of 7.5 to 8.0 mt/ha of land for three crops.

Except for a few farmers' resenting the low price of wheat, there appear to be no market problems. However, wheat is slowly being replaced by green peas.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) Cultivation is intense. Many farmers grow three crops with a 300 percent cropping intensity.

b) Farmers are eager to improve their farming techniques, particularly using improved seeds and fertilizer. Better agricultural technology has been extended to this area, and farmers have accepted it.

c) All 40 members of the irrigation organization appear to be equally active and willing to contribute resources for essential irrigation tasks.

d) Farmers are very conscious of the need for effective maintenance to improve irrigation system performance.

e) Most farmers are owner-operators.

f) Farmers are enjoying high paddy yields, due in some measure to the suitable soils in the area.

2. Weaknesses

a) There is usually insufficient water at the source.

b) The main canal has no pucca structures.

c) No formal record-keeping exists within the irrigation organization.

3. Summary and Conclusions

Yampa Phant irrigation system is small -- about 40 ha on highland terraces. There is a conflict over water rights between the farmers of Yampa Phant and those of Satra Say Phant. The main canal seems to be in good shape and is stable. There are no drainages across the main canal.

The Yampa Phant farmer system possesses an informal, but very alert and active organization. Tradition, rather than formal, written rules and regulations dictate farmer irrigation behavior. Written regulations may not be that important for managing this system. Having a strong tradition known to all members of the irrigation system makes the system functional and effective.

Upper caste Brahmins are owner-operators and do not rent out their land. This agrarian structure also contributes to group solidarity despite the absence of a formalized organizational structure.

The total command area of the system appears to fully utilize the available irrigation water by growing three crops in a year. The introduction of improved varieties of cereals appears to be satisfactory. However, farmers have adopted few improved agricultural practices, including plant protection measures. Lentils and peas are being grown in larger areas which need to be seeded with better varieties. Production inputs have to be accelerated with more intensification in production.

IV. DIHM-MANAGED TERAI SYSTEMS

1. PANCH KANYA (UPPER KHAGERI) PROJECT

A. INTRODUCTION

The Panch Kanya Project was constructed and is operated by Chitwan Valley Development Project of DIHM with the financial assistance of the Asian Development Bank. This project irrigates Wards 4, 5, 6, 7 and 9 of Ratna Nagar Village Panchayat about 8 km east of Bharatpur along the Bharatpur-Hetauda highway (Figure 10).

The main system started operating in 1980, but some of the branch and lateral canals (field channels) have been built only recently. Some of the lateral canals are still under construction.

The gross command area of the system is about 600 ha, but due to various factors, the system currently irrigates only about 300 ha. By improving portions of the main canal, structures, source of water and some of the lateral canals, the command area can be extended up to 600 ha.

The Panch Kanya irrigation system is located on the middle terraces of the Narayani and Budhi Rapti Rivers' flood plains. The land slopes less than .5 percent through most of the system except at the tail where the slope increases to 1 to 2 percent.

There are two important features of Panch Kanya. One, the physical system is in great disrepair, with excessive leakage and seepage. The water distribution is poor throughout the system and farmers are vocal in their complaints about system operation and maintenance. The second important characteristic of Panch Kanya is the existence of a farmers' irrigation committee in at least some portions of the system. This committee was established by the farmers, and members attempt to manage water despite the serious physical problems in the system.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

One water source for the irrigation system is the Panch Kanya River, which is spring-fed. Since the Panch Kanya River is not large enough to fully supply the irrigation command area, the project has already constructed an intake (except fixing the regulator gate) from

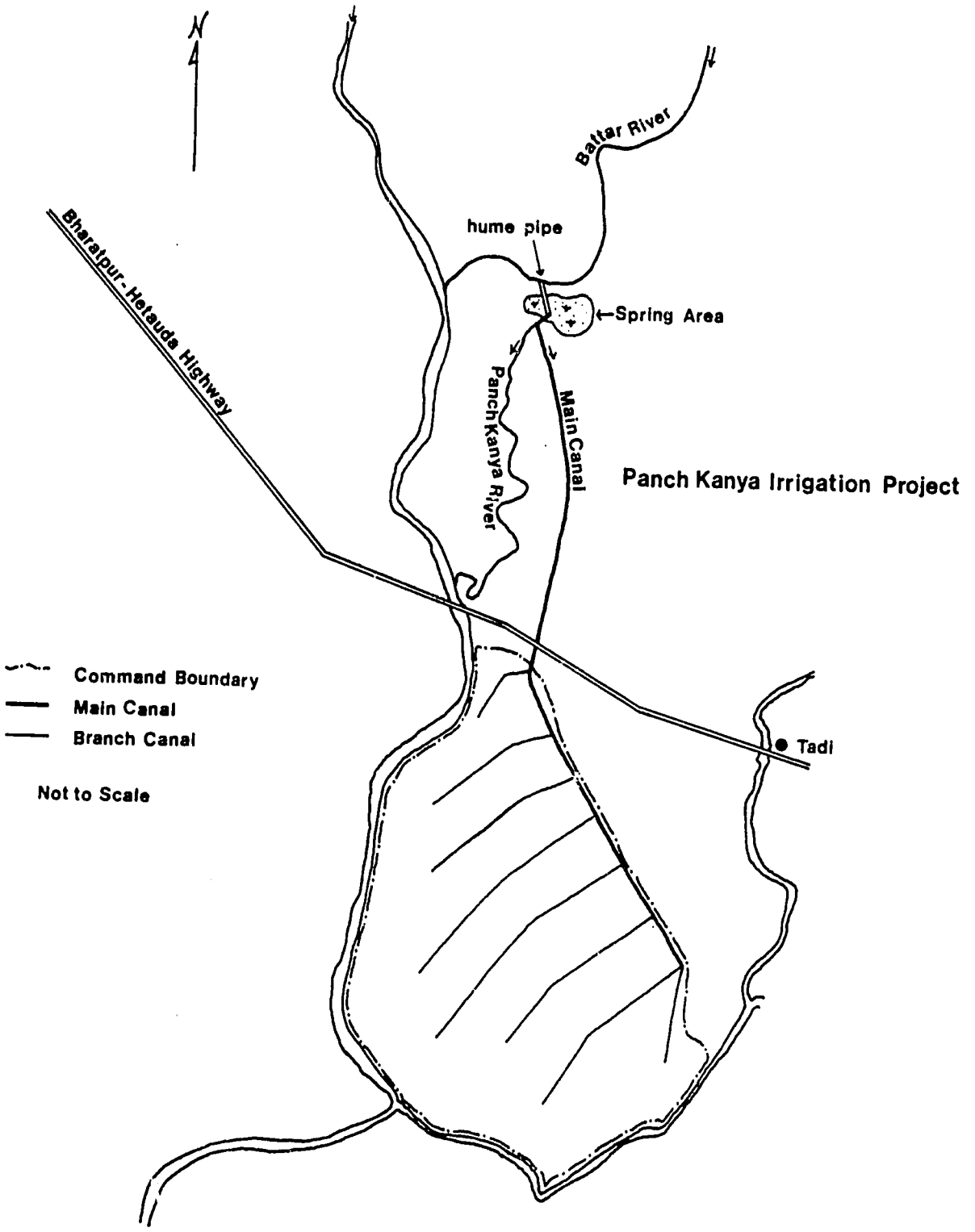

Figure 10. Panch Kanya Irrigation Project

Battar Khola (about 125 m west of Panch Kanya) to divert water from the Battar Khola to Panch Kanya using 1 m diameter underground hume pipe. A steel gate at Battar Khola to divert water to Panch Kanya scheme is expected to be erected this year. Hence, after the diversion of Battar River, the system should have enough water for late paddy and a winter crop.

Though the system seems independent, it is indirectly related to the pump canal of Chitwan Valley Irrigation Development Project and the old Khageri irrigation system. It is planned that the Battar River, which is currently the source of the old Khageri system, shall be diverted to the Panch Kanya irrigation system. To offset the diversion, a pump canal is to supply water to the old Khageri system to irrigate the western command area of this system. As long as the pump canal continues to supply water to the old Khageri system, diverting the Battar River to Panch Kanya may not cause any problems.

2. Canals and Structures

The main canal of Panch Kanya irrigation system is 4.8 km long. The capacity of the canal varies according to the command area of each section as shown in the following table. The idle length of the main canal is about 1.5 km. Judging by size, the main canal should have enough capacity to command 600 ha.

Main Canal Bed Width, Full Supply Depth, Canal Grade, and Design Discharge at Panch Kanya Irrigation System

Chainage (km)	Canal Bed Width (m)	Full Supply Depth (m)	Canal Grade	Designed Discharge (l/ha)
0.00 to 1.557	1.50	1.17	1:2500	1700
1.557 to 1.898	1.40	1.13	1:2000	1500
1.898 to 3.092	1.20	1.10	1:2000	1320
3.092 to 3.646	1.00	1.05	1:2000	1050
3.646 to 4.80	0.90	0.80	1:2000	540

At 1.5 km the main canal crosses the Bharatpur-Hetaunda highway. At this crossing, a 1.0 m diameter hume pipe goes under the highway. Up to 1.5 km, the right bank of the main canal is completely lined and the left bank is partially lined. From 1.5 km to 3.646 km,

the main canal is completely lined with stone masonry. The side slope of the main canal throughout its length is 1:1. Along the main canal there is a road that is passable to 4-wheel drive vehicles. The main canal does not have any other structures except one hume pipe crossing the highway and head regulators for the branch canals.

Eight branch canals take off from the main canal. The average area commanded by each branch canal, and the length and capacity of the branch canals are listed in the following table.

Length, Capacity and Approximate Command Area for the Branch Canals in Panch Kanya Irrigation System

Branch Canal	Chainage from Main Canal (km)	Length (km)	Capacity (l/s)	Approx. Command Area (ha)
F1	1.898	1.20	180	90
F2	2.200	0.80	120	60
F3	2.800	0.80	120	60
F4	3.092	1.60	120	60
F5	3.646	1.50	180	60
F6	4.064	2.20	180	90
F7	4.246	1.80	120	60
F8	4.800	2.20	240	120

Most of the branch canals are earthen, although some sections are lined with stone masonry. In addition to the branch canals, there are a large number of field channels for water distribution. The system does not have regulators on the branch canals to the field channels.

Though the system has a good network of field channels and branch canals capable of irrigating 600 ha of land, the system currently irrigates only about 300 ha -- most likely due to the following reasons:

1) A current shortage of water because the Battar River diversion to Panch Kanya is not yet complete.

2) The poor condition of the main canal up to 1.50 km, probably due to poor construction. A road follows the eastern canal bank. Along most of this 1.5 km, the western bank opposite the road is very narrow. Perhaps more than 50 percent of the water seeps through the narrow western bank through the deteriorated lining. Local DIHM officials also stated that this excessive leakage is one of the most serious problems they face. Major repairs are needed in this portion.

3) The 1.0 m diameter hume pipe at the highway crossing at chainage 1.500 is too small to convey the needed discharge.

4) From chainage 3.600 to the tail, a drain runs along side the main canal. At places, the bed level of the drain is 1.0 m below the bed level of the main canal. Even though the main canal is lined, a large amount of water seeps from the main canal into the drain. This excessive seepage is another major problem identified by local DIHM officials. Looking at the tail of the main canal, it appears that water has never reached the tail.

5) Most of the branch canals are not functioning because of poor leveling and construction, although some of the branch canals that were constructed later seem to function quite well. Due to the water shortage and the poor condition of the main canal up to 1.50 km, the seventh and eighth branch canals have never received water. The development of field channels and the improvement of branch canals are still to be done.

3. Soils

The soils of the area are of recent alluvial origin that show little profile development in the 50 cm depth inspected. The soils in the head to middle reaches are medium-textured loams. Toward the tail and especially in the lower elevations approaching the Budhi Rapti River, the soil is a finer clay loam. The soil is fertile. The watertable lies about 10 feet below the soil surface.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

The Chitwan Valley is known as the "76th District" of Nepal, although Nepal only has 75 districts. The name derives from the great number of people who have immigrated to Chitwan from all over Nepal in the last 20 years. The relative prosperity of the valley is evident in the many rubber-wheeled bullock carts and tractors seen in the area. The following table shows the villages served by Panch Kanya Irrigation Project.

Villages Served by Panch Kanya Irrigation System

Villages	Approx. Area (ha)
Sisai	100
Dbekwa	34
Bhojad	20
Tekauli	17
Bhedi	11
Mohana	100
Nipauni	Not Available
Lower Mohana	100
Debauli	48
Gadauli	51
Bagmara	68

Land

There appear to be four socio-economic classes of farmers at Panch Kanya irrigation system: large landowners, medium and small landowners, landowner-cum-sharecroppers, and landless laborers and pure sharecroppers.

The largest farms in the area are estimated to be 15 to 18 ha. These large farms are relatively rare; most larger landholders appear to own 6 to 9 ha. The fields of the large landowners seemed equally distributed from the head to the tail of the system.

Most farmers at Panch Kanya own 0.3 to 1.2 ha. In the areas near the head, however, the smallest landholder was identified as having 1.3 ha of land. A few farmers in Panch Kanya own less than

0.15 ha. One written source reported that the average landholding per family in Panch Kanya is 0.7 ha, down from 1.6 ha in 1972.

Owners-cum-sharecroppers are fairly prevalent in the area -- estimated between 10 and 20 percent of the farmers. Most of the sharecropping at Panch Kanya appears to be shared 50:50, with the landowner providing seeds, but no other inputs.

Most sharecropping occurs during the paddy season. The sharecropper and landowner are often relatives, and thus, the question of tenancy rights does not often occur. We were also told that many landowners have sold land they didn't need in order to avoid conflicts with Nepal's Tenancy Act. Lower castes were the primary sharecroppers at the tail of the system, though some farmers stated that Brahmins and Chettris also sharecrop. We were also told that some Brahmins and Chettris own no land.

Many of the landless people who sharecrop live near the head of the system in the small bazaars on the Bharatpur-Hetauda highway. There are agricultural laborers in the area who earn approximately Rs. 15 to 20/day, or Rs. 30/day for plowing if they use their own bullocks. Women laborers earn less, about Rs. 10 to 12/day. Many of these seasonal agricultural laborers migrate to Chitwan from India.

Other landless people semi-contract their labor to landowners. Halis, for instance, are agricultural laborers who work for Brahmins, especially to help plow. At Panch Kanya, we found semi-contract laborers who were allowed to farm 0.1 to 0.2 ha and were paid about Rs. 1,500 per year. The laborer could keep all the produce from his plot of land, but had to provide labor to the landlord whenever the landholder needed help. When not working for the landlord, however, the laborer was free to sell his services to any other landowner.

Castes and Ethnic Groups

There are a number of different castes and ethnic groups at Panch Kanya including Brahmins, Chhetris, Tharus, Darais, Gurungs, Kumals, and Tamangs. One prominent farmer estimated that in the total command area, Tharus make up approximately 50 percent of the population.

The castes and ethnic groups are scattered throughout the system, though each group usually settles in a particular area. For instance, there are Tharu villages along branch canal 1 and near 6, and Brahmin settlements were found near branch canals 4 and 5.

A Darai farmer said there was no discrimination among castes in water distribution or in other matters. The list of the main system committee members shows seven Brahmins, three Tharus, and one Tamang. A Brahmin widow who owns 3 ha of land, however, did claim

that there was discrimination against women in the area. She said that after planting her paddy this year, she had to wait one month for water, while male farmers in her area did not have to wait that long.

Farmers contacted said that all castes cooperated in irrigation activities. Some farmers said inter-caste cooperative activities ended with irrigation. Other informants, however, reported that members of different castes and ethnic groups often help one another build schools and roads, and attend each others' weddings and funerals.

Power

Power in the community seems positively related to landholding size, but other factors are also important. Farmers stated that education and economic well-being also contribute to a person's power. (Of course, education and economic well-being are often associated with landholding size.)

Caste was not reported as a major contributor to individual power, at least among castes. Many farmers commented on the status and power of a Tharu farmer who owns 15 ha. Other farmers reported that a Brahmin with 3 ha would have more power than a Tharu with 6 ha, but only if the Brahmin was more involved in community affairs. In Chitwan, where many farmers are comparatively recent immigrants, traditional indicators of power (i.e., size of landholding) may not be as important as in other areas.

2. Irrigation Organization

The five springs that feed Panch Kanya River were the source of water for a farmer-managed irrigation system constructed 77 years ago by the Tharu community to irrigate 60 ha of land in Surrai and Bhojad villages. A *jamindar* took responsibility for irrigation system management. In June-July, the irrigators, under the direction of the *jamindar*, made a brush dam near the Panch Kanya springs and cleaned the canal. All the members of the household, excluding women within the village, had to volunteer their labor. Those who failed to participate had to pay a fine which usually was equivalent to one day's wage. Water was distributed on rotation when water supplies were low. If a farmer did not follow the rotation schedule and stole water from another's turn, he would be deprived of water in his turn.

With malaria eradication, new roads, and the clearing of forest after 1956, people began immigrating to this area as elsewhere in Chitwan District. More land was brought under cultivation and the demand for irrigation water increased. Eventually, the farmers of Ratna Nagar Village Panchayat worked to develop an alternative source of irrigation water.

Expanded Panch Kanya Irrigation System

The Department of Irrigation undertook the responsibility of expanding the irrigation system and began constructing the scheme eight years ago. Irrigation water was released six years ago at Gate 1. Gate 1 starts from the south side of the Bharatpur-Hetuada highway at Ratna Nagar Village Panchayat. This area used to receive irrigation water from the traditional farmer-managed irrigation system.

The command area of the expanded irrigation system is about 600 ha. Water is now released from four gates at the main canal. Farmers complain that the water flow in the canal is insufficient. This complaint was discussed with DIHM officials in charge of the Chitwan Irrigation Project. They gave the following reasons for insufficient water flows in the system:

1) An attempt was made to take supplemental water from Battar River to the intake of Panch Kanya last year, but gates were not ready.

2) The high water leakage from the canal north of highway has resulted in the loss of a tremendous amount of water in the system.

3) The bend of the canal under the highway has reduced the flow of water in the canal south of highway.

The Irrigation Committee

The irrigators water management committee for Panch Kanya irrigation system was formed some time ago. The current committee was elected two years ago. The present committee has 11 members including the chairman. The functions of the committee are:

1) to prepare the water distribution schedule for the outlets considering the proportion of water to the land irrigated and the type of land. (There are two types of land: lowland, which does not require water, and upland, which requires irrigation water.)

2) to settle the conflicts caused by water share.

3) to give water priority to farmers holding less than 1.0 *bigha* of land (0.66 ha).

4) to supervise the construction of the canal.

5) to mobilize voluntary labor to maintain the system as and when it becomes necessary.

6) to communicate and discuss the problem of irrigation with the irrigation authorities responsible to Panch Kanya Irrigation Project.

Outlet Sub-Committees

There are currently four outlet sub-committees consisting of 5 members each. The chairman of the sub-committee is a member of the irrigation committee. The sub-committee is supposed to allocate water within the outlet command area, mobilize people to clean the channels, and resolve water share conflicts.

Outlet 5 has no sub-committee because water cannot be delivered at the tail end, according to the chairman of the irrigation committee.

Separate Systems Within a System

During field observations, two systems were identified within Panch Kanya command area that supplement water in the command area. To trap the drainage and seepage water from north of the highway, a separate canal was constructed with farmers' contributions to supplement water in the command area of Outlet 1.

The Mohana canal traps water from the lowlands of Nipari. This canal irrigates about 40 ha of land in Mohana and Gadauli villages. There are 33 irrigators in this system. By household, the irrigators in the command area contribute labor for cleaning and maintaining the canal. This year, the irrigators contributed 2 days of labor. Those who fail to participate are fined the equivalent of a day's wage. The irrigators would like to continue operating the Mohana system.

Farmers interviewed in the villages served by Panch Kanya have expressed the opinions that, except in some places near Bagmara, water has come, but not in sufficient quantity; the rotation period is too long; and the field channels are not level so water hardly flows in the uneven field channels.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATIONS, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

The Pancha Kanya irrigation system is plagued by excess leakage in the first 1.5 km of the main canal and also at the tail of the system near branch canals 4 and 5. As the water supply decreases, it is more difficult for farmers and DIHM officials to allocate water efficiently along the main canal. When there is sufficient supply, water flows continuously in the main canal. During much of the paddy and winter season, however, a rotation system must be used. Although farmers along the branch canals gave different answers concerning the amount of irrigation time allocated to each branch canal, most said that they had to wait 15 to 2 days to receive water.

There are formal, written rules for allocating water at Panch Kanya irrigation system. Since the project is technically still under construction, DIHM has not yet instituted a set of allocation procedures. The farmers' committee derived the allocation rules and developed a rotation schedule for the branch canals. Based on the size and type (upland, lowland) of land at each branch canal, water is allocated for a set number of hours. The larger the area and the more upland farms, the longer the number of hours. If there is not enough time to get water to all fields along the branch canal, the dry fields must wait until the next turn.

The farmers themselves also distribute water along the main canal by putting mud and rocks into the outlets to close them. They also have tools to open and close the regulator gates. One farmer said that it takes two farmers to open an outlet gate along the main canal, but it can be done. Local DIHM officials stated that dhalpas open and close the gates along the main canal.

Farmers at branch canals 4 and 5 stated that they are the last people on the system to receive a consistant water supply. Even at this "tail" of the system, farmers know the main system rotation schedule and how many hours of water their branch canal is scheduled to receive. They stated that it is very hard to follow the rules, however, and often they take water whenever they can.

Farmers further down the system on branch canals 6, 7 and 8 rarely receive water reliably. Some of them rent diesel pumps to lift water from the river to irrigate their fields.

Water charges are rarely collected from the farmers. DIHM has given the farmers' committee the responsibility for collecting the

fees. Committee members, however, say that they cannot collect the water charges from farmers if reliable water is not supplied to them.

2. Maintenance

Farmers at Panch Kanya said that DIHM rarely, if ever, provides maintenance along the main canal. They stated that the farmers must clean the canal annually, usually before the paddy season. The farmers said that they clean the weeds from the main canal, primarily at the head, but that de-silting is too difficult for them to do alone.

Further down the system, near branch canal 3, a farmer said that area farmers used to clean the main canal, but now that the canal is lined up to his land, he has no need to participate in main canal maintenance. It is unclear how much maintenance work is performed by farmers at the tail.

Local DIHM officials stated that farmers do not maintain the main canal. These officials said that DIHM maintains the main canal through the services of a contractor. The officials called the work of the contractor unsatisfactory.

DIHM officials stated that their biggest main system maintenance problem was working with the farmers on branch canal maintenance. Officials said that along the branch canals some farmers participate in cleaning and maintenance, while others don't. Until the responsibility of branch canal maintenance is clarified, officials feel that problems will continue.

It was reported that farmers clean field channels as a group once in a season at the initiative of a farmer. Farm channels were reported to be cleaned seasonally by individual farmers. Non-participation in group maintenance activities is punishable by fining the person the equivalent of one day's wage. Many farmers were unaware of the fine system and others who knew of the fine were sure that it was not enforced.

3. Conflict Management

The inadequate water flow in the system results in conflict between irrigators and DIHM officials, between farmers on one outlet and farmers on another outlet, and among farmers on the same outlet. Almost all farmers at all locations said that conflicts were frequent. Conflicts were usually started by farmers in need of water, were presided over by a member of the committee, and were solved through discussion and negotiation. Conflict between landlords and sharecroppers sometimes occurs, but such incidents are usually of short duration and low intensity. A more common pattern of conflict is larger landowners arguing with smaller landowners.

4. Water Adequacy, Reliability, and Equity

Head and tail (tail defined as branch canals 4 and 5) farmers were interviewed to ascertain their opinions on water adequacy and timeliness. Virtually all farmers said that water was inadequate and untimely in the early paddy season, though two tail farmers reported that water arrived regularly and on time. All head farmers said that water was inadequate in the monsoon paddy season, and approximately half of the interviewed head farmers said that the water did not come at the right time. Surprisingly, half of the tail farmers contacted reported adequate and timely water in the monsoon paddy season. Some tail farmers, however, are able to capture and reuse the drainage water from the higher, upland farms. All head farmers said water was inadequate in the winter and some also said it was untimely. One head farmer said that he had too much water due to the leakage from the main canal. Another head farmer produced winter paddy because his field was so wet due to rain canal seepage. A few the tail farmers reported adequate and timely water in the winter season.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURE SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Currently, water resources are available for about 350 ha of late paddy, 20 ha of early paddy at the head of the system, and 125 to 150 ha of mustard (one irrigation). Based on the availability of water, farmers develop and adapt their cropping patterns and agricultural practices.

The flat topography of land, high precipitation (dew, fog) in the night, and the low to medium watertable have given the farmers the opportunity to grow a large number of crops and vegetables. Paddy, maize and mustard are three important crops grown widely. Wheat, lentils, pulses, vegetables and a few green manure crops are grown to some extent.

The success of the crops, including paddy and mustard, depends on receiving timely rain and supplementary irrigation. Late rain not only affects planting dates and paddy yield, but also determines mustard cultivation and yield.

The cropping patterns in the following table have been adopted by the farmers of the command area. All farmers reported using the traditional calendar to determine cropping times, and there was little difference in cropping patterns between head and tail farmers.

Cropping Patterns in Panch Kanya Irrigation System

Location	Cropping Pattern More Prevalent	Cropping Pattern Less Prevalent
Irrigated lowland	Paddy-mustard-maize	Paddy-wheat-fallow
Partially irrigated lowland	Paddy-mustard-maize	Paddy-lentil
Rainfed lowland	Paddy-fallow-fallow	
Upland	Maize-mustard-fallow	Upland paddy-mustard-fallow or Paddy-paddy-fallow/wheat

According to farmer interviews, at least three-quarters of the land at the head and tail is planted in monsoon paddy, and half the land at the head and tail is planted in mustard. Farmers complained that they often could not plant more crops in the winter because wild animals (rhinos and deer) from nearby Chitwan National Park destroy their crops. In the dry spring season, approximately one-third of the head land is planted with maize, and two-thirds of the tail land.

Cropping intensity varies from 100-250 percent depending on water availability. However, the average cropping intensity of the total command area is reported to be 179 percent (from crop cutting report of 1983).

2. Production Inputs

Draft animals, as well as tractors, are used to prepare land, thresh grain, and transport the produce. Most of the farmers in the command area use improved varieties of paddy, wheat and maize. Masuli paddy is grown extensively as it matures earlier than other varieties of main season paddy, giving farmers ample time to grow mustard (which is predominantly a local variety) as a cash crop. Farmers maintain their own seed except for wheat, which is purchased through cooperatives.

Farmers invariably use fertilizer in addition to using manure primarily in the following ratio for each crop.

Crop	N P K (kg/ha)
Paddy	40-20-0
Mustard	20-20-0
Maize	20-0-0
Wheat	60-30-0

In the monsoon, most head farmers reported using a combination of organic and chemical fertilizers, but some farmers claimed they used no fertilizer on their paddy crop. All tail farmers said they used fertilizer on paddy, usually either a combination of chemical and organic fertilizer, or chemical fertilizers only. For mustard, all head and tail farmers reported using some fertilizer, either purely chemical or a combination of chemical and organic. For maize, some head farmers reported using only chemical fertilizers, while other head farmers and all tail farmers contacted used either organic fertilizer only or organic and chemical fertilizers mixed. Pesticides are being used by the farmers, especially when insect infestations are severe.

Agricultural services and research results are within reach of the command area farmers. The area farmers are served by a junior technical assistant from Chitwan Irrigation Project, District Agriculture Development Office, and also by the cropping system program personnel. Farmers of the command area can apply for loans to purchase fertilizer, seeds, and insecticides from the Cooperative. The agricultural bank in Bharatpur provides credit to support their livestock and agricultural tools.

3. Yields

Although the command area is far from achieving the potential yields from irrigated agriculture, the improved practices and cropping patterns adopted by the farmers have yielded satisfactory results in production per unit area of land as well as in total annual production per unit of land. Where supplemental irrigation is available at the right time and in the right amount during the monsoon, paddy production is reported to be high. Sowing mustard (under optimum soil moisture content) with only one timely irrigation has greatly enhanced the yield. Similarly, maize supplemented with 1 to 2 irrigations has shown better yields.

The yields in the following tables have been obtained from different sources for different crops.

Average Range of Yield of Major Crops in Mt/ha

Name of Crop	Range of Yield Reported by Farmers	Average Yield (1972)	Source of Data	
			Farmers	Crop Cut
Paddy	(Head) 1.9-4.1 (Tail) 2.1-4.6	1.66	3.5	3.6
Mustard	(Head) 0.3-1.2 (Tail) 0.2-0.7	0.60	0.80	0.73
Maize	(Head) 0.4-4.5 (Tail) 0.5-1.8	1.24	2.56	3.52
Wheat	-- --	1.19	2.50	1.95

Average Yield as per Land Classification (1984/85)

Crop	Land Classification	Yield (mt/ha)
Paddy	Irrigated	3.8
	Partially irrigated	3.3
	Upland	2.4
Mustard	Upland	0.9
	Lowland	0.8
Wheat	Lowland	2.2
	Rainfed	1.3
Maize	Upland	3.5
	Lowland	1.7

Average annual yield: 6.7 mt/ha (cropping pattern report)

Although the towns of Tadi and Bharatpur are near the command areas, marketing is still in the hands of a middleman. Farmers com-

plain about the low price of their produce, especially for wheat. Two reasons for the area cropped in wheat to be decreasing are the price and the poor market.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) Despite a great deal of adversity, Panch Kanya farmers have remained organized. The farmers continuously express hope for an improvement in defective structures. The struggle of the farmers to obtain reliable and adequate supplies of water through organization is a definite strength.

b) There is an old, indigenous farmer-managed irrigation system within the command area of Panch Kanya. Farmers have maintained the autonomy and independence of that system and have not become dependent on government assistance.

c) Farmers have adapted their cropping pattern to the water situation very well. They are interested in higher yields and are trying to get maximum cropping per unit of land.

d) The medium-textured soil at Panch Kanya is very suitable for irrigated agriculture. The field and farm channels have been well maintained.

e) Fields appear to be level.

2. Weaknesses

a) The physical system at Panch Kanya is badly deteriorated. The main canal is not well maintained and has considerable leakage and seepage. Additionally, the underground pipe at the road-crossing is undersized, seriously hampering the proper delivery of water to the system.

b) The irrigation system, including all main and branch canals, is not functioning properly or as designed.

c) Farmers have lost faith in DIHM capability to supply them with reliable and adequate water. There is little effective communication between the farmers and DIHM, and conflicts are always present.

d) There has been an expansion of the command area without an expansion of supplemental water supplies. Some farmers feel totally disenfranchised by the system.

e) Roving wild animals eat crops at night, which sometimes forces farmers to adopt less-than-optimal cropping patterns.

3. Summary and Conclusions

Since the Panch Kanya system is closely related to the old Khageri system and the pump canal, the water source is not very reliable. Because of the poor condition of the main canal up to chainage 1.500, the system is not getting enough water. Also, the Battar River diversion to Panch Kanya River is not completed. The system needs major repair for proper functioning.

Nevertheless, with some correction in defective infrastructure and additional water in the intake from the Battar River, there can be a tremendous improvement in agriculture within command area. The system has a very good network of branch canals and field channels to irrigate 600 ha of land. Additionally, farmers have helped compensate for the water insufficiency and faulty infrastructure with their involvement in irrigation management, which is a very positive sign. The relatively equitable distribution of land in the area, as well as the lack of a predominant caste or ethnic group, indicate that the social structure in the area should not hinder improvements in the irrigation system. The indigenous people in the area (Tharus, Darais) do not appear to have large conflicts with the relative newcomers (Brahmins, Chettris, Magars, Gurungs).

The agricultural status of the command area, in spite of the presence of all other facilities (i.e., different components of production and the suitability of the land) still depends on the timely availability of rain as well as irrigation water. The timely availability of water appears to be critical, not only for increasing yield and cropping intensity, but also for diversifying agriculture.

2. PITHUWA IRRIGATION PROJECT

A. INTRODUCTION

The Pituwa irrigation system is extremely interesting, as it is a unique combination of a DIHM and farmer-managed system. It was constructed by DIHM but is operated by a farmer's committee. Pithuwa irrigates all the wards of Pithuwa Village Panchayat except Ward 6. Pithuwa irrigation system lies in the Chitwan District about 18 km east of Bharatpur and 2 km north of Tadi on the Bharatpur-Hetauda highway (Figure 11). Pithuwa Irrigation Project was constructed in 1972 and started operating in 1973.

The designed command area of the system is about 600 ha, but the farmers have built field channels and branch canals to feed about 1300 ha. Since the canal's capacity does not allow enough water flow to supply all 1300 ha, the farmers rotate the paddy biannually. With the present capacity of the main canal, the farmers can irrigate about 475 ha of late paddy. The water available in the river can supply one irrigation for the winter crop.

Pithuwa Irrigation Project lies mostly on the Kaier River floodplain, which makes the head of the system vulnerable to flooding during the monsoon season.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The water source for Pithuwa Irrigation Project is the Kaier River, which flows seasonally. The river discharges about 200 l/s at the intake from June to December. After December the river has a very small flow which is difficult to tap because the river is about 200 m wide.

There are three farmer-managed irrigation systems upstream of the Pithuwa intake, and intakes for two other farmer-managed systems lie close to the intake of Pithuwa. One intake is for Budi Kulo, which was dug by the Tharu ethnic group long ago, and the other intake is for Chainpur Kulo. All five of these systems are older than Pithuwa.

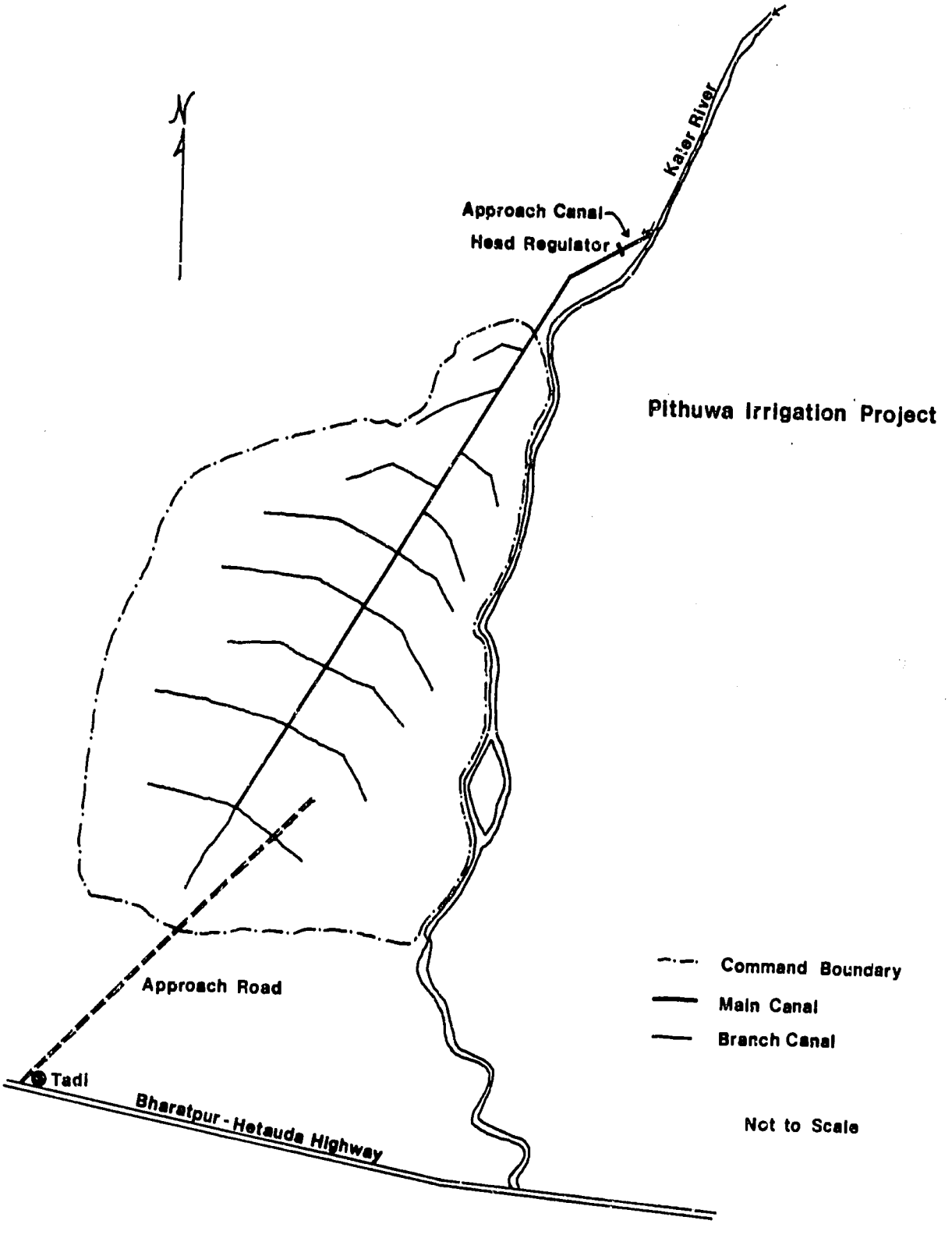

Figure 11. Pithuwa Irrigation Project

During periods of water stress, water stealing among the systems takes place. Although Pithuwa has an agreement with Chainpur Kulo to share water every 12 hours, the agreement is seldom followed. This water sharing problem has forced the Pithuwa irrigation committee to be strong and effective.

2. Canals and Structures

No permanent intake structure exists at the Kaier River. Every year water is diverted by an approach canal which is about 75 m long from river to head regulator and by a boulder and sand weir across the river. After every flood, the approach canal and the temporary weir are washed out. It takes two to three days to construct a new approach canal and weir. One earth mover (bulldozer) has been provided to Pithuwa by Chitwan Irrigation Project to repair the approach canal during the rainy season.

One head regulator exists at the intake of the main canal to control the water flowing into the main canal. The main canal is about 7.5 km long. A service road runs along most of the length of the main canal. The main canal is about 3.0 m wide at the intake and the maximum depth of water in the canal is about 1.0 m. The capacity of the main canal at the head reach is about 1000 l/s, but because of silt deposits (at an average depth of 40 cm) the canal may not draw more than 750 l/s.

There are 19 falls in the main canal of about 1.5 m each. The main canal does not have any cross drainage. The main canal and the branch canals are earthen.

There are 16 branch canals that divert water from the main canal. The main canal runs north to south and the branch canals east or west. The average length of the branch canals is about 2.0 km. Most of the branch canals irrigate about 30 ha, except for branch canals 1 (10 ha), 2 (100 ha), and 14 (20 ha).

There are no regulating structures at the intakes of the branch canals. All of the branch canals receive water from the main canal through hume pipes averaging 300 mm in diameter.

Because of the large amount of silt deposited in the canal bed, the capacity of the main canal is reduced. To get the required water, the farmers try to bring more water in without leaving any space for free board. In several places, water spills over the banks. Operating the canal this way has created a greater fall depth at the drop structures than the structures were designed for, which is causing erosion of the downstream canal banks and the launching apron (downstream canal bed) of the fall structure. In most places, the downstream bank has been reconstructed of dry boulder masonry to its

original shape and size, but some of the drop structures need immediate maintenance.

3. Soils

The recent alluvial soils of the area range in texture from light to medium and show little profile development. Soils of deep sandy loam (high in humus) were observed, and soil fertility is good.

The command area of this system slopes from north to south an average of about .2 percent, and the watertable lies about 70 ft below the surface.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

The Pithuwa irrigation system is a relatively prosperous and progressive settlement area. Fields are rectangular and well attended. Rather than living in distinct villages, farmers dwell in houses scattered throughout the command area. The houses are well kept, and a few are made of brick. During the study of Pithuwa Irrigation Project, at least two women were observed with more modern, urban hairstyles. Another woman in the command area wore stylish glasses, obviously purchased outside of Pithuwa. These proxy indicators led us to believe that the farmers at Pithuwa are more urban-oriented and economically advantaged than farmers in some other areas in the Terai.

Land

Most farmers in Pithuwa appear to own 1.2 to 1.8 ha of land. There were, however, differences in landholding size between the head and tail. The largest landholders at the head owned from 3.0 to 3.6 ha. At the tail, one landowner was said to hold 60 ha; and three or four other farmers apparently each own about 14 ha of land. Larger landholdings at the tail might be related to the tail farmers' proximity to the Bharatpur-Hetauda highway.

Approximately 20 percent of the farmers at Pithuwa are sharecroppers, 10 percent are owners-cum-sharecroppers and 10 percent are landless farmers. The sharecropping arrangement is usually done 50:50, with the owner and sharecropper equally sharing the cost of all inputs (fertilizer, seeds) and also the agricultural output. In many other systems we saw in Nepal, the owners did not share the cost of the inputs.

Sharecropped land was scattered throughout most of the command area except for the head, where there was more sharecropped land on

the east side of the main canal than on the west. The land on the east is closer to the river and more susceptible to flooding. Landowners may prefer to rent out this less valuable land to others than to rent out other landholdings.

There are many absentee landlords at Pithuwa; some of them reside as far away as Kathmandu. Very large landowners often rent their land on contract, sometimes on a three-tiered arrangement. For instance, one landowner at Pithuwa leases his land to another farmer for Rs. 1,500/bigha (1 bigha = 0.66 ha) and Rs. 30,000/20 bighas. The contracting farmer then does what he wishes with the land. In this case, the contracting farmer divides the 20 bighas into smaller parcels and sharecrops the land with several other farmers. As with other sharecropping arrangements, the cost of all inputs, and the yield, are divided 50:50.

Castes and Ethnic Groups

Several different castes and ethnic groups farm in the Pithuwa Irrigation Project -- Brahmins, Chettris, Magars, Gurungs, and Newars. The castes and groups seem equally scattered throughout the command area, though some people estimated that 75 percent of the tail farmers were Brahmins or Chettris. At the head, Brahmins, Chettris, Magars and Gurungs were encountered along branch canals 2 and 4.

There appears to be a great deal of interaction and cooperation among the different castes and ethnic groups. At the head of the system, Chettris and Gurungs were observed socializing together, and Brahmins and Magars were freely entering each others' houses to discuss irrigation.

A female Brahmin farmer whose husband works in Kathmandu stated that she felt no discrimination in water distribution, even though she lived only with her children. She did say, however, that she would not go out alone at night to irrigate her crops, and she was reluctant to ask her neighbor to help her with night irrigations. She said that her crops suffered as a result.

Power

As in other locations in Nepal, large landholdings were identified as a primary source of power. Farmers at Pithuwa stressed, however, that education and being "convincing" also added to an individual's power. One Chettri farmer declared that power at Pithuwa could be gained through community involvement and honesty and applied these terms to an important irrigation committee member.

At another household, two farmers stated that the three most powerful people at Pithuwa were the largest landholder in the area, the pradhan panch, and a women who is the Chitwan District repre-

sentative to the Nepal Women's Organization. The inclusion of a woman on this list was unexpected and an interesting feature of the Pithuwa irrigation system.

History of Development Around Pithuwa

Except for the small village at Khairate, the rest of the command area was forested until 25 years ago. The forest land was distributed to the hill people under the Rapti Zone Development Project. These settlers from the hills of Nepal had to clear the forest. Most of the settlers in this area are from the hill districts of Dhading, Gorkha and Lamjung.

Khirate village was on the route to Thori from Kuringhat of Gorkha. In those days, the people of Gorkha and Dhading took this route to Thori to buy salt for domestic consumption. At that time, the Chitwan district headquarters was located at Upaidang Gadi, which was on the route between Gorkha and Thori. The district headquarters of Chitwan was shifted in 1961 to Bharatpur, which was a newly deforested area with few physical facilities.

The early settlers in Pithuwa had difficulty getting drinking water. At that time, the only irrigation system was farmer-managed and was known as Khairate irrigation system. It commanded about 40 ha outside Khairate village. The water supply for this system was used for drinking water until recently. Comparing the accounts of the early settlers and the observations of the current agriculture and growth of the villages around Pithuwa irrigation system, one witnesses a large transformation that occurred within only the last 25 years.

2. Irrigation Organization

Prior to 1973, the lack of water within the current command area of Pithuwa allowed farmers to grow only maize. In 1970, farmers were given Rs. 15,000 under the Minor Irrigation Development Program to construct an irrigation system in Pithuwa. Using voluntary labor and this fund, the main canal was dug. However, the canal did not function properly and the people again approached the government. Finally, DIHM undertook the construction of Pithuwa Irrigation Project in 1973.

After DIHM completed the main canal, irrigation water was released. At first, water distribution was laissez-faire. "Might is right" prevailed in the system resulting in conflicts and feuds over water share.

Then, one prominent farmer took the initiative to organize the other farmers on Branch 14 into a committee, which formulated rules for water allocation and distribution along Branch 14. With farmer participation in committee activities, conflicts over water sharing

along the branch canal decreased in a short time. Other branches started to follow the example set by the farmers of Branch 14. Eventually, all the branch farmers created branch committees for water allocation and distribution; some as recently as four years ago. Once the branch canal committees were working satisfactorily, a federation of the branch canal committees created a general assembly of farmers and a main canal committee.

General Assembly

All the farmers in the Pithuwa irrigation system are members of the general assembly. The farmers meet once a year in June at a central location to discuss the following issues:

a) general principles for managing water in the system

b) electing the secretary of the main committee

c) approving or disapproving the accounts of the system presented by the secretary

d) deciding the outcome of outstanding conflicts within the system

e) reviewing whether the decisions made during the previous assembly meeting were duly undertaken or not.

Main Committee

The main committee has 18 members. Originally, the chairman was elected from among the assembly members; today, the *pradhan panch* of Pithuwa village panchayat is the *ex-officio* chairman of the committee. The secretary of the main committee is still elected by the assembly during the annual meeting. The other sixteen members are the chairmen of the branch committees.

From late June until late October the committee is active and holds at least one meeting each month, depending on the issues that have to be decided. The major functions of the committee are to implement the decisions of the assembly and supervise the overall operation of the main canal. The specific responsibilities of the main canal committee are:

a) to supervise and maintain the main canal.

b) to allocate approximately Rs. 18,000 for the fuel and operation costs of the bulldozer that is used for maintenance.

c) to communicate the decisions of the main committee to the branch canal and determine the water allocation for the branch canals.

d) to contract with and establish relations with external agencies (e.g., the government or other irrigation systems upstream of the intake).

e) to allocate the area in the main canal that must be desilted by the branch canal farmers and to mobilize labor as needed to otherwise clean the main canal.

f) to keep proper accounts of income and expenditures.

g) to resolve conflicts over water allocation among the branch canals.

Branch Canal Committee and Farmers' Assembly

Initially, there were 15 branch canals, but one more was added later to expand the irrigation command area at the tail of the system. The rapid appraisal team interviewed the secretaries of branch canals 1, 2, 3, and 16. All of these branch committees have written rules, account books, and minutes of the meetings.

There are two organizational units in each branch: the branch canal farmers' assembly and the branch canal committee.

Branch Canal Farmers' Assembly: Once a year, usually in June or July, all the farmers along a branch meet to discuss:

a) the election of the branch chairman and the branch secretary;

b) the method of water allocation;

c) the registration for the paddy transplantation schedule;

d) the time allocation for water use based on landholding;

e) setting the priority for water allocation;

f) settling the annual account of the branch; and

g) the water allocation for winter crops.

Branch Committee: The branch committee consists of a chairman, a secretary and representative members from the branch. These members are elected for one year during the branch farmers' assembly. Once a member is elected, he can continue in that position

for several years as long as he receives annual approval from the assembly each year. The number of members on the committee varies from branch to branch, but averages five or six members per branch.

The branch chairman presides at the assembly meeting and the branch committee meetings, represents the branch committee, and communicates the decisions of the main committee to the branch committee and the farmers of the branch.

The secretary keeps records and implements the decisions of the branch committee. The secretary supervises the water rotation schedule and is expected to prevent damage to the branch canal bunds during rotations. The secretary of the branch canal seems to be the most wanted person from late June to late October. He has to be present in the system day and night to monitor the rotation and prevent conflict. One secretary's wife complained that his office has taken so much of his time that his own farming operations have suffered. The secretary receives no renumeration for the job he performs for the community. In the four branch canals we looked at closely, the secretaries have six to seven years of work experience and the farmers want them to continue as secretaries.

Fine Imposition

The farmer who breaks the rotation schedule is fined Rs. 25 the first time. If he disobeys the rules a second time, he is fined Rs. 50 and his turn for water is cancelled. For a third offense, he is not allocated any water at all. These rules are strictly followed, and few problems in water distribution and water allocation are reported.

In general, committee system seems quite effective in Pithuwa. With the introduction of individual branch committees, the system is more flexible for meeting farmers needs. Also, effective rules are formulated and enforced.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

The Department of Irrigation, Hydrology, and Meteorology built the approach and main canals at Pithuwa Irrigation Project. After the water passes the headworks, the farmers are responsible for allocation. Local DIHM officials compared the allocation and distribution system at Pithuwa with nearby Panch Kanya, and all officials stated that the Pithuwa system has a better source and there are fewer conflicts with farmers.

During both the paddy and the winter seasons, water flows in the main canal continuously. The 16 branch canals remain open the entire year. If there is a severe water shortage, the committee arranges a rotation system. They then allocate water to the tail outlets first for a set number of days, and then to the head outlets. Farmers also plant their crops on different dates, which means that irrigation water is required at different times. A kind of rotation system is instituted to take advantage of varying planting dates. Farmers register for water for paddy transplantation during the general assembly. At this time, water is allocated according to the registration list -- no consideration is given for the location (head or tail) of the fields in the system.

Along the branch canals, water is allocated to farm outlets by the branch canal committee. Farmers request water from the branch canal secretary, and they are given a token that guarantees them a water turn. The token is returned to the secretary when the irrigation is complete.

Time allocations differ from branch to branch. In branches 1 and 2, four hours of water per bigha (0.66 ha) are allocated, whereas in branches 3 and 16, two hours per bigha are allocated. The time for allocation is based on the nature of the soil, the size of the fields, the volume of water available, and the frequency of watering required for the crop. On some branches, daytime water is allocated for transplantation, and nighttime water is allocated for fields that are transplanted. Each committee has adopted rules that suit their soil, crops, and the availability of water in the branch canal.

Pipe outlets and wooden gates are used to distribute water along the branch canals. Representatives of the branch canal committee, as well as the irrigators themselves, make sure that the time allocated for an irrigation turn is not exceeded.

On field channels, which are shared by several farmers, the farmers collectively distribute water. Then, individuals distribute it to their own farm channels. All farmers reported that there is no priority system, and all water is delivered by rotation.

2. Maintenance

Until 1983, the main canal maintenance was done by Chitwan Irrigation Project. Maintenance money was made available to the Chitwan Project by the Irrigation Department, and Chitwan Irrigation Project contracted the maintenance work. Last year, the maintenance money allocated for Pithuwa was made available to the main committee itself.

A few years ago the funds were as high as 1 lakh of rupees (Rs. 100,000). Lately, however, the budget has steadily declined,

and this year, the project will receive only Rs. 31,000. The committee is required to keep books showing how these funds are spent. DIHM officials are allowed to examine these books whenever they wish.

Every year the committee must set aside at least Rs. 15,000 to pay for diesel fuel for a bulldozer. The bulldozer is used to repair the diversion structure on the Kaier River, because every year the intake is damaged by floods. The funds left over must take care of all other maintenance tasks. This year the money available will come to about Rs. 31,000. This is a relatively small sum for a 600-hectare irrigation system which delivers some water to over 1,000 ha. Local farmers, however, contend that they can perform 1 lakh rupees worth of work for only Rs. 25,000.

DIHM officials stated that their biggest problems in helping farmers maintain the main system are delayed maintenance due to lack of funds, and repairing the approach canal every year. Repairing or replacing structures along the branch canals is almost impossible due to the shortage of money. Farmers stated that if no money for repair was forthcoming, they would attempt to repair the structures as best they could using their own resources and skills. The fuel cost for running the bulldozer is also a continuing problem for DIHM. Currently, DIHM does not charge the committee to use the bulldozer. According to DIHM, the recurring costs of fuel and machine operation are problems that need to be solved.

Once a year, just before the paddy season, the main canal is partially cleaned under the supervision of the irrigation committee. Sometimes the committee simply contracts with a group of farmers or laborers to perform the cleaning and repair work.

The branch canals are also cleaned at least once a year, supervised by the branch canal committee. There are two methods for maintaining the branch canals. Branches 2 and 16 contract the maintenance to a third party. Interested contractors submit a bid, and the lowest bidder is awarded the contract. The funds for the estimated bid are raised based on the size of the farmers' holdings. A sub-committee of area members supervises the job. On branches 1 and 3, the farmers desilt and maintain the branch canals themselves. Here farmers working independently may clean the branch canal as many as three or four times a year depending on their individual needs. Voluntary labor is contributed.

All farmers consider the cleaning of farm channels to be a routine accomplished from once in a season to once in a year. Farmers on the channel initiate the work, and nonparticipation is fined Rs. 15 to 25/day of work missed. All farmers interviewed reported that the fine is enforced and collected.

3. Conflict Management

Conflict is reported by all farmers to occur over water distribution and is reported to be started by farmers whose crops are in need. The committee members of the branch canal mediate disputes, and differences among individuals are settled by discussion during meetings called for that purpose.

4. Water Adequacy, Reliability, and Equity

Five of twenty head farmers interviewed reported water inadequacy and untimeliness in the monsoon paddy season. Very few head farmers reported water inadequacy and untimeliness in the winter season.

Eleven of twenty tail farmers contacted reported water inadequacy and untimeliness during the monsoon paddy season. Five of the twenty tail farmers reported inadequate and untimely water supply for the winter crop.

Many farmers also report that the temporary Pithuwa diversion structure makes the water supply unreliable. Head farmers on the east side of the main canal name monsoon flooding as a major problem for cropping, particularly during harvest. Some tail farmers reported the need for a drain to remove water.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

By providing a supplementary irrigation source, the Pithuwa irrigation system appears to have had a profound influence on agricultural activities. Multiple cropping, the development of a more reliable cropping pattern, and the gradual adoptation of improved technologies has resulted not only in higher yield/unit of land, but also higher total yields annually. In the winter, farmers grow mustard on more than 90 percent of the command area and grow wheat on more than 5 percent of the command area.

Intensive cultivation practices have allowed little time between crops for land preparation and sowing. As a result, farmers use tractors, especially for mustard cultivation, and draft animals for maize and paddy cultivation. Most farmers broadcast mustard and corn seeds. Pulverised or wet seed beds are used for paddy, and early varieties are preferred. Mixed cropping and green manure practices have been introduced recently. Buffalo are invariably raised by every household for additional income.

A wide range of crops and vegetables can be grown in the command area. However, the main crops are paddy, mustard, corn, potatos and wheat.

The general condition of the paddy, mustard, and potato crops appeared quite satisfactory. Mustard usually receives one irrigation and this makes a good stand. Additionally, as the watertable is low (70 ft below the surface), root germination and development are profuse, resulting in more yield. Corn and wheat more or less depend on rainwater late in their growing stage. The cropping patterns the farmers use and the area under different patterns follow.

Cropping Patterns and Area for Pithuwa Irrigation Project

Cropping Pattern	Area (ha)
Maize - mustard	730
Maize - potato - wheat/(mixed cropping)	100
Maize - paddy - mustard	200
Fallow - paddy - mustard	240
Fallow - paddy - wheat	33

At the head of the system, some farmers reported reduced cropping in the spring, and they all reported some maize production instead of early paddy. Water supply limited cropping to 61 percent of the area of the farms studied. Tail farmers also reported spring maize production instead of early paddy. The cropped area was 67 percent of the 20 farms studied.

In the monsoon paddy season, cropping was reported on 81 percent of the 20 head farms studied. At the tail, all 20 farmers contacted grew summer monsoon paddy, with 67 percent of the area cropped.

In the winter season, most head farmers produced wheat and mustard. The cropped area in winter was 79 percent of the total area for the 20 farms studied. All tail farmers reported growing mustard, but very little wheat. The winter cropping area at the tail was 94 percent of the farm studied.

Large landholders rotate maize and paddy biannually due to water shortages. The total cropping intensity of the area exceeds 235

percent, compared to 176 percent in the nearby DIHM operated Panch Kanya irrigation system. All farmers reported that they determined cropping times by the calendar month, synchronizing dates with their neighbors.

2. Production Inputs

More than 90 percent of the total cropped area (except for that in mustard) grows improved varieties. Farmers prefer early maturing varieties to fit the cropping patterns. Fine paddy is liked as it commands a good price.

Farmers use fertilizers on most crops, except for maize, in the following ratio:

Crop	N P K (kg/ha)
Paddy	40-20-0
Mustard	20-20-0
Wheat	60-30-0

Farmers are gradually using more pesticides in potatos, mustard, paddy, and maize. The following table summarizes land use under different crops and fertilizers.

Summary of Land Use Under Different Crops and Fertilizers

	Crops						
	Paddy		Mustard		Wheat	Maize	Potatos
	I*	NI	I	NI	I	NI	NI
Area (ha)	472	-	265	830	30	933	100
Fertilizer (kg/ha)	75	-	75	-	75	-	150
	(urea)		(urea)		(urea)	(Manure)	(combination)

* I = irrigated, NI = not irrigated

The services of a junior technical assistant and cropping pattern personnel stationed at the town of Tadi are available, and the farmers themselves appear to be agriculturally advanced. Farmers get inputs through the Tadi cooperative and private dealers. The service provided by the local cooperative is poor.

Production credit is available from the Tadi market and the bank. The cooperative in the command area is non-functional because loans were not repaid satisfactorily.

3. Yields

The average yield as reported by the farmers is presented in the following table.

Yield Variation and Average Yield for Crops Grown in Pithuwa Irrigation System

Crop	Yield Variation (mt/ha)	Average Yield (mt/ha)
Paddy	2.5 - 4.0	2.9
Wheat	2.0 - 3.5	2.2
Maize	1.5 - 2.5	1.6
Mustard	0.6 - 1.2	0.8*
Potato	10 - 16	11.2*

*True average yield figures for mustard and potato may be higher than these figures reported by farmers.

Farmers said that marketing through middlemen and low prices for produce are growing problems.

F. STRENGTHS AND WEAKNESSES

1. Strengths

a) Pithuwa irrigation system has a strong, disciplined farmer organization which the farmers consider their own. The rules and regulations of the organization are effective, and farmers' participation seems quite high.

b) The farmers' organization has effective control and distribution of water and, if necessary, enforces water rationing and budgeting. The overall management of the system is very effective.

c) There is little conflict among the different castes and ethnic groups, or between head and tail farmers. Most of the farmers have harmonious relationships with other farmers in the system.

d) Though the system was designed to serve 600 ha and it is officially referred to as a 600-hectare system, farmers have designed management procedures and channels to increase the command area to over 1,000 ha. We estimate that 1,300 ha receives some irrigation water.

e) The main canal and field channels seem to be functioning quite well.

f) Most of the command area has a high cropping intensity, sometimes as high as 250 percent.

g) The cropping pattern is well adapted to the water supply. Water is usually available throughout the system.

2. <u>Weaknesses</u>

a) Because of the temporary diversion on the river there is not an ensured supply of water, particularly during floods in the rainy season when the diversion is damaged. Silt from floods blocks the intake, and a bulldozer must be used to clear the intake.

b) The soils at the head of the system are sandy and not ideally suited for irrigated agriculture.

c) There are no drainage outlets at the tail.

d) The main canal below the drop structures is badly eroded.

e) As there are irrigation systems upstream from the Pithuwa irrigation system, conflict exists between the upstream farmers and the Pithuwa farmers.

f) Large, absentee landlords control much of the land in the system, particularly at the tail.

g) Farmers depend on a shrinking maintenance budget from DIHM. Much of this budget must be used for bulldozer operation.

h) There is no clear responsibility between DIHM and the farmers concerning the maintenance of the main canal and the structures.

3. Summary

Pithuwa Irrigation Project was constructed by DIHM, but is operated by a farmer's committee. The 9.5 km main canal has 16 branch canals and irrigates about [illegible] ha of paddy and supplies one irrigation for the winter crop. Farmers have developed enough branch and field canals to supply about 1300 ha. However, the current canal capacity cannot provide water for more than about 475 ha for late paddy. The area under paddy could be increased by improving the canal sections and structures.

A serious problem on Pithuwa is not having a permanent intake structure. During monsoon the system may suffer having its temporary diversion washed away by flood at any time.

Since there is no silt control at the intake, frequent silt removal from the canal bed is needed. Silt deposits reduce the capacity of the main canal.

Pithuwa irrigation system is functioning well, and many things can be learned from it. The volume of water at the intake has forced Pithuwa to operate effectively to make agriculture profitable. Pithuwa is a hybrid system, neither completely DIHM-operated nor completely farmer-managed, although farmers have taken more responsibility for operating the system. Pithuwa irrigation system could be a model for many medium-sized DIHM-operated irrigation systems.

Additionally, despite the disparity in landholding size, farmers of all castes and ethnic groups seem to cooperate on irrigation tasks. Few serious conflicts were noted, and most features of the social system indicated that it was relatively egalitarian and harmonious.

The agricultural undertakings of the Pithuwa irrigation system appear to be satisfactory. When compared with the nearby DIHM-operated Panch Kanya irrigation system, Pithuwa has a more reliable water supply, more effective farmer participation, better adoption and intensification of improved agriculture practices and land use patterns.

3. KAMALA IRRIGATION SYSTEM (RAGHUNATH PUR BLOCK)

A. INTRODUCTION

The Kamala Irrigation Project is located on the border of the eastern and central development regions of Nepal. The source of irrigation water for the project is the Kamala River, which divides the two development regions. Kamala irrigation system is designed to irrigate 12,500 ha on the eastern and on the western bank of the Kamala River (a total of 25,000 ha). All 25,000 ha, however, are not currently receiving irrigation water. On the west side, the Kamala River irrigates Dhanusha District of the Jankapur Zone, and on the east side, it irrigates Siraha District of the Sagarmatha Zone.

This project was constructed by DIHM and started operating in FY 1982-83. There were no farmer-managed irrigation systems in this area before the government project was constructed. However, rainfed agriculture was practiced in this area.

The east side of the Kamala irrigation system is part of the Sagarmatha Integrated Development Project financed by the Asian Development Bank. Small canals are under construction there as part of a command area development scheme. On the west side, no improvement activities are in progress.

On the west side, there are three branch canals, 19 minor canals, and several field channels constructed by the farmers, all designed to irrigate 12,500 ha of land. Roughly, one minor canal has to irrigate about 700 to 800 ha of land.

The rapid appraisal team was unable to examine the whole project and, therefore, decided to appraise a block of 2,300 ha on the west bank of the project (Figure 12).

The selected block irrigates Raghunath Pur, Baramajhia, Paterwa and Balabakhar Panchayat towards the head of the west bank command area in Dhanusha District. The block is surrounded by the Charnath and Kamala Rivers on the east, the main canal on the north, Mahinath Pur branch canal on the west and Khajuri branch canal on the south.

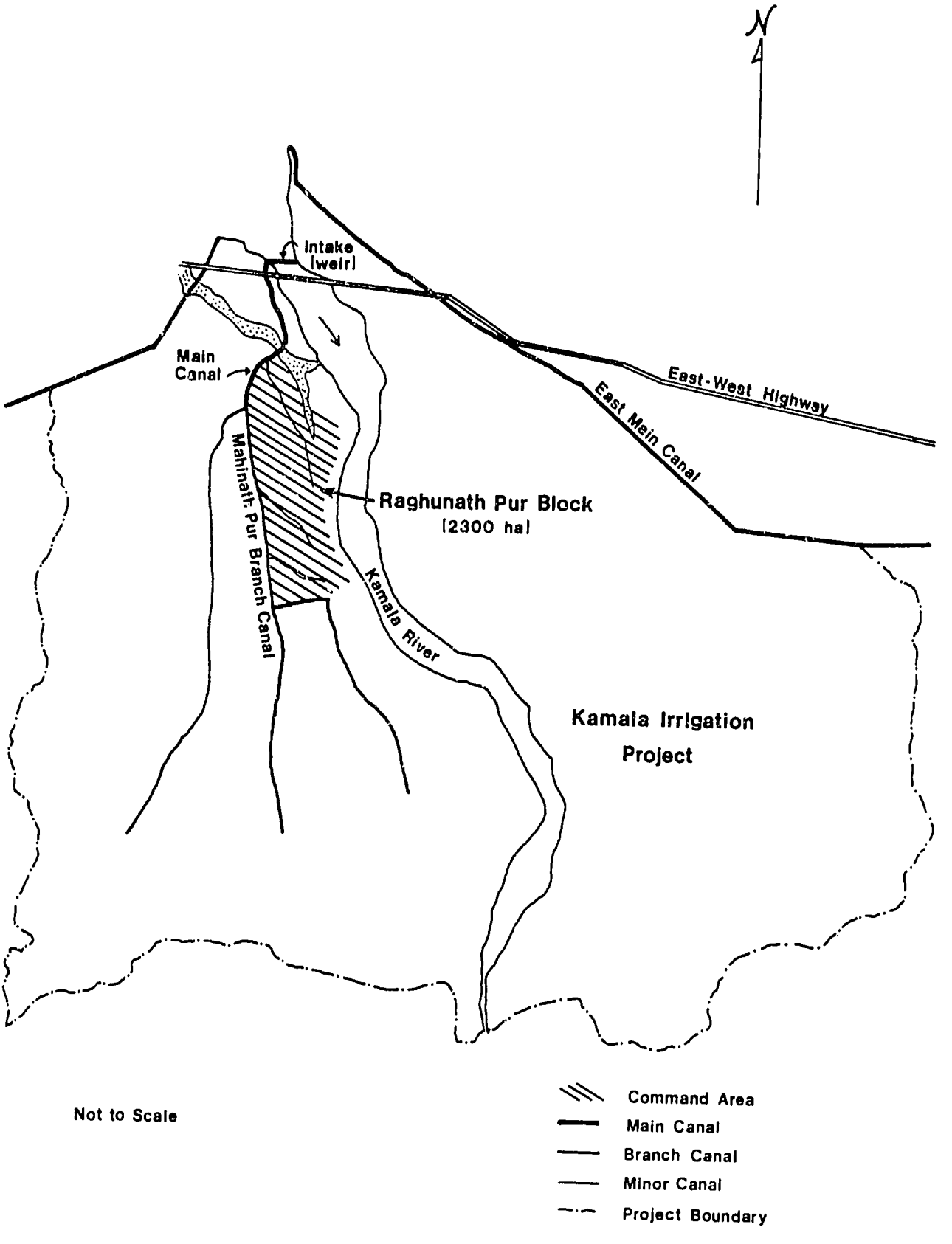

Figure 12. Kamala Irrigation Project

The salient features of the entire west bank command area are as follow:

Designed discharge of head regulator	=	16.0 m^3/s
Designed discharge of main canal	=	14.0 m^3/s
Length of main canal	=	5.5 km
Deisgned command area in paddy	=	12,500 ha
Designed command area in wheat	=	8,500 ha
Total length of branch canals	=	53 km

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The Kamala River is perennial. The catchment area of this river is 15,150 km^2. The minimum discharge recorded is 2.0 m^3/s in May. The monthly discharge of the river was not available. During the rapid appraisal on February 17, 1986, the discharge on the main canal of the west bank was calculated as about 2.0 m^3/s.

2. Canals and Structures

The intake structure (a concrete weir) and the main canal on the west bank are in good shape. Most of the main canal is lined with cement concrete blocks. The capacity of the main canal is 14.0 m^3/s. At 5.5 km, the main canal bifurcates into Parawahai branch canal and Mahinath Pur branch canal.

The block studied by the RA team is located at the head of Mahinath Pur branch canal. This block has three minor canals, and about 10 field channels which were constructed by farmers. The three minors and 10 field channels are directly connected to the main canal and the Mahinath Pur branch canal. Only about 1,700 ha of the 2,300 ha examined are irrigated due to the lack of field channels and the poor condition of some of the minor canals.

Raghunath Pur Minor

This head minor canal takes off from the main canal. It has a head regulator at the main canal. Raghunath Pur Minor is supposed to irrigate about 900 ha on the east side of the block, but it irrigates only about 700 ha due to the lack of field channels. This canal is about 5.5 km long. Farmers at the tail complained that the size of this canal is too small. It has not been cleaned for many years. The

outlet from this canal does not have control regulators. Except at the tail, and the poor cleaning, Raghunath Pur minor canal looks quite good.

Kothia Minor

Kothia Minor takes off from the middle of the Mahinath Pur branch canal. Kothia Minor is about 1.1 km and irrigates about 200 ha of land. This canal seems to function well. The outlets from this canal do not have any regulators.

Baghaban Minor

Baghaban Minor takes off from the tail of the Mahinath Pur branch canal. This minor canal is supposed to irrigate about 600 ha on the southern part of the block. However, due to the poor condition of this minor canal and also its lack of field channels, it irrigates only about 200 ha of land. At a few places, the canal passes through depressions in the land. The canal does not have structures in such portions and quite often is breached by the farmers. This canal needs to be improved to cover the designed command area. The total length of Baghaban minor canal is about 3.4 km.

Field Channels

The 10 field channels that take off directly from the main and Mahinath Pur branch canals irrigate the west side of the block parallel to the branch canal. All of these field channels get water through hume pipes without control regulators. The average command area of each field channel is about 60 ha. The field channels are constructed by farmers and the length of these channels is about 600 to 1,000 m.

3. Soils

The soils on the west bank of the Kamala project tend to be deep silt loams in the western portions of the command area, which become thin to nonexistant near the Kamala River. Soils adjacent to the Kamala River range from sandy loams to pure sand. Thus, the western portion of the selected command area contain soils that should be relatively fertile (depending on their depth), and the soils near the Kamala River tend to be infertile with high infiltration and percolation rates.

Much of the command area is suitable for irrigation (generally the western half of the command area). The soils adjacent to the Kamala River are poor agricultural soils and are not well-suited for irrigation.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

There appear to be three distinct socio-economic classes at Kamala: landless, owners-cum-tenants, and large landholders. The percentage of landless people seems to decrease from tail to head, and the average size of landholdings gradually increases from tail to head.

At the tail village of Balabakhar, the rapid appraisal team estimated that from one-third to one-half of the people are landless. Some farmers at the tail told us that up to 75 percent of the local people did not own land. Another 40 percent of the tail farmers are small landholders, usually owning less than 1 bigha (0.66 ha), but sometimes owning up to 3-4 bighas (2.0 to 2.6 ha). Most of these farmers also rent land from larger farmers. Their rental land is sometimes larger than the land that they own. Approximately 5 percent of the tail farmers are large landholders. Some own up to 25 bighas (16.5 ha) of land.

In the middle of the system, about one-third of all the farmers are landless. Another 20 percent of the farmers own less than 1 bigha (0.66 ha), and 33 percent own from 1 to 5 bighas (0.66 to 3.3 ha). These farmers also usually rent land. The remaining 10 to 15 percent of the farmers are larger landowners, averaging 10 to 15 bighas (6.6 to 10 ha) of land. Some farm families were reported to own more than 25 bighas (16.5 ha).

At the head of the system, only 5 to 10 percent of the farmers are landless, though approximately two-thirds of the farmers own 1 bigha (0.66 ha) or less. Perhaps another 15 to 20 percent of the farmers own more than 5 bighas (3.3 ha).

Since most of the smallholders at Kamala do not own enough land to sustain their families, tenancy is prevalent. Most tenancy arrangements seem to follow the legal requirements of 15, 12, or 8 maunds (1 maund = 40 kg) of paddy per bigha to the owner every year. The amount of grain depends on the quality of the land; tenants farming better quality land must pay more to the owner.

Many of the landless people at Kamala work as daily agricultural laborers. They are paid 3.75 to 4.00 kg of grain per day or Rs. 12/day. No food is provided to the laborer while working.

There are also a significant number of haruwas at Kamala. Haruwas are similar to the halis encountered at Chitwan. Haruwas are life-time servants to the larger landowners, who work the fields for the owners. In return for the work, they are given food and a place to live.

The most populous ethnic group at Kamala is Yadav. Other groups include Dunwars, Telis, Khatnes, Muslims, Brahmins, and Chettris. At the tail of the system, almost all of the farmers are Yadavs. The Yadavs, however, seem to be split into two groups or factions, and there is often conflict between these two groups. This split sometimes goes beyond the Yadavs with other groups of farmers taking sides.

Throughout the system, farmers said that power at Kamala is primarily based on size of landholding. A professional degree (i.e., doctor) or higher education also is associated with power. Those having a degree or education, however, usually also possess large amounts of land.

At the head of the system, Yadavs, Muslims and Telis are the most numerous, but the 10 to 12 Brahmin families in the area appear to be the most powerful. The pradhan panch is a Brahmin and many of the large pucca houses at the head village belong to Brahmins. The power of the Brahmins is not absolute, however. We were told that during an acute grain shortage in 1972, a group of farmers looted the grain stores of large Brahmin and Yadav landowners. The Brahmins left the area at that time and went to Janakpur (50 km from Kamala). They returned to the head village after the police arrested a number of people.

At the middle village of Parshai, power seemed much more equitably distributed. This is a multi-ethnic village, with no single group dominating the others. Farmers at Parshai claimed that large landowners cannot dominate the farmers in this village. There appeared to be a sense of belonging and cooperativeness at this village, which was not encountered in other villages.

While the rapid appraisal team was at Parshai, the upa pradhan panch immediately called together a large group of farmers who met with us. This group was composed of many different ethnic groups and random questioning of farmers revealed a relatively equitable distribution of land. At this meeting, the farmers said that they had organized themselves to construct field channels in their area, and had charged landowners Rs. 40/bigha for the labor.

Elsewhere, an incident at Raghunath Pur, the second middle village, seemed to characterize the emotion and conflict present in other parts of the system. While we were talking with one Ragunath Pur farmer, another farmer came by who had done some contracting on the irrigation project. The first farmer immediately pointed at the second farmer and began shouting loudly that the second farmer had stolen money and was dishonest. A heated, spontaneous argument ensued, with other farmers soon joining in and making loud accusations. At one point, the original two farmers almost came to

blows, but the situation finally calmed down. It was, however, an indication of the strong feelings present throughout the project area.

2. Irrigation Organization

Kamala irrigation system is exclusively a DIHM project. Construction started in 1974-75 and was finished in 1983-84. The project is under the Eastern Regional Irrigation Directorate.

The western half of Kamala Irrigation Project has no farmers' organizations. Any litigation in the western command area is referred to Danusha District police, court or Chief District Officer's office since the western command area lies in the central development region.

The Kamala Irrigation Project has three components: administrative, technical and financial. The administrative sector has a store branch and a general and personnel branch. The store branch has one joint accountant and one mukhia (clerk). The general and personnel branch has one section officer, one storekeeper, one mukhia (typist), one bahidar (clerk), two drivers, and 10 peons and chowkidars. The technical branch has three assistant engineers, 11 overseers, one tracer (map), and 14 peons and chowkidars. The financial branch has one senior accountant, one internal account scrutinizing officer, and one peon. Over these people is the Project Chief, who is an engineer. The Project Chief said it was not clear what the personnel quota was for his project. Another officer stated that while the project has been operating for many years, as yet none of the personnel recruited for the project have been regularized and integrated into the government civil service.

The project organization's major task is perhaps only to maintain the huge concrete headwork and see that water is diverted to the main canal. How the water flows in the command, how it is used, and who is using it, probably are not its concern.

Some project officials said that operation and maintenance do not exist. To maintain and operate the main system, the project proposed to permanently recruit 180 dhalpas (1 dhalpa for each 2 km). Since this recruitment would cost the government a great deal, the Ministry of General Administration suggested that these people be recruited seasonally for four months: July 1 to November 1 when the water is released and there are heavy activities in the field. The project officials say that nothing has happened in this direction. They feel that is why there is no supervision of the canal network.

The project officials also said that the maintenance fund is insufficient. They say the contractors are not paid on time, so they neglect the maintenance work. There are no developed field channel networks in western Kamala Irrigation Project. As a result, the farmers breach the branch canal and take water as they wish. The

officials say that this has become a very serious problem. Some farmers have built some minor channels themselves. Those farmers, however, whose fields are already irrigable do not allow farmers to build field channels through their fields.

As there is no organization at the water use level, water distribution is inequitable. The farmers at the head village of Baramajhia use and waste much water, and it rarely reaches the middle and tail end. The team members did observe, however, a very cooperative spirit among the Parshai (middle village) farmers when it comes to acquiring water regularly in the minor canal.

Water rarely reaches Balabakhar, the tail village cluster, since the canal lining is defective. Also, the command area has been elevated and the canal water stagnates in some low lying fields.

In the middle village of Raghunath Pur, the largest, and perhaps richest village cluster in the command, the farmers complained that water was not released in time. They also claimed that sometimes maintenance was deliberately done at the start of monsoon, which damages the system more. They feel that under strong administrative supervision, a more rational alignment of the branch canal system could be done. They are prepared to contribute what labor and money that they can. The farmers of Parshai village even more strongly supported this idea.

So far no water cess is imposed and collected. The project has no landholding records. Project officials are trying to get such records from the Land Revenue Office, Dhanusha. Officials propose to recruit some amins to keep these landholding records.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

Irrigation water in the Kamala project is essentially run-of-the-river, in that when water is flowing, water is available for irrigation. Low flows during December and January permit some irrigation at the head of the system. Only in very wet years would there be enough water to irrigate the entire potential command area during the winter months.

Since field and farm channels were not constructed by the project, in the upper reaches of the Mahinath Pur branch only lands adjacent to the main and minor canals have water, while land at some distance from the canals is unirrigated.

Most of the minor canals are poorly maintained, resulting in decreased water flow. Also, field channels to distribute water to

individual fields have not been designed. Field or farm channels tend to be short, and water flows from field to field through level basins.

Water allocation is primarily first come, first served. Thus, farmers at the head of minors tend to get all the water they need, while farmers at the tail often receive inadequate and unreliable amounts of water. This situation has often led to conflict between head and tail farmers. Sometimes hundreds of farmers from the area near the middle village of Parshai will take spears and large sticks and go together to the head village of Baramajhia to demand that water be released. At Baramajhia, farmers are often guarding their water with weapons. If water is released, Parshai farmers have had to maintain armed guards to assure that the minor canal remains open.

Water within the potential command area is poorly distributed primarily because there are few field or farm channels and control structures on minor canals. Water is also wasted because there are no drain channels to divert waste water back into the system. Thus, low lying lands are often flooded, and often there is no water to produce upland crops.

2. Maintenance

According to farmers, maintenance of the main system by DIHM has been carried out without consultation with the farmers. Thus, the main system canals have been shut down for maintenance during the dry season for as long as three months with little or no advance warning.

The upper reaches of the main and branch canals appear to have been adequately maintained by DIHM. Minor canals appear to have received little maintenance by either farmers or DIHM. There is also a lack of control structures throughout the system. Control and diversion structures would ensure a more reliable flow of water, while at the same time lessening the need for future maintenance at certain points within the system. Minor canals were very poorly maintained, with water spreading out over large areas due to bank failure and running around concrete pipes instead of through them.

The farmers indicated they are not happy with the maintenance of the system and generally feel that maintaining the minor canals is the responsibility of DIHM. However, many farmers said that they might be willing to organize and maintain the minors themselves.

On-farm systems are mostly well-maintained, but because farm systems are small, they do not require much labor or organization for maintenance.

3. Conflict Management

Farmers at the head of the system receive adequate, reliable supplies of water. The further on proceeds away from the main and branch canals, and along and away from the minor canals, the system rapidly deteriorates. Thus, there is conflict over winter crop irrigation between tail farmers and head farmers.

4. Water Adequacy, Reliability and Equity

Farmers close to a water source are fairly well assured of adequate and reliable supplies of water, while farmers further from the source face water shortages for crops other than late paddy. Thus, to tail farmers the system is not reliable or equitable.

An important aspect of the system is that much of the potential command area is not commanded at all. For farmers in the uncommanded area, agriculture remains much the same as before the Kamala project was constructed. Most of the system can be characterized as not being reliable, adequate, or equitable.

Extending the present command area is feasible. The system could be significantly improved if the farmers were organized and given some technical advice regarding placement of minor canals and field channels.

Agricultural production is currently very poor. A limited amount of technical advice, organization and inputs could dramatically increase agricultural production. Installing small, inexpensive water control structures could help to ensure an adequate and reliable source of water to most of the potential command area. Cropping intensities could be increased 100 percent or more throughout most of the area. Because Kamala is a perennial river, there is the potential to increase cropping intensities to 300 percent in a significant portion of the head reaches. The current situation is characterized by the lack of effective farmer and official organizational capacity to utilize the resources available to them.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Prior to the construction of the Kamala irrigation system, agriculture in the command area was reported to more or less depend on the vagaries of nature, which resulted in uncertainty of crop harvest and low paddy yields. Monocropping paddy in the lowlands and Badhiya (broadcasted paddy) followed by small millet in the uplands was the usual practice adopted by the farmers. Irrigation water from the Kamala system has assured farmers of at least one crop of paddy with a

better yield, and has also helped farmers to introduce some additional crops like wheat and mung in a small area. However, the area still lags far behind what could be achieved with irrigated agriculture.

More than 90 percent of the command area is used for late paddy. The area under early paddy (Badhiya, Ansu, Chaite) is negligible (4 to 5 percent). About 20 to 30 percent of the area is cultivated with wheat, especially in the fields where an early maturing, improved variety of paddy (Masuli) is grown. Lathyrus is next in importance to wheat, although the yield is poor. Mustard, lentil and linseed are usually mixcropped in the paddy field prior to the paddy harvest. This usually takes place one month before or after harvest when the land is still wet. These mixed crops are usually neglected.

Most of the farmers reported damage by grazing animals. Mung, a new addition to the farmers' cropping system, is gaining popularity and is slowly increasing in the command area. Kodo (finger millet) and broadcasted paddy are grown in uplands in areas where irrigation is not available. The yields of these crops are also very poor. Cash crops like tobacco and potato are also grown in the area.

Cultivation practices for irrigated paddy, wheat, tobacco, potatos, and mung appear to be slightly improved compared to other crops. Irrigation requirements for winter crops appear to be low. Generally, one irrigation is given to wheat. Linseed, lentil, and lathyrus are usually not irrigated.

The official land use reported in the production blocks in Baramajhia and Raghunath Pur that is organized by the local agriculture extension unit is as follows:

Land Use in Winter 1984/85 in the Production Block Organized by Extension*

Crops	Raghunath Pur Command Area (%)	Barmajhia Command Area (%)
Wheat	34.0	38
Mustard	4.0	11
Gram	1.5	3
Lentil	1.5	6
Potato	2.0	2
Lathyrus	27.0	14
Fallow or other crops	30.0	14

*The survey was conducted in the production blocks that had maximum irrigation facilities and where extension activities were intensified. The area surveyed in Raghunath Pur was 530 ha and in Barmajhia was 266 ha.

Farmers contacted in both areas revealed that 90 percent of the commanded area is covered with paddy during summer. For winter crops, the farmers more or less agreed with the extension information, except that the farmers reported wheat cropping to be 20 to 25 percent and lathyrus to be about 18 percent.

Almost all the farmers organized in an 1,100-hectare production block in Raghunath Pur grew paddy in summer. However, in winter only about one-third of the farmers on 60 percent of the land cultivated a winter crop. It was reported by the farmers that small landholders intensify agriculture more than the big landholders.

Since many crops are grown by the farmers, no crop calendar has been adopted. Small farmers, as dictated by various factors (economic condition, size of holdings, availability of water, topography of land) have adopted different cropping patterns. In contrast, big landholders usually practice very few definite cropping patterns. However, in the wetlands, any cropping pattern is based on paddy, and in the uplands in areas where irrigation facilities are not available, minor crops like upland paddy, small millet and mustard are grown. The most important patterns adopted on irrigated land are the following:

Paddy - wheat - fallow

Paddy - linseed/lentil - mung/lathyrus

Paddy - wheat - mung/lathyrus

Paddy (mixed with lentil/linseed) - fallow

Early paddy (Badhiya) - late paddy - linseed

Farmers are very interested in early paddy provided irrigation can be made available to them in time. The poor conditions of crops like lentil, linseed, tobacco, and wheat in most areas; the small areas growing improved varieties of paddy; and the prevalence of poor agricultural practices among most farmers in the command area indicate the subsistance nature of the agriculture. Higher production per unit of land and crop can be achieved in the command area through better management of available irrigation water and by providing inputs, credits and extension services to the farmers.

2. Production Inputs

Agricultural statistics provided by the local agricultural district show that 35 to 40 percent of the paddy grown in the production blocks of Raghunath Pur and Baramajhia is improved (Masuli and B44 Pankaj). Both large and small farmers contacted by the rapid appraisal team revealed that very few farmers (10 to 12 percent) have adopted improved paddy varieties. Farmers argue against using improved varieties because these varieties need more fertilizer and timely control of insect damage since the improved varieties ripen earlier than the local varieties.

Small farmers rotate local varieties with improved varieties in alternate years. Much of the wheat, tobacco, and mung grown are improved varieties, whereas linseed, lentil, lathyrus, kodo, mustard, and gram are mostly local varieties. Farmers usually save their own seeds for planting except for wheat and, to some extent, for mung which are provided by a cooperative or the local extension agency.

Paddy receives irrigation several times due to the sandy soil. Wheat needs two to three irrigations. No irrigation is provided to the rest of the crops.

Almost all the farmers having more than 3 ha use fertilizer on paddy, wheat, tobacco and potatos. Small farmers use fertilizer for wheat and only improved varieties of paddy. Based on the interviews with farmers in the command area, the following doses of fertilizers are applied:

Crop	Large farmers Complex/ha	Urea/ha	Small Farmers Complex/ha	Urea/ha
Local paddy	No fertilizer		No fertilizer	
Improved paddy	60 kg	60 kg	--	30 kg
Wheat	90-120 kg	60-90 kg	60 kg	60 kg

No fertilizer is used for linseed, lentil, lathyrus, mung, gram, kodos, and upland paddy. Only one farmer reported using potash on wheat (30 kg/ha).

Insecticides are used on improved varieties of paddy. No plant protection measures are taken by the farmers in other crops.

An agriculture extension subcenter is located at Raghunath Pur. One junior technician and two junior technical assistants serve the command area. Farmers interviewed in Raghunath Pur and Baramajhia appear to be satisfied with the service. However, farmers in other villages complained about the services.

3. Yield

High variations in the yield of different crops were reported by the farmers. Sampled farmers revealed that there is about a 50 percent difference in the yields of irrigated and non-irrigated wetland paddy. Similar yield differences could be observed in wetland late paddy and Badhiya paddy. Improved varieties yielded 30 to 35 percent more than the local paddy if fertilizer was used. The average paddy yield varied from 1.5 to 3.5 mt/ha depending on water availability, fertilizer use, and improved varieties. Wheat yield varied between 1.5 to 2.5 mt/ha. Tobacco yield was reported as 0.5 to 0.7 mt/ha. The yields of lentil, linseed and other minor crops are extremely low, unstable and unpredictable (0.01 - 0.4 mt/ha).

Most of the produce is sold in the village to middlemen for low prices due to poor transport and the lack of nearby markets. Farmers complained about the low price of their agriculture produce.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) The intake structure on the main canal appears to be well-maintained and functioning.

b) The head reaches of the main canal and Mahinath Pur branch canal are in satisfactory condition.

c) Some farmers at the middle of the system posses a strong cooperative spirit and showed indications of effective farmer participation.

d) The current irrigated area in the western half of the Kamala project can be significantly increased by better management of existing water supplies. For instance, sufficient water is available to irrigate all 12,500 ha of the western half of Kamala for late paddy. Corresponding intensification of agriculture is also possible by growing at least two crops per year.

e) If small changes are made in the system (e.g., extending certain canals), the potential benefits are very large.

2. Weaknesses

a) It appears that the system beyond the main and branch canals and a few minor canals is totally neglected. Overall management of the system is not satisfactory.

b) There are only three minor canals to distribute water within a 2,000 ha block.

c) Some of the existing minor canals have structural defects and are not functioning properly.

d) Field channels have yet to be developed in this portion of Kamala.

e) There is an absence of discipline throughout the system, with breaches in the canals and wastage of water. Though destructive, this farmer behavior is rational considering the other weaknesses in the system.

f) Conflict among farmers is prevalent in the system. Relations are also poor between farmers and local irrigation officials.

g) In general, agricultural practices are poor. There are few improved varieties sown, and fertilizers and pesticides are not commonly used.

3. Summary and Conclusions

The Raghunath Pur block of the 2,300-hectare command area is on the west side of the Kamala Irrigation Project. This block is irrigated by three minor canals, two from Mahinath Pur branch canal and one from the main canal, and 10 field channels directly connected to Mahinath Pur branch canal. Only about 1,700 ha of the command area is being irrigated due to the lack of field channels, poor water distribution, and poor condition of some of the minor canals.

By improving one minor canal and with better management of the irrigation water, the command area could be enlarged to its designed value. Currently, the system does not have any controlling gates on the minor canals or on the field channels.

The farmers at Kamala are divided over conflicts between head and tail farmers. The prevalence of tenancy and landlessness in the area suggests that power and wealth are not equitably distributed. Yet, there are pockets of cooperation in the system which could be exploited.

The project's largely bureaucratic organization only seems able to effectively maintain the concrete headworks. No agency exists at the water-use level for the disciplined distribution of water. Most of the time, might appears to be right. The western Kamala project is a contradiction; ugly at the water-use level, but beautiful at the water-release level.

4. KANKAI IRRIGATION PROJECT

A. INTRODUCTION

Kankai Irrigation Project is a DIHM-managed system located in far eastern Nepal in the Jhapa District of the Mechi Zone on the right bank of Kankai River (Figure 13). The Kankai Irrigation Project is operated by the Kankai Development Board of His Majesty's Government of Nepal. Shivaganj, Panchgachhi and Mahabara Panchayats are all within the main command area of Kankai.

The construction of the Kankai irrigation system is being completed in two phases. The first phase, completed in 1976, brought 5,000 ha under irrigation. Water was released for 700 ha in 1977, 2,000 ha in 1978 and 5,000 ha in 1979. The entire command area received irrigation water in 1980. The second phase, which may be completed in a few years, will bring another 3,000 ha into the command area. Currently, Kankai is irrigating only 4,000 ha due to flood damage to one of the siphons in the system. We were told this siphon may be re-constructed within a year or so.

Kankai Irrigation Project is located on the middle terraces and floodplain of the Kankai River. The land slopes up to one percent in the upper reach, while at the tail, the lack of relief coupled with a high watertable has made upland crop production difficult.

Though there are several streams running through the command area, there are no farmer-managed irrigation systems. Rainfed agriculture was practiced before irrigation was introduced in the command area. Except for a few old villages populated by Tajpurias and Rajbangshis, other settlements are new.

There are two particularly interesting features of Kankai. First, farmer organizations were functioning relatively effectively only a few years ago at Kankai. The organizations have significantly deteriorated in the last year or two. Second, the physical structures at Kankai are still new, and for the most part, still functioning.

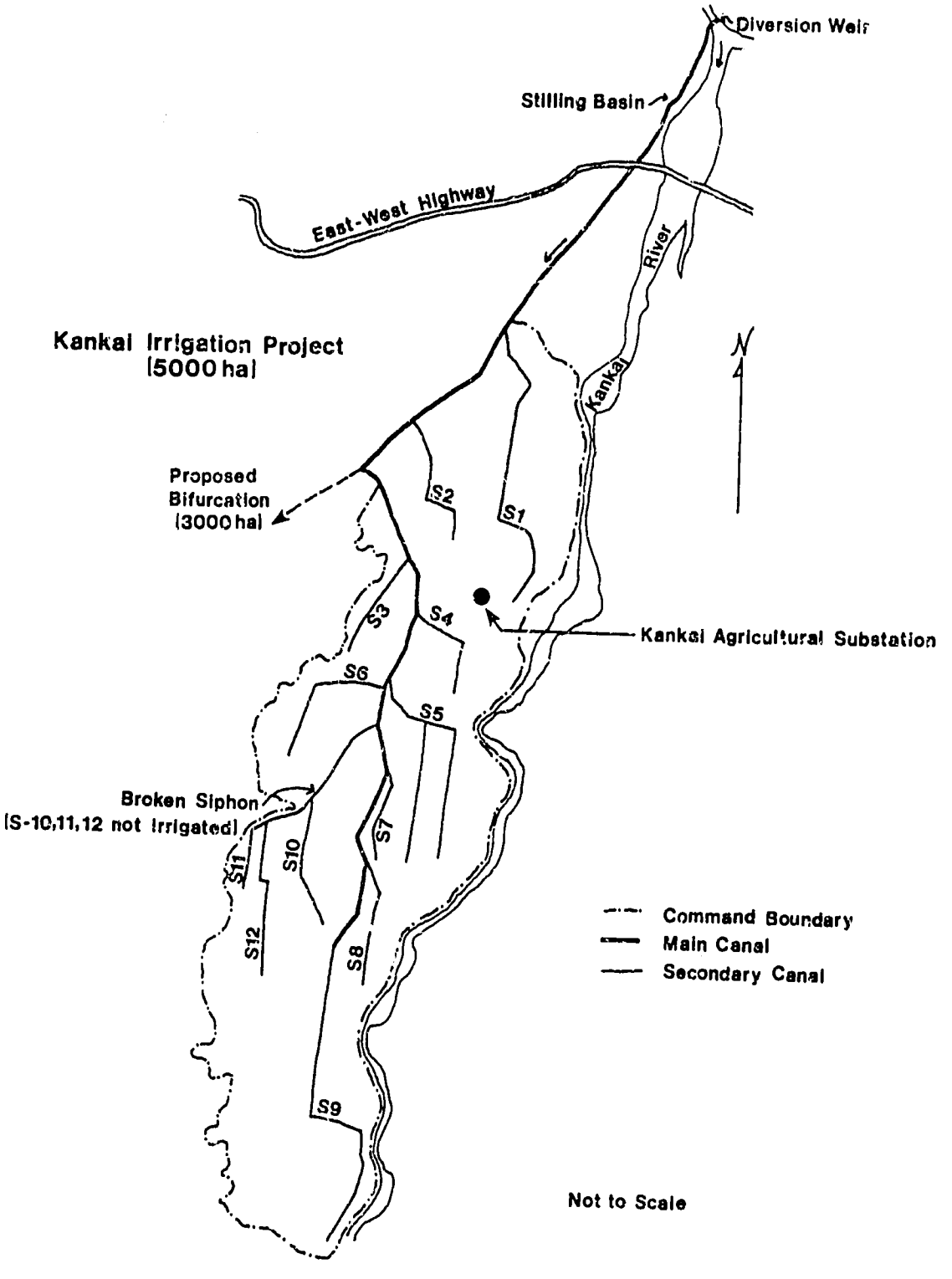

Figure 13. Kankai Irrigation Project

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The water source for the system is the Kankai River, which is perennial. The minimum discharge of the system seems to be 7.50 cumecs in April. There is enough water available to supply the current 4,000 ha for all three cropping seasons, but after all 8,000 ha are developed, there may not be enough water to grow early paddy in the entire area.

2. Canals and Structures

The intake structure for Kankai irrigation system lies at the foot of the eastern hills on the Kankai River. The intake is a concrete weir 126 m long and 1.5 m high with three sluice gates that are 3.50 m by 1.85 m.

A stilling basin lies 1.426 km downstream of the intake. The stilling basin is 144 m long. The bottom width is 6.0 m, and the water depth is 2.6 m at the upper end and 3.6 m at the lower end. The stretch of canal that runs between the intake and the stilling basin is completely lined and has a designed discharge capacity of 10.15 cumecs.

The main irrigation canal starts at the stilling basin and is divided into four reaches. The following table lists the reaches and gives their designed discharges.

Main Canal Reaches on Kankai Irrigation Project

Name	Type	Length (km)	Slope	Discharge (m^3/sec)
1	Concrete lined	11.500	1:1000	10.15
2	Unlined	2.600	1:1850	4.55
3	Unlined	2.767	1:1540	1.95
4	Unlined	5.533	1:1540	1.95

Near the end of reach 1, the main canal bifurcates: one canal supplies the current 5,000 ha and one canal will supply the future 3,000 ha. Only the canal supplying the 5,000 ha is currently operating. At the end of reach 2, the main canal again bifurcates

into reaches 3 and 4. Currently, the Reach 4 canal irrigates only about 300 ha because the broken siphon is in this section.

There are 12 secondary canals and 30 tertiary canals diverting water from the main irrigation canal. To distribute irrigation water properly, each secondary and tertiary canal bifurcating from the main canal has a Parshall flume immediately downstream of the outlet. The design features of the secondary irrigation canals are listed in the following table.

Design Features of Secondary Canals of Kankai Irrigation System

Name	Location (km)	Reach	Length (km)	Net Command Area (ha)	Discharge (l/s)
S-1	5.65	1	5.80	746.1	851
S-2	7.59	1	3.90	226.6	259
S-3	10.72	1	3.40	372.0	425
S-4	11.50	1	4.65	417.5	477
S-5	12.86	2	6.60	798.0	910
S-6	1.40	3	2.15	136.1	154
S-7	2.764	3	8.70	230.2	262
S-8	2.764	3	8.70	676.1	704
S-9	2.523	4	1.20	126.5	144
S-10	4.00	4	3.23	259.3	295
S-11	5.53	4	3.20	114.4	165
S-12*	5.53	4	11.10	385.0	441

* Because of siphon breakdowns in Reach 4, S-10, S-11, and S-12 are not functioning. Designed discharge figures are given.

There are 165 tertiary canals bifurcating from the secondary canals and the main canal. The tertiary canals occur about every 600 m. The average area supplied by each tertiary canal is about 30 ha. On each tertiary canal, outlets through division boxes are located about every 100 m to irrigate about 6.0 ha of land.

Check structures are provided in the main irrigation canal immediately downstream of the secondary turnouts to maintain the water level in the main canal.

Along the main irrigation canal there are 5 siphons, 13 culverts, 26 drop structures, 5 overflow spillways, and 7 road bridges. All these structures are made of reinforced cement concrete.

On the secondary canals, there are a total of 29 check structures, 67 drop structures, 65 culverts, 15 cross drains and one road bridge. These structures are also cement concrete.

Roads

Kankai irrigation system has three roads: the trunk road, main road, and secondary road. The trunk road is 6.5 m wide and graveled. It leads from the main east-west highway to the command area. The main road runs along the main irrigation canal and some secondary irrigation canals. The secondary road runs along the remaining secondary irrigation canal. The lengths of the trunk road, main road and secondary road are 20.364 km, 70.694 km and 71.50 km, respectively.

System Performance

Though the command area of the system is 5,000 ha, the rapid appraisal team only observed 4,000 ha of the system because the remaining 1000 ha were not operative.

Since the system was recently constructed, it functions well, except for the 1,000 ha not currently supplied with water. The headworks and the main canal up to 11.50 km (Reach 1) look good, except in one or two places where there are landslides in the main canal. Where the watertable is high, the main canal is block-lined. Due to the high watertable, the block lining has severely deteriorated in some places and needs maintenance.

The capacity of the main canal up to 11.50 km (Reach 1) is 10.15 cumecs. This portion of the canal was designed to supply water to the entire command area, including the second phase (8,000 ha) which is not complete. However, during monsoon it seems that more water is flowing in the main canal than it was designed for. Since about 40 percent of the command area is lowland, farmers do not need water from the canal when it is raining. Hence, during the monsoon when there is rain, farmers close the tertiary canal gates which increases the water flow in the secondary canal and causes banks to breach. This phenomenon was observed mostly in S-8. Also, there are no field drains in the command area of S-8.

Because of the increased discharge and also because of uncontrolled buffalo which go to the canal to drink, most of the earthen banks downstream of the fall and check structures are damaged in Reach 3 of S-8. In time, the structures themselves may be damaged if the problem is not addressed.

The main canal in Reach 1 has more flow velocity, and few silt problems. However, the secondary and tertiary canals bifurcating from the main canal (especially S-1 and S-2) have more silt problems. Silt

in S-1 seems to be about 1.0 m deep in the head reach of the canal. Even so, with the help of a check structure, water was flowing in that canal, which may eventually damage the canal bank.

The head reach of S-2 for about 200 m lies in a deep cut, and has landslides. This portion of canal seems to have been lined, but the lining has been destroyed because of landslides.

The remaining branches have few problems, mainly bank erosion downstream of structures.

It seems little attention is given to the silt in tertiary canals. Some tertiary canals are cleaned by farmers, but because of deep silt in the tertiary canals, farmers often put timber planks of more than the designed depth in the check structure to increase the water level in the canals. Most of the tertiary canals function.

3. Soils

The soil of the command area appears to be of recent alluvial origin, being brought under cultivation primarily after deforestation. The soil of the upper land is loam to sandy loam with high humus content and is reported to be difficult to plow at times. The soil of the lower area (about 40 percent of the total command area) is primarily clay loam and is usually called wet soil. The texture of the upper soil is good due to the high humus content and regular applications of manure. However, all of the soils in the command area are acidic. Many crops can be grown in the upper soil, whereas only paddy or jute can be grown in the wet soil. Wheat yield is low compared to other projects because of the acidic soil.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

There are approximately 2,000 families in the Kankai command area. Many live in large houses propped up by wooden poles three or four meters off the ground. Influenced by Darjeeling, the houses were sometimes painted and had bay windows and porches. Some women in the area were wearing shorter, more modern hair styles, and other women were wearing glasses with stylish frames. These may be used as proxy indicators that the people of this area are more cosmopolitan.

In the past 20 years, the Kankai area has vastly changed. The power and social structure of the area appears to be gradually shifting away from the local indigenous people (Rajbanshis, Tajpurias) to the recent immigrants from the hills. At Kankai, there are now many Brahmins, Chettris, Limbus, Rais, and Tamangs, who have immigrated from the nearby hill districts of Terathum, Taplejung, Panchtar, and

Ilam. This immigration is continuing to affect landholding, tenancy patterns, agricultural labor, and relations between the various castes and ethnic groups.

Landholding

Ten years ago, statistics from Kankai show that 10 percent of the farmers owned 10 ha or more, 30 percent owned 2.5 to 10 ha, and 60 percent owned less than 2.5 ha. Those figures are probably accurate today, with the average farm family owning 2.0 to 2.5 ha. This is slightly larger than the average landholding size throughout the Terai.

The largest landowner at Kankai was said to have 46 ha, but only half of that land is in his own name. Along most secondary canals, farmers claimed the largest landholder in the immediate area owned about 13 to 20 ha. At one secondary canal, farmers stated that due to land fragmentation among large families, the largest landholder owns only 6.5 ha. In most locations, farmers stated that the majority of farmers owned 0.6 to 3.3 ha. A typical Kankai farmer might be an immigrant from the Taplejung district who now owns 0.75 ha of land, but rents a similar sized parcel of land from a large farmer.

Only Nepalese can own land in Nepal. Indian farmers migrating from the south cannot legally own land at Kankai.

An estimated 30 to 50 percent of the land at Kankai is rented. A local agricultural official said that this figure is gradually decreasing as larger landholders sell their extra land. An estimated 15 percent of Kankai land is owned by absentee landlords.

Agricultural officials also estimated that 40 to 50 percent of the 2,000 farmers at Kankai are involved in some way with renting land. This figure may be too high, as we encountered farmers along some secondary canals who claimed that only 25 percent of the local farmers were renting land.

There are both registered and unregistered tenant farmers at Kankai. The registered tenant has his name, along with the owner's name, on the property deeds. Tenant farmers must pay the owner a set amount of paddy (usually 9 to 13 maunds/bigha depending on the soil type), while keeping the remainder of the produce (1 maund = 40 kg; 1 bigha = 0.66 ha). The unregistered tenant farmer usually has a negotiated, informal agreement with the owner. At Kankai, it is common for the unregistered tenant to share the monsoon paddy crop with the owner on a 50:50 basis, with the landowner supplying all of the inputs.

Regardless of the tenancy agreement, most farmers renting land at Kankai are owners-cum-tenants, who own small parcels of land and

rent additional land from larger farmers. Approximately one-half to two-thirds of the tenant farmers are registered and protected by Nepal's Tenancy Act. The number of registered tenants is decreasing, however, as landowners continue to sell land and change tenants from one year to the next.

An estimated 15 to 20 percent of Kankai's 2,000 farm families are landless, a high figure for Nepal's Terai. At one village in the middle of the command area, farmers stated that half the local farmers are landless. The number of landless farmers may be increasing due to the continued immigration of people from India and the Nepal hills to Kankai. Farmers did say, however, that the landless people were both indigenous people and recent immigrants.

Note that the landless immigrants at Kankai may be better off than they were previously. For example, we encountered a West Bengal farmer from India, who obviously could not own land at Kankai, but had been a tenant farmer here for five years. He is sharecropping on a 50:50 basis and stated that his life is much better at Kankai than it was when he was living in India.

Other landless people at Kankai include halis, who are servants and laborers for landowners. The halis receive 40 to 60 maunds of paddy per year for their services, regardless of drought or crop failure. Halis we talked to were pleased with the arrangement because it gave them a measure of security they would not have as tenant farmers.

While Nepalese certainly make up part of the landless population, Indians without land have also moved to Kankai. Both the Nepalese and the Indians provide seasonal agricultural labor, with the Indians often coming to Nepal only during paddy-planting and harvesting.

Agricultural laborers are paid in cash or in kind. The daily agricultural labor wage rate at Kankai was reported to be Rs. 12 to 20/day for men and Rs. 7 to 12/day for women. The justification for a lower wage rate for women was that females cannot work as much as male laborers. Other laborers are paid the agricultural produce from two katthas (0.1 bigha) for every one bigha of land they harvest. Essentially, these laborers are paid 10 percent of the produce. Still other laborers negotiate separate arrangements with landowners.

Castes and Ethnic Groups

The Kankai farmers divided people into 2 groups: the indigenous people who have lived in the area for generations (Rajbangshis, Tajpurias) and the relatively recent immigrants from the hills (Brahmins, Chettris, Rais, Limbus, Tamangs). Approximately 40 to 50 percent of the people at Kankai are Rajbhangshis and Tajpurias,

10 percent are Limbus and Rais, and the remainder are Brahmins, Chettris, Tamang and other ethnic groups. At some locations in Kankai, Brahmins and Chettris seem the most numerous, while Rajbangshis and Tajpurias dominate other areas. In general, there seems to be a great deal of integration among the various castes and ethnic groups throughout the system.

Local agricultural officials, however, said that the Rajbangshis and Tajpurias are gradually being displaced by the hill people. The Rajbanshi and Tajpuria were described as very risk adverse, and not early adopters of new agricultural technology. Their yields are said to be correspondingly lower. They often live in small village clusters relatively far from their land. This makes transporting manure to their fields difficult at times. The hill people live in their own houses directly on their land.

Local officials also said that there are a disproportionate share of landless Rajbangshis and Tajpurias at Kankai. Though farmers at some locations stated that Rajbangshis and Tajpurias are the largest landholders in their immediate area, others said that Rajbangshis who used to own 10 ha years ago, are now landless. It was said that 20 years ago, some Rajbangshis and Tajpurias owned as much as 200 ha of land, but that most of that land has been sold.

Despite the changes in social structure, it appears that farmers of all castes and ethnic groups are relatively amicable at Kankai. We witnessed Brahmins in friendly conversations with Rais, and Brahmin farmers discussed their problems with us at a Rajbangshi's house. We did not hear of any overt or severe intercaste or ethnic group conflicts.

Power

Perhaps because this area has changed so much in the past 20 years, power is not associated with land size as strongly as in other irrigation systems. Although land size obviously plays some role in defining power, some recent immigrants claimed that those people who have lived at Kankai a long time have the most power. These immigrants said that the older Kankai people controlled most of the resources, while new immigrants had neither monetary resources nor land. Agricultural officials, however, said that the newly arrived hill people are more financially astute and politically active, and that power has shifted naturally into their hands.

Some Rajbangshi and Tajpuria farmers defined power in terms of who could stay at the canal all night protecting his water. These farmers said that since Rajbangshis will not spend the night at the canal, other farmers can easily take water at night. A prominent Rajbangshi farmer stated that power now rests with the Brahmins or

Chettris, or with farmers who have many sons (muscle power) to physically control other farmers if need be.

2. Irrigation Organization

Kankai Irrigation Project has a separate agricultural farm within the command area, which is managed by an agricultural expert who has been in this area for 10 years. He has three officers, JT (Junior Technician), field supervisors, and field assistants. The agricultural sector of Kankai is supervised by the Agriculture Division, and the farm manager is the chief of this division.

The assistant engineer of Kankai Irrigation Project is in charge of operation and maintenance. Under him, there are 4 overseers, 2 supervisors, and 45 dhalpas. Above the O&M assistant engineer there is one divisional engineer and one project manager at the project head office.

Initially, the farmers' organization was a distinctive feature of Kankai Irrigation Project. However, after the first two years, the farmers' organizations became inactive and ineffective.

The Agriculture Division took the initiative to organize the farmers' organization. A multi-purpose farmers' organization was visualized with the following functions:

a) to introduce better water management practices.

b) to strengthen communication among the farmers.

c) to help the agriculture division operate demonstrations in farmers' fields.

d) to take initiative for settling conflicts.

e) to help farmers better align field channels and farm channels.

f) to conduct meetings to settle problems among farmers and farmer groups.

Farmers organizations were felt essential in order to regularize the activities in irrigation water management. The farmers' organizations are supposed to participate in the following activities:

a) Prevent people outside the command area from diverting irrigation water to non-command areas.

b) Prevent animals from grazing in the canal or around it.

c) Prevent lawlessness in water distribution and help the dhalpas to perform their duties.

d) Prevent the damage of canal roads.

e) Seek the cooperation of village panchayats and farmers in properly managing the system.

f) Observe the rotation of water delivery.

g) Help organize agricultural training.

h) Seek solutions for farmers' problems.

The farmers along S1 were the first group to use irrigation water during the construction of the system. To motivate farmers to practice better water management, the Agriculture Division envisioned creating multi-purpose farmers' organizations. The purposes of the farmers' organizations' were to provide knowledge of better agriculture practices and practice better water management.

The Agriculture Division held mass meetings and seminars to educate the farmers about farmers' organizations. The zonal administration, district administration and district panchayat also helped the farmers to organize.

Where there were farmers' organizations, the Agriculture Division selected areas for demonstration farms. The demonstration farms and the intense interaction with the Agriculture Division motivated more farmers on other secondary canals to organize. With farmers' organizations, the small farmers got priority in water distribution and water share. However, the farmers' organizations were active and effective for only two years.

It appears that the farmer organizations became ineffective because there were no incentives or motivating factors for the farmers. Decreased budget and supervision contributed to the deterioration of the farmers' organizations. In the farmers' organizational meetings, the Agriculture Division participated more than the Engineering Division.

Though the farmers' groups are now ineffective, the structure of the groups still exists. Farmers are organized in groups according to the secondary canal that delivers their water. The organization is composed of 11 members, a chairman, a Secretary, and nine other members. If the secondary canal is big one, it can have more than one farmers' organization. Altogether 25 farmers organizations were formed.

A rotation system for early paddy was introduced in consultation with the farmers which lasted for two years. The rotation system was introduced in the current command area to prepare farmers for the rotation system that will be in effect after 3,000 ha are added to the system.

It seems there is no rotation among the farmers on secondary canals. This is true for all secondary canals except for S-2. Usually, farmers on the head tertiary monopolize the water at the expense of farmers on the tail tertiary. Water seldom reaches the tail tertiaries of the secondary canals.

During the first two years, Kankai irrigation system worked properly: structures were intact and regulations were enforced. Now, structures are not properly repaired and rules are not enforced, which is causing further damage to the irrigation system. Currently, farmers do not know whether farmer organizations exist or not.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

For much of the monsoon and winter seasons, the main canals at Kankai operate with continuous flow. Despite the reduced flows in the winter, the lack of farmer interest in growing rabi crops has made continuous flow possible.

A few years ago, a rotation system was introduced in the early paddy season to compensate for reduced water supplies. The 5,000 ha were divided into 4 blocks; and in consultation with the farmers, it was agreed that every fourth year a different block would not receive early paddy irrigation water. The farmers in the block not receiving water would grow other crops or leave the land fallow. In any single year, the other three blocks would receive a continuous flow of water. From all reports, this innovative rotation system worked well for two years, and the farmers' organizations were instrumental in helping operate the rotation. Later, however, it lost financial support. When the command area was reduced to 4,000 ha due to the damaged inverted siphon, the rotation system for early paddy was discontinued. This block rotation system is a good precedent not previously encountered in Nepal by members of the rapid appraisal team.

During the monsoon season, Kankai often has too much water. Because of the high rainfall in the area, gates must often be closed along the main canals. With so much lowland, Kankai farmers are justifiably worried about waterlogging in their fields during the monsoon. Kankai project personnel, therefore, must not only allocate and distribute water, but also must remove excess water from the canals at times.

A major constraint at Kankai is the lack of reliable information and communication services within the project. A DIHM engineer said that he has no way of knowing how much and when water is released into the main canal or when gates will be opened or closed.

It appears that DIHM officials and farmers operate the gates on the secondary and tertiary canals. The gates are easily opened and closed and few have locks. (One DIHM official said that when the gates are locked, farmers break the locks at night.) Farmers said that DIHM chowkidars rarely open or close gates on time, so they have taken over.

Water allocation along the main canal, therefore, has been at times chaotic. Along the secondary and tertiary canals, farmers often build their own earthen checks to get water to their fields. Farmers reported that the tertiary outlets are higher than the secondary canal so they must raise the water level by checking. These earthen checks often cause the water to overlap the upstream canal banks and restrict water flow downstream of the check. While the farmers sometimes cooperate with one another to equitably distribute water, at other times farmers and groups of farmers quarrel over water distribution. "Might is right" is the general rule for water distribution along the tertiaries.

One agricultural official stated that if a Rajbanshi and Tajpuria community was at the head of a tertiary canal with a group of Brahmins and Chettris at the tail, sometimes the Rajbanshi and Tajpuria farmers would have to send water to the tail before their irrigation is complete. At the tail of some remote secondary and tertiary canals, other farmers said that they sometimes received an inadequate supply of water. Farmers complained that dhalpas do not perform their job properly, so lawlessness prevails in water distribution.

Another agricultural official said the biggest problem is the lack of coordination between the Irrigation and Agriculture departments at Kankai. He claimed that water is not usually distributed in conjunction with agricultural needs. Ideally, the Engineering Division, in consultation with the Agriculture Division, would determine the schedule for water release in the main canal. Water releases would be announced early so that farmers are prepared.

However, the schedule is not always followed. Sometimes, water is released without informing the people who should know, which results in flooding at the tail; damaging crops or destroying the prepared fields.

Communication among the farmers, the Engineering Division (in charge of water release) and the Agriculture Division needs to be strengthened.

An incident the rapid appraisal team witnessed at the tail of the system characterizes all the above difficulties. A few farmers owning fish ponds requested canal water for a day or two to fill their ponds. The water was released, flowed all the way to the tail of system, but then ran continuously for four days, flooding many fields in the area. Farmers owning these fields bitterly complained that their yields would be reduced. The lack of an effective management system for water control and distribution contributed greatly to this situation. Many farmers, however, did say that they could better manage the system up to the tertiaries' if proper rules and regulations were carried out throughout the system.

Analysis of Water Distribution at the Farm Level

Most head farmers reported that the dhalpas distributed water from the main system (tertiary canals) to the field channels. A few farmers reported working in concert with the dhalpa, and others reported that anyone could open the gates at will. One farmer reported that he opened gates himself, and a second reported that the water users distributed water collectively.

Fewer tail farmers reported water distribution from the main system by the dhalpas. Some reported distributing water in concert with the dhalpas and other farmers at the tail reported that they distribute water entirely by themselves. Two said anyone could distribute water, two said head farmers did this task, and two said it was done by the group with individual participation.

Farmers at the head and tail unanimously responded that they and their sons or employees distributed water through field channels to farm channels to the crops.

When head farmers were asked who had priority in water distribution, three-quarters of the farmers said that the head farmers, the strong farmers, and "might makes right" prevailed in determining priority to access water. Only a few stated that the group and mutual understanding among users determined the priority. Three respondents said that they had priority, one said tail farmers had priority, and one said no one had priority.

When asked about priority, tail farmers (80%) generally responded that head farmers, strong farmers and "might makes right" had or made priority. A smaller number stated that the group through mutual understanding determined the priority, and two said no one had priority in water access.

Some head farmers also reported misused or excess use of water in the system. Only a few tail farmers reported misuse. Water misuse is attributed by the farmers to the lack of management by project officials and poor supervision of the dhalpas.

Among tail farmers, most said that head farmers take too much water. The numerous other factors mentioned that account for misuse of water included farmer ignorance of water use (lowland accumulations, crab and other animal caused leakage and broken canal beams).

2. Maintenance

DIHM is technically responsible for main system maintenance and cleaning, including the secondary and tertiary canals. This maintenance is to be done primarily from October to December. Yet, local officials stated that their biggest problem at Kankai was that regular maintenance could not be done, primarily due to an insufficient budget.

Therefore, maintenance is carried out on priority. High priority defects are identified in the main system, and DIHM makes the necessary repairs or cleans only at the selected spots. Other locations must suffer. Part of the rapid appraisal team observed silt and sand in S-1 at least 1 meter deep. There seems to be little motivation to perform better and more comprehensive maintenance.

Farmers themselves often clean portions of the secondary and tertiary canals. They collect money to hire laborers to clean the canals and make minor repairs, or they do it themselves. Some farmers along S-5 claimed that every house contributes at least one person for maintaining and cleaning the tertiaries. At the tail of this secondary, farmers also claimed that they do the cleaning and maintenance as DIHM never comes there.

Field Channel Maintenance

Almost all of the farmers at Kankai receive their water through field channels. Most of the farmers interviewed reported that field channel maintenance was accomplished as a group effort, while some farmers said that they maintain the channels individually and a few farmers hire laborers.

Most of the farmers reported that maintenance was done twice a year and was initiated according to the amount of weed growth and silt deposit in the channels. Many farmers also mentioned animal damage to channels as a reason for initiating maintenance.

Few farmers interviewed reported that there were sanctions for not participating in group maintenance.

Farm Channels

Less than half of the farmers interviewed at Kankai reported that they had farm channels on their farms. Almost all of the farmers with farm channels reported that the farm channels were permanent. Most of these farmers said they maintained the channels themselves, although there were a few farmers at the head of the system who said they hire laborers to do the work or help with the work.

Most of the farmers reported that they maintain and repair the channels twice a year, usually in response to weed growth and silt deposits in the channels. Several farmers added that animal damage (by cattle, crabs and rats) was another important factor in initiating maintenance along with weeds and silt.

3. Conflict Management

When asked if water conflict exists, three-quarters of the head farmers interviewed said no. Among the head farmers who said there were conflicts, over half said the conflict was started by head farmers or strong farmers. Several said that conflicts were started by anyone and by the tail farmers. Half of the farmers who reported conflicts said that conflicts were resolved when the entire group came to a consensus. Many other farmers said that the participants resolved the conflict through mutual agreement, and some farmers said that the water committee or the farmers' organization resolved conflict. All cases were reportedly solved by discussion.

Less than half of the tail farmers contacted said there were no conflicts over water. Of those who said there were conflicts, most reported that conflict was initiated by the head farmers and strong farmers, but many other farmers said the tail farmers started conflicts. As at the head of the system, over half of the farmers reported that conflict was resolved by the group, and many other farmers said conflict was resolved by the participants or by the panchayat or the water committee. Most conflicts were reported to be resolved through discussion, but some cases were said to be settled arbitrarily or by force.

4. Water Adequacy, Reliability, and Equity

Only one-third of the head farmers contacted reported problems of inadequate or untimely water during early paddy season, in contrast to three-fourths of the tail farmers. This information is reflected in the cropping areas for early paddy. Head farmers reported that approximately 85 percent of their land was cropped during early paddy season. Tail farmers reported that about 42 percent of their land was cropped at this time.

During monsoon season, almost 100 percent of the command area is cropped, according to farmers. However, while few head farmers reported problems with water adequacy and timeliness, over one-third of the tail farmers reported that water delivery was unsatisfactory.

In winter, several farmers interviewed at the head and the tail reported that they did not receive water. Of these head farmers that received water, some reported that water was inadequate and untimely. A few head farmers reported that their fields received too much water to grow upland crops. In all, about one-fourth of the head farmers grew no crops in winter, making the cropped area at the head about 25 percent.

In contrast, almost half of the tail farmers do not crop in winter. Some of those farmers refrain from cropping because their fields are too wet to cultivate. Of those farmers who receive water and grow crops, over half reported that water was inadequate or untimely. Only 12 percent of the tail is cropped in winter.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

Prior to the construction of the Kankai Irrigation Project, the command area fully depended on rainfed agriculture, which was more or less traditional subsistance farming. Currently, the availability of irrigation water, together with the extension of technical know-how and the easy delivery of inputs from the project, have resulted in intensified agriculture and higher yields per unit of land in the command area.

Many crops are grown in Kankai such as paddy, maize, wheat, jute, oilseed, pulses, vegetables and fruits. Fish and livestock are also raised. Paddy (early and late) is the principal crop. Winter crops are grown, but not in more than 20 percent of the total command area due to various reasons (40 percent of the area is lowland; poor market prices; labor shortages).

Early paddy is grown on more than 75 percent of total area, whereas late paddy covers almost 100 percent of the command area. Farmers pay special attention to their paddy crops. Wheat, legumes and oilseeds are usually broadcast, and farmers take little interest in preparing land, intercultural operations, and other agricultural practices that would benefit those crops.

Many cropping patterns have been recommended by the project officials for different command areas based on the availability of irrigation water. However, farmers choose their own cropping patterns, in which paddy is the primary crop. They are as follow:

a) Paddy - paddy - fallow

b) Paddy - fallow

c) Jute - paddy

d) Paddy - paddy - wheat/oilseed

e) Paddy - wheat - fallow

f) Paddy - legumes/oilseed.

The cropping intensity is almost 185 percent of the total command area.

2. Production Inputs

More than eighty percent of the command area is covered with improved varieties of paddy, wheat and maize. Legumes, oilseeds and jute are local varieties. Since most of the command area lies on newly reclaimed forest land having highly fertile soils, little fertilizer is used. A few farmers use recommended doses of fertilizer and harvest good yields. Manuring is practiced by the majority of farmers. The following table shows the percentage of farmers contacted who use fertilizers in Kankai for early paddy, monsoon winter crops. Pasticides are used during epidsmics by the farmers near the agricultural farm.

Percent of Farmers Reporting Fertilizer Use in Kankai Irrigation Project

Season	Location	No Fertilizer (%)	Manure Only (%)	Commercial Only (%)	Combination* (%)
Early Paddy	Head	22	40	4	78
	Tail	37	50	0	13
Monsoon	Head	48	16	18	18
	Tail	59	24	9	8
Winter	Head	8	53	8	31
	Tail	13	63	7	7

* Combination of manure and chemical fertilizers.

The command area is served solely by the Agriculture Division of the project which is on a 52-hectare agricultural farm in the command area. Seeds and seedling multiplication techniques are developed to meet farmers' demands, and the Agriculture Division also provides extension services to the command area farmers. The Agriculture Division has released several crop varieties to the farmers. Agriculture officials organize various demonstrations, distribute minikits (small packages of fertilizer, improved seeds, pesticides), and hold training and field days for the farmers. Currently, supervision and demonstrations are limited to the S-1 command area due to a low budget and inadequate transport facilities.

3. Yields

Even though fertilizer use is low, paddy yield is reported to be high throughout the command area. Most farmers reported a little higher yield of early paddy than of late paddy. The following table gives yield figures reported by farmers for crops in Kankai Irrigation Project.

Yield Variation and Average Yields for Crops Grown in Kankai Irrigation Project*

Crop	Yield Variation (mt/ha)	Avg. Yield (mt/ha)
Early Paddy	**0.7 - 4.8 (head)	3.0 (head)
	**0.6 - 3.6 (tail)	1.6 (tail)
Late Paddy	1.5 - 4.8 (head)	3.1 (head)
	1.2 - 4.2 (tail)	2.2 (tail)
Wheat	***1.2 - 3.3 (head)	1.9 (head)
	0.6 - 2.4 (tail)	1.4 (tail)
Mustard	0.3 - 1.2 (head)	0.9 (head)
	0.3 - 1.2 (tail)	0.6 (tail)
Potatos	--	8.0 (head)
	--	--
Linseed	--	0.3 (head)
	--	--

* Taken from interviews with 50 head farmers and 54 tail farmers.
** The low yield figures for early paddy may be inaccurate. It is unlikely that farmers would grow paddy with yields under 1.5 mt/ha.
*** The high yield figures for wheat may be inaccurate. The acidic soil at Kankai might prevent wheat yields above 2.0 mt/ha.

Farmers appear to be dissatisfied with the current marketing structure and the low price policy. Prices of jute and wheat are so low that farmers are cultivating less and less of these crops.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) The Kankai Irrigation Project has a good precedent for building effective farmers' organizations. They have experimented with farmers' water users groups, which worked well. The farmers' organizations helped implement the successful, large-scale, block rotation. Local DIHM officials state that Kankai farmers are more "cooperative" than farmers in other DIHM systems.

b) There is enough water at the source to irrigate the command area; at times, Kankai has too much water.

c) Kankai is new and still functioning. It appears to have relatively good construction work and structures. There is also sufficient physical infrastructure (average of 1 outlet for every 6 ha) up to the tertiary level.

d) An agricultural farm has been fully integrated into the system and is providing valuable services to the farmers. Local farmers appear to trust the agricultural personnel, and the farm operators were instrumental in forming the farmers' water users' groups.

e) The irrigation system has brought change to innovative farmers. Most farmers have moved from growing one to growing two paddy crops per year. Local agricultural officials also say that most farmers easily adopt new agricultural technology.

f) There is a great potential for agricultural improvement at Kankai, and there is enough water for farmers to plant winter crops.

g) The soils at Kankai are very suitable for irrigated agriculture.

2. Weaknesses

a) Effective DIHM management, motivation, and responsibility is lacking at Kankai. Currently, no direction or control is exercised from the top, leading to a lack of interest in effective system management. Poor communication within the Kankai project also hinders management.

b) A gap is growing between DIHM and the Kankai farmers. The project does not cooperate with farmers' organizations, and after a promising start a few years ago, has not promoted effective farmer involvement.

c) The lack of effective farmers' organizations means that there is little control over water allocation and distribution. Currently, there is no set rotation when needed along the secondary and tertiary canals leading to a "might is right" situation, inequitable water distribution, and lower cropping intensity at the tail. Farmers place timber planks and checks in the canals to gain some degree of water control, but this often causes the water in the canals to rise too much, leading to erosion and breaches in the canals.

d) The physical infrastructure of Kankai is not well maintained, and neglected maintenance and repair work has cost the project much money. The poor maintenance also has led to a number of conflicts among farmers as well as between farmers and DIHM.

e) As the main canal was designed to carry enough water to serve 8,000 ha, there is often too much water in the canal for the 4,000 ha currently under command, and the farmers have become accustomed to this large quantity of water. There is a related drainage problem because while there are main drains, there are no secondary or farm drains.

f) There are few farm channels. Indeed, most farms appear to have no farm channels.

g) Approximately 40 percent of the Kankai command area is lowland, which is too wet and limits the types of winter crops that can be grown successfully.

h) Strong cleavages are forming which are separating local indigenous people from the newer immigrants from the hills. Though not violent, the cleavage pattern suggests that Kankai could one day be characterized by "haves" and "have nots."

3. Summary and Conclusions

Kankai irrigation system, being newly constructed, looks quite good. It has 11.5 km of lined main canal, 10.8 km of unlined main canal, 56.9 km of secondary canal, and 71.5 km of tertiary canal for 5,000 ha of command area. One outlet is provided in the tertiary canals for every 6.0 ha (on average). There are no major problems with the physical system. All the structures are cement concrete, and Kankai has a road that is about 162 km long. The source of the system,, a perennial river, has enough discharge to supply 5,000 ha of land.

The infrastructure of Kankai irrigation system is elaborate, and control systems are in place. However, farmer participation in managing the system has not grown as expected.

There is potential at Kankai for the farmers to become divided into two conflicting groups. The indigenous "have-nots" and the immigrant "haves". The rapid social changes taking place at Kankai could leave large segments of the farm population behind.

With proper management and strengthened communication among the involved parties, the Kankai farmers might actively respond and increase their participation. Better management and effective farmer participation in irrigation activities could mean that potential benefits could spread more equitably throughout the system.

Four thousand hectares of the Kankai command area could receive water for all three cropping seasons provided water was delivered on time and repairs and maintenance were done. Such an accomplishment demands better management. Also essential to operating the project efficiently is obtaining the confidence of the farmers. Right now, farmers lack confidence in the system. To increase the cropping intensity of the command area, the lowlands must be made suitable for winter cropping. The wide gap between DIHM made personnel, the Agriculture Division, and the farmers has to be closed to take maximum advantage of the potential of Kankai irrigation system.

V. FARMER-MANAGED TERAI SYSTEMS

1. LOTHAR IRRIGATION SYSTEM

A. INTRODUCTION

Lothar is a farmer-managed irrigation system in Chitwan District about 30 km east of Bharatpur and 1 km south of Bratap Pur on the Bharatpur-Hetauda highway (Figure 14). The Lothar system irrigates Wards 1, 2, 3 and 8 of Piple Panchayat. The gross command area of the system seems to be about 800 ha. Some farmers claimed that the command area is continually expanding and said that the system now irrigates well over 1,000 ha.

Farmers reported that the system has operated for 50 years or more. At first, the farmers brought in water from the Lothar River, about 4 km east of the command area. In those days, the farmers irrigated only paddy because not enough water was available in the Lothar River for a winter crop. With the expansion of the command area and because of the increasing demand for food, in the winter the farmers constructed a 2-kilometer canal which brought water from the Rapti River across the Rapti floodplain and over the nearly dry Lothar River. The Rapti River diversion has operated for 15 years.

With such a large command area, the farmers need a large supply of water. Water from the Lothar and/or Rapti Rivers provides sufficient water for most irrigation. Sometimes there is even surplus water, particularly in the monsoon season. Water shortages do occur during early paddy season. Yet, there is a continual struggle to mobilize enough labor to channel water from the 2 rivers to the command area. Water acquisition and labor mobilization, therefore, are two critical variables that always concern Lothar farmers.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The Lothar irrigation system receives water from two sources, the Lothar and Rapti rivers. The Lothar and Rapti rivers are approximately 4 km east of the irrigation system. The two rivers run in a southwesterly direction parallel to each other. Near the command area they merge and share a mutual floodplain. The Lothar irrigation system lies west of the Lothar-Rapti floodplain. The Lothar River is closer, but does not supply enough water to meet the irrigation needs of winter crops and early paddy. To obtain additional water, the

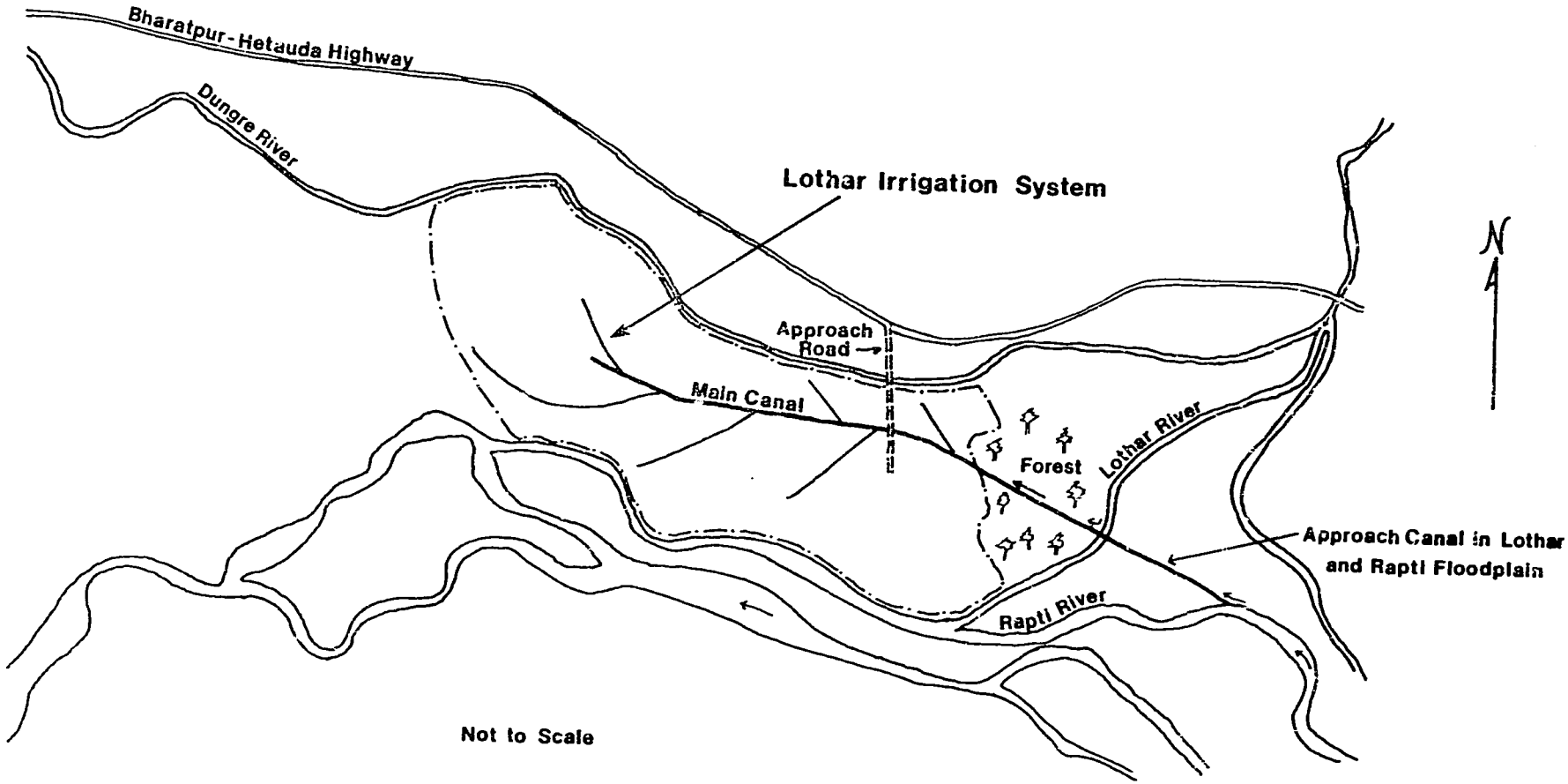

Figure 14. Lothar Irrigation System

farmers constructed a canal through the floodplain to capture water from the Rapti River, which lies approximately 2 km east of the Lothar River. The approach canal from the Rapti River is washed out yearly during the monsoon floods.

The Kulekhani hydro-electric power station is located in the hills above the Lothar system, and uses the water from the Rapti River. Depending on the needs of the Kulekhani station, more or less water may be released into the Rapti River, particularly in the winter. Rapti River flows, therefore, can fluctuate a great deal.

2. Canals and Structures

There is no intake structure on the main canal--only a guide bank made of boulders and gravel to divert the water. Along the upstream side of the guide bank, an approach canal crosses the floodplain of the Rapti River and the Lothar River. The approach canal runs about 2.0 km through boulders and gravel.

The Rapti River often changes course and some of the farmers reported that at times the approach canal must be made longer than 3.0 km. Since the approach canal lies completely on the riverbed, more than 75 percent of the water leaks from the canal. Therefore, the approach canal is large. Some of the farmers reported that, on average, 300 laborers must work 15 days every year on this diversion work alone, which is damaged again after every flood.

The total length of the main canal is about 4.5 km excluding the long approach canal on the riverbed. The main canal irrigates from both banks. Lothar system has six branch canals of approximately equal capacity. The main canal seems to be about 4.0 m wide with a maximum water depth of 0.5 m. The capacity of the main canal is about 1.6 m^3/s. About 50 percent of the main canal passes through a thick forest and the rest through cultivable land. The entire length of the main canal seems stable with good banks.

There are many small canals and field channels to irrigate the respective fields. The system does not have any pucca structures and no water measuring structures, and it does not have any cross drainage in the main system.

At the tail of the system, however, the rapid appraisal team observed a wooden diversion structure to divide field channel water into two streams in a two to one ratio. A log was placed across the canal, with 2 wooden notches cut into the log, one notch twice as large as the other. Water from each notch flowed into separate channels. While the farmers pointed out that the structure could be easily tampered with, this apparently rarely happened. They pointed out that they must trust each other. Thus, water theft was rare. A wooden adjustable check structure was also seen near the tail of the

system, along with wooden aquaducts that crossed the main canal. While there were very few control structures, it appeared that they were not needed due to the surplus of water available.

3. Soils

The Lothar irrigation system is located just below the confluence of the Lothar and Rapti rivers. Until 20 or 30 years ago, the area was forested and innundated almost annually during monsoon floods. Dikes now prevent much flooding. Top soils tend to be thin (15 cm to 60 cm) with fine sandy loam to sandy loam. Subsoils consist of sand and gravel.

Because these soils are thin, fertility tends to be low. They are not well-suited to irrigated agriculture because percolation and drainage tend to be rapid. However, high percolation rates are probably offset by a high watertable during the monsoon.

Soil resources are being depleted at Lothar. Many fields are lowered (at considerable expense to the farmers) in order to command water from improperly placed branch and field canals. The soils in this area are very thin. Thus, the fertility of the lowered fields is reduced considerably. While lowering the fields is probably not very detrimental to paddy, reduced fertility adversely affects upland crops. Thus, these farmers will be less adaptable to agricultural change in the future.

Since the soils at Lothar are mostly shallow with a gravel substratum, drainage does not appear to be a problem. In fact, excessive drainage in the area probably results in low irrigation efficiencies.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

There seems to be two classes of landowners at Lothar: a few are relatively large landholders; the rest are smallholders. Three or four families in the area own up to 17 bighas (11 ha) of land. Perhaps 75 percent of the landowning families own 0.5 bigha (0.3 ha) or less. Statistics from the Agriculture Department indicate that 90 percent of all landowning families in Piple Panchayat own less than 1 ha. These same statistics show that approximately 20 percent of all farm families at Piple Panchayat are landless.

There is very little tenancy at Lothar. The farmers, however, have devised a unique system of sustaining the landless farmers. In times of water stress, such as during early paddy season, the committee does not give all farmers enough water to irrigate all their crops. Rather, larger farmers are encouraged to rent part of their

land to landless people. Water is then given to that larger farmer. All agricultural inputs and outputs are shared 50:50. A farmer owning 10 bighas, for instance, might rent 1.5 bigha parcels to three or four landless farmers. Then the landowner and the landless farmers would receive water.

Most farmers at Lothar are Brahmins or Chhetris who have settled in Chitwan in the past 20 or 30 years. There are also smaller numbers of Dunwars and Darais. Dunwar families live toward the tail of the system and each appears to own slightly less land than the upstream Brahmins and Chhetris. All ethnic groups seem to cooperate in irrigation activities.

Most power at Lothar is concentrated within two or three families, with other power shared relatively equitably among the rest of the population. Both Brahmin and Dunwar farmers called the irrigation committee chairman the most powerful individual in the area. Farmers were very careful to point out, however, that the chairman was not powerful before being elected chairman. It was his election to the position of chairman that gave him the power.

2. Irrigation Organization

The new Lothar irrigation system was built by farmers in 1972. In 1971, a Lothar River flood destroyed the summer irrigation system on Lothar and devastated the command area. The government of Nepal constructed a big dam between the command area and the Lothar River which cut off the old intake for the command area. At that time, the farmers decided to tap the perennial Rapti River.

The farmers approached DIHM and asked them to construct a new intake which would also use Rapti River water. DIHM personnel visited the site and after the survey declared that the irrigation structure would cost Rs. 300,000 to build. Since the farmers could not afford this amount, they decided to build a new structure themselves. During summer, farmers make alternative structures to obtain Lothar River water.

Three hundred laborers were mobilized for 17 days to build the main canal and an intake-diversion on the Rapti River. Farmers contributed Rs. 10,000 to the construction.

The Lothar farmers have two major problems with water acquisitions: 1) The approach canal must be repaired every year, and 2) silt must be cleared from the system every three to four months.

These problems have led the farmers to organize. During the relatively slow post-harvest period of January-February, the farmers attend a general assembly and elect a chairman and a vice-chairman. The incumbent chairman has held the position for the last five years.

Before him, his kinsman was the chairman for two years. The chairman is a Brahmin and a small landholder, owning only 5 katthas (0.2 ha) of land. He has continuously been elected unanimously.

Each of the six branch canals has a committee and the chairman appoints the members of the six branch canal committees during the general assembly. There are five members on each branch canal committee. We were told that the ethnic composition of these 30 committee members fairly accurately reflects the ethnic groups in the Lothar area. The current chairman practically holds a mandate from the general assembly to implement the assembly decisions. Farmers said that they elect the current chairman because they see him as a farmer whose command is obeyed willingly and they usually accept his judgement. There are no written rules and regulations, but the general assembly's decisions are written down.

It is the duty of the chairman to see whether or not the system is working. At times of potential floods, he may assign five strong farmers to watch the river. If a flood appears imminent, the five farmers will breach the diversion.

The general assembly decides when to rebuild and clean the approach canal, the diversion, the main canal, and the branch networks. It also determines the labor mobilization for these purposes. There are approximately 300 owner-cultivators. It is compulsory for every owner-cultivator to contribute one laborer. If the owner-cultivator does not contribute his labor, he is penalized Rs. 15 to Rs. 20 (depending on the daily market wage). The chairman told us that in the last five years, they have collected Rs. 17,000 in penalties. This money is deposited in a nearby bank, and is used in welfare programs like school maintenance.

The chairman employs two peons who bring the farmers' grievances to the notice of the chairman and other relevant people. The peons do not have to contribute labor for maintenance. They tell the farmers when, where, and why to gather for meetings and maintenance. Last winter, 350 laborers worked for seven days to link the approach canal with the Rapti River. They then worked for another eight days to erect the diversion and maintain and clean the system canal network.

How could there be 350 laborers when there are only 300 owner-cultivators in the command and each one only has to contribute one laborer? The landsharing arrangement with landless farmers mentioned previously solves this problem. Since there are landless laborers, but no tenancy in the command, and since the system requires more labor for the maintenance and rebuilding purposes, the owner-cultivators provide some part of their land to the landless laborers in winter. In return, the landless laborers must contribute to the system maintenance and repair in exchange for the temporary oppor-

tunity to cultivate a field. Perhaps such an arrangement was considered necessary because the labor contribution is not in proportion to landholding size.

The farmers of Lothar irrigation system do not feel that the panchayat authorities can interfere with their irrigation works. They think that Lothar irrigation system belongs only to the users.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

From January to July water is tapped from the Rapti River. During the rest of the year, enough water can be diverted from the Lothar River to supply the entire command area. During early paddy season, however, neither river provides sufficient water to irrigate the entire command area. At this time, the Lothar farmers institute water allocation measures which farmers consider equitable.

Before the early paddy season, the General Assembly decides what percent of the entire command area can be irrigated. Larger landholders are limited to this percentage of their particular landholdings. Thus, if the water users decide that only 20 percent of the command area can be irrigated, a farmer who owned 5 *bighas* would be limited to irrigating 1 *bigha*. However, the association's decision to irrigate only part of the command area may be altered if larger landholders agree to rent some part of their land to landless farmers. During early paddy, when water is scarce, water is rotated through the six branch canals. Thus, farmers receive water at least once every seven days.

On each channel farmers appear to obtain water on demand. During late paddy, when there is plenty of water available, all farmers receive water on demand. Farmers themselves direct water into their paddies. For the most part, there were no water control structures on the system. Farmers achieved water control by using earthen and sometimes wooden check structures.

All the fields are level basins, and since they are used to produce at least one crop of paddy, they are quite level. Most of the fields have a direct intake from at least a tertiary canal. However, there is some paddy-to-paddy flow. Some fields had outlets for waste water, but most of the water seemed to flow to the next paddy.

2. Maintenance

Every farmer receiving irrigation water is responsible for donating labor to maintain the approach, main, and branch canals from the top to the tail of the system. Individual farmers are responsible for maintaining field channels and tertiary canals.

During our site visit, most of the main and branch canals contained significant amounts of silt. Farmers stated that these canals would be cleaned and deepened before the start of the early paddy irrigation season. Most of the tertiary and field channels appeared to have been well-maintained. Continuous maintenance of the Lothar system is probably necessary due to the sandy subsoil in the area.

3. Conflict Management

All of the farmers interviewed stated that there were no conflicts. The chairman of the irrigation system appeared to be respected by all. No cases were reported where fines are imposed to resolve a conflict in water distribution. (Fines were reported, however, involving non-contribution of labor.) Some farmers said that they do not like to impose fines, because it reflects badly on a person's character and may actually cause more conflict. Imposing a fine was a negative punishment and farmers stress amicably settling water distribution disputes. Amicable resolution helps maintain a high degree of cooperation among the farmers.

What few conflicts do arise are apparently settled amiably between individual farmers. Probably few conflicts arise because there is usually a surplus of water. In fact, farmers below the Lothar system rely on waste water from Lothar to irrigate.

4. Water Adequacy, Reliability and Equity

All farmers interviewed thought that there were adequate amounts of water and that it was reliable. This was true even for tailend farmers, who stated that there were no problems, and "the water would come." In winter, water is more or less adequate if farmers can get water from the Rapti River. Farmers perceive the water in the irrigation system as adequate, reliable, and equitable.

All farmers interviewed stated that it was the best irrigation system in the area. That there is a conscious effort to include landless farmers in the system says much about the social consciousness of the larger landowners. Of course, the large landowners are fully aware that the landless farmers are needed to fill labor demands.

While water delivery is perceived by farmers as reliable and adequate, the original design and layout of the canal system may not be the best. Many lands adjacent to the canals are not commanded. To obtain water for paddy, many of the farmers have or are presently lowering their land. Rather than solve the problem of improperly placed canals, they are adjusting the elevation of the land surface. As the command area expands, conflicts may arise. However, there appears to be more than enough water in the Rapti River for expanded irrigation, if the diversion structure on the Rapti River is enlarged.

During crises when immediate repairs are needed, the chairman of the committee is authorized to demand or hire labor to solve the problem immediately. Since there are few control structures on the system, we asked what would happen during a flood. The farmers replied that since the diversion structures on the Lothar and Rapti rivers would be washed out, the flood waters would not be able to enter the command area.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

The addition of irrigation water from the Rapti intake during the winter and spring has resulted in a change from monocropping to multiple cropping. At the same time, the use of improved varieties of paddy and wheat, with increased application of fertilizers and manure, has accelerated production. The intensified agriculture has also corresponded to the use of tractors and increased demand for agricultural labor.

A wide range of cereals, oilseeds, pulses and vegetables can be grown in the command area. However, farmers currently grow more paddy, wheat, maize, mustard, and lentils. The area under wheat is decreasing due to low prices and also to damage by wild animals, especially rhinoceros and deer. Lothar farmers have not been able to solve this serious problem of "rhino aggression" from across the Lothar and Rapti Rivers. The protected rhinos living in Chitwan National Park come to the fields at night and eat the wheat. The chairman of the irrigation committee stated that one rhinoceros could easily eat 5 katthas (0.2 ha) of wheat during one night.

The area in pulses and oilseeds is increasing. Farmers put their maximum labor and energy into early and late paddy cultivation.

The general condition of the wheat and lentils appeared satisfactory during the visit. Mustard was being harvested. Mixed cropping of mustard and lentil is practiced. In the upland area, land was ready for sowing maize.

The cropping pattern adopted by the farmers is as follows:

Area	Pattern
Irrigated	Early paddy - late paddy - wheat Early paddy - late paddy - lentil or mustard
Partially irrigated	Late paddy - wheat/lentil + mustard
Non-irrigated upland	Maize - lentil/mustard

Farmers interviewed appeared to be anxious to cultivate early paddy, but many could not do so in view of water shortages during that period.

Local extension officials conducted a survey in 1984-85 with 174 farmers on 287 ha of land. They discovered the following land use pattern for the command area:

Crop	Area Under Cultivation (ha)	No. of Farmers
Late paddy	287.0	174
Early paddy	57.0	70
Wheat	13.4	111
Spring maize	11.3	70
Mustard	63.8	111
Lentil	107.8	Not Available
Linseed	1.7	111
TOTAL	582.0	
Cropping intensity	203%	

Farmers interviewed at the head and tail of the system reported no definite cropping pattern nor any definite crop calendar. Weather conditions (the onset of the monsoon and winter storms), soil

type, labor availability, pricing, and prevalence of wild animals all determine the crop calendar.

2. Production Inputs

More than 90 percent of the command area is covered with improved varieties of paddy and wheat. About 15 percent of area is covered with improved maize. The other crops are local varieties. Farmers show great interest in improved varieties of mustard, lentils and linseed, but currently farmers cannot obtain these varieties. While farmers depend on the local cooperative for wheat seed, they usually maintain seed for other crops by themselves or purchase them from other farmers.

Farmers in this area extensively use farmyard manure supplemented by fertilizer. Those farmers who grow three crops are using more fertilizer. Farmers use complex as the basal dose and urea as top dressing. However, small holders use more urea than complex. Early and late season paddy, wheat, mustard, and maize receive fertilizers. No fertilizer is used on lentil, linseed, lathyrus and buckwheat. The usual doses of fertilizers are reported to be as follows:

Crop	Complex (kg/ha)	Urea (kg/ha)
Early paddy	60	30
Late paddy	90	60
Wheat	150	60
Maize	(Manure)	
Mustard	30	30

Farmers use insecticides in paddy, wheat, maize and mustard. Most of the farmers reported that pesticides were not available when needed from the local cooperative or the Agricultural Input Corporation in Bharatpur. They also reported that pesticides were not available in small packets.

Although a junior agricultural technician is supposed to serve the command area farmers, he is usually not available. Head and tail farmers invariably reported very poor or no agricultural service in the area. Radio programs appeared to be the only means for farmers to obtain technical knowledge about agriculture. Few training programs

have been organized, and the farmers have not been given the opportunity to visit nearby demonstration farms and the agricultural stations. A production program has been launched, and participating farmers have been gradually exposed to improved technology through demonstrations and minikit programs.

Inputs and credit are available through a cooperative.

3. Yield

The yields of paddy and wheat appear to be satisfactory. Yield variation from location to location and from farmer to farmer (2 to 4 mt/ha) has been reported. The yield of lentil, linseed and mustard are reported to vary greatly in the uplands and the lowlands. Upland mustard yield was reported to vary from 0.75 to 1.0 mt/ha, whereas lowland yields scarcely go above 0.5 mt/ha.

Moisture in the lowland areas (a majority of the command) contributes to the low yield of mustard, linseed, and lentil.

Crop	Range of yield reported by farmers (mt/ha)	Average yield by crop cutting in production block (mt/ha)
Early paddy	3.5 - 4.0	4.8
Late paddy	3.0 - 4.0	3.1
Wheat	2.0 - 3.5	2.2 (soil damage)
Mustard	0.4 - 0.3	1.0
Lentil	0.4 - 0.6	1.0

Farmers are not satisfied with the existing market structure and low prices. Farmers reported a Rs. 15 to 25 higher price in the town of Tadi as compared to the local market. The middleman still plays a prominent role in the local market.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) Lothar possesses an organized irrigation committee with high farmer participation and a powerful, trusted

chairman. Organization rules are equitable and apparently followed by all members.

b) Lothar is capable of mobilizing many laborers to perform essential irrigation tasks.

c) Farmers seem very willing to cooperate. They actively work together to sustain the landless people in the area.

d) Lothar has two separate, but related, sources of water. When one source becomes dry, they use another source.

e) Despite the long approach canal, the system functions well.

f) There is an abundance of water at Lothar most of the year. Even when water supplies are low during early paddy season, the organization's rules equitably divide and distribute the water.

g) Lothar has the potential to increase crop yields greatly.

2. <u>Weaknesses</u>

a) The diversion and long approach canal across the river beds require large amounts of labor to maintain every year. Some farmers are discouraged with how much labor is required every year to maintain the intake.

b) Because of the time and effort required to maintain the intake and approach canal, the command area and distribution system have been neglected. Physically, the system is crude, and water distribution can be adversely affected.

c) The distribution canals at Lothar are often improperly aligned. Farmers have adapted by lowering their field elevation. Under these physical conditions, it would be difficult to control excess water during a flood.

d) Converting uplands to paddy lands by lowering the field elevation means that upland crops will not be possible in the future because the watertable will be higher and there will be less fertile soil. The farmers are forfeiting their future options.

e) Many wild animals (rhinos, deer) destroy crops, particularly in the winter.

3. Summary and Conclusions

The command area (800 to 1,200 ha) in Piple village panchayat of Chitwan District is irrigated by a 4.5-kilometer main canal from the Lothar and Rapti Rivers. Enough water is available to grow three crops a year. A major weakness in the system is the intake, which is a temporary diversion that is approximately 2.0 km long.

The main canal has a capacity of about 1.6 m^3/s and seems to be functioning well. The system has many branch and field channels.

Though power and land seem to be concentrated in only a few hands, the Lothar organizational apparatus seems to operate effectively and farmers seem satisfied. The irrigation committee seems to effectively meet the two major system objectives: water acquisition and labor mobilization.

The chairman seems to have a mandate from the farmers' assembly to exercise centralized control over the system's maintenance and rebuilding activities. The Chairman also appoints the branch canal committee members. Note that all the farmers contacted expressed confidence in the chairman. This confidence appears to provide a fair measure of legitimacy to the Lothar irrigation system organization.

The Lothar irrigation system appears to be reliable, to provide adequate amounts of water, and to equitably distribute water. Few conflicts arise within the system, most likely because often there is a surplus of water, at least for late paddy.

2. SURTAN IRRIGATION SYSTEM

A. INTRODUCTION

Surtan is a farmer-managed irrigation system in Chitwan District about 17 km east of Bharatpur and 2 km south of Parsa on the Bharatpur-Hetauda highway (Figure 15). Surtan system irrigates Ward 5 of Khaireni Village Panchayat.

This system is old. One farmer reported that it was constructed 150 years ago. A very important feature of the Surtan irrigation system is the prevalence of Tharus, one of the oldest ethnic groups in Nepal. Tharus constructed the system, and it is still completely under the control of Tharus. Except for a few households, all the farmers in the command area are Tharus. Some ethnic groups from the hills have recently started to farm in the area, and the Tharus and new groups of farmers are still learning to adjust to one another.

The system usually commands 350 ha, although the main canal can supply water for more than 1,000 ha of late paddy. The 650 additional hectares receive surplus water during the monsoon season.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1 Hydrology

The source of irrigation water for the system is the Dhungre Khola, which is springfed. The maximum discharge of the river during monsoon seems to be about 20 to 25 m^3/s, and the minimum discharge is about 100 l/s. There is one system downstream of Surtan irrigation system which takes water from the same source. There are also several independent systems upstream of Surtan drawing water from the river. As a result, during early paddy season the main canal draws only about 100 l/s, though there is plenty of water for late paddy and a winter crop.

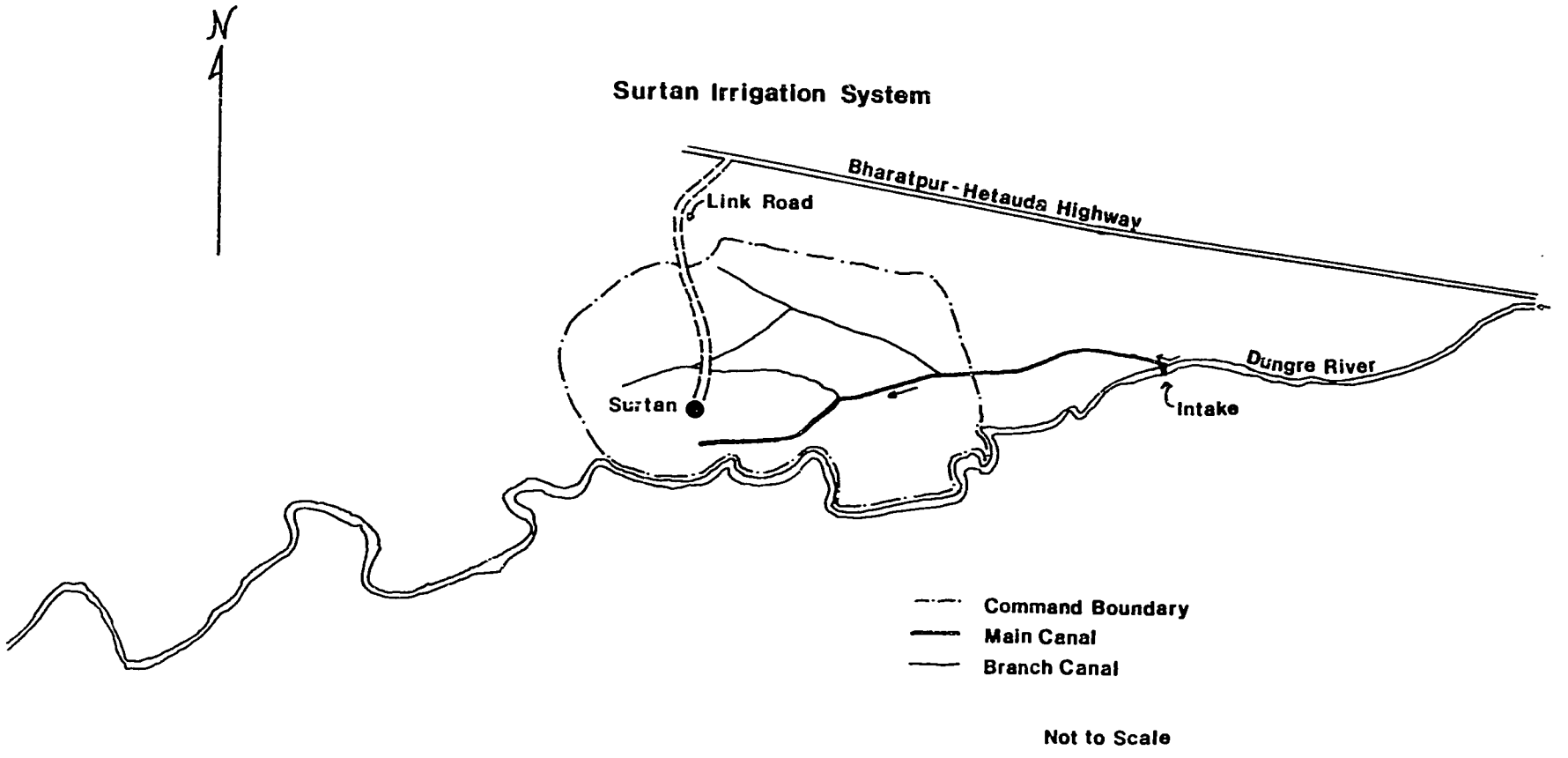

Figure 15. Surtan Irrigation System

Originally, a Tharu chieften (jamindar) arranged the laying of a dhungro (a round, wooden pipe) to bring water from the Lothar River into the Surtan diversion. The farmers called the Lothar River the Dhungre Khola. After a devastating Lothar flood in 1971, a spring was discovered north of the Mardar River bridge on the Bharatpur-Hetauda highway. The Tharu farmers harnessed the spring and also use Mardar River for irrigation water. The farmers call the spring Dhungre Khola, also.

2. Canals and Structures

The intake of Surtan system consists of a gabion weir about 50 m long. There is no regulator and no undersluice. The gabion weir intake was constructed recently by the farmers with some financial assistance from the district panchayat. Since there is no regulator in the main canal, during monsoon large amounts of water enter the main canal.

The main canal is very large compared to the command area. It is about 5.0 m wide and 2.0 m deep for a length of about 2.0 km. Some farmers reported that the maximum water depth in the main canal during monsoon is about 0.6 m, which indicates that the maximum capacity of the main canal is about 4.0 cumecs.

There are two branch canals: Badki Kulo and Village Kulo. Badki Kulo is about 4.0 km long with a capacity of about 1.0 cumecs. Village Kulo is about 3 km long.

There are many small canals and field channels. The main and branch canals function well and have good banks on both sides. The main system does not have any cross drainage.

No control structures were observed in the system. Because of the abundance of water, there is little need for them.

3. Soils

Soils at the Surtan irrigation system appear to be deep, fine, sandy loam. They should be very fertile with good drainage and a high waterholding capacity. The soil in this area would appear to be well-suited to irrigated agriculture.

During our investigation all soils were gleyed, indicating a high watertable for much of the year particularly during the monsoon. Wells in the area are placed at a depth of approximately 20 ft.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

Most of the farmers at Surtan are Tharu. Their landholding pattern is similar to the old Nepalese jamindar system of landlords. One family in the area owns approximately 75 bighas (49 ha) of land, which is sub-divided among three sons. Each son owns 17 to 25 bighas (11 to 17 ha) of land. This one family dominates the area in power and prestige.

Other Tharus in the area own an average of 1 to 2 bighas (0.66 to 1.3 ha), a landholding size that seems larger than the average at nearby Lothar farmer-managed irrigation system. There are also Brahmins and Chettris who have moved to Surtan in the past 20 years. They usually own slightly less land than the Tharus. There appears to be little, if any, tenant farming at Surtan. All farmers are owner-operators.

A unique feature of Surtan is the large number of agricultural laborers from the Birgunj area. The larger Tharu landholders have become very dependent on these seasonal laborers. One large Surtan farmer claimed that one thousand agricultural laborers come to this area every year. Though perhaps a slight exaggeration, this figure roughly indicates the magnitude of employment provided to seasonal laborers. Laborers are paid Rs. 15 to 20/day.

The most striking feature of the Surtan social structure is the communal nature of the Tharu village of Surtan. At the end of the rapid appraisal study, some local Tharu farmers told us that at first they were very worried when our team arrived in Surtan. They thought that we were from the government and were going to propose that their farmer system be incorporated into a government system. The farmers were very vocal that they wanted to maintain the autonomy of their irrigation system, and wished no interference from the government. They questioned whether any government assistance could help their system.

The Tharu farmers are uneasy about the hill people entering the area. The Tharus are clearly the majority, but they are apprehensive that Brahmins and Chettris will continue to move from the hills to Surtan and buy more land. The Tharu community now has a great deal of solidarity. Almost all of them live in one village. Four or five Brahmin families also live in the village, but more of the Brahmins live in farm houses close to their fields.

Tharu farmers said that Tharu women do not work in the field, and the farmers will not use animal manure. The recent immigrants from the hills do both, and the Tharus admitted that the hill people

farm more intensively. The Tharus seem concerned that the hill people's more intensive agricultural practices will soon give them an economic advantage over the Tharus.

Although relations between the Tharus and hill people are usually amicable, there were reports of Tharu farmers beating a hill farmer from outside the command area when that farmer alledgedly stole water from the Surtan main canal. Another story was told of hill people throwing a dead dog into the main canal to pollute the water. In addition, the Tharus were once forced to pay Rs. 12,000 for 5 katthas (0.2 ha) of a Brahmin's land that was being flooded from the intake structure. This also caused some resentment. (The purchased land was duly registered in the committee's name at the land revenue office.)

Brahmins and Chettris from the hills stated that there were disagreements with the Tharus at times, but usually they were settled quickly. The hill farmers said that they themselves, like most of the Tharus, are small landholders and, thus, had common interests.

Though some Tharus are wary of the hill farmers, power in the irrigation system is still with the Tharus. In addition to the large landholding family, the local ward sadaysa from Khaireni Panchayat and a lawyer are Tharus who were mentioned as powerful people. The lawyer owns 4 bighas (2.6 ha) of land. The position and education of these two people apparently confer power to them.

2. Irrigation Organizations

The Surtan irrigation organization is a farmers' committee. There is a chairman and six members on the committee. Annually before the pre-monsoon activities, the farmers meet and elect the chairman and members. The election is usually unanimous. The hill farmers presently have no representation on the committee, but they have no complaint about this absence. The assembly decides about reinforcing the intake diversion, and cleaning and maintaining the main canal and the canal networks. There are no written rules.

The committee mobilizes labor for repairs and maintenance. The committee has made it compulsory that all able-bodied males from a family who owns land in the command contribute their labor, irrespective of landholding size. The heads of households, those attending school, and shepherds are excluded from this work. The number of laborers who participated in 1985 was 150. There are 116 Tharu and a few hill peoples' houses in the two communities. Those farmers absent from the labor activities are fined Rs. 20/day according to the current wage rate.

The current issue dividing Tharu and hill farmers is the criterion that should determine the level of labor contribution. The

larger Tharu landholders argue that the present system (every household regardless of landholding size contributes all able-bodied males) is equitable, as everyone then contributes to the best of their abilities. The hill farmers, who usually own smaller plots of land, believe that labor contribution should be more progressive, and based on the criterion of bighahaddi - one laborer is contributed for every bigha owned.

In 1985, the irrigation committee received Rs. 10,000 from the district panchayat to make a more pucca diversion, since the old one washed away by the monsoon flood. The committee mobilized labor that equaled Rs. 60,000 to erect the stone-net diversion.

The committee has a peon who informs the farmers about the date, site and nature of work for labor contributions. He also conveys their grievances to the committee. He annually receives two pathis of paddy from each command household.

D. CHARACTERISTICS OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

The Surtan irrigation system is composed primarily of residents from a Tharu village. Thus, the unique agricultural habits of the Tharu villagers dominate the irrigation scheme. Very little of the land area is devoted to early paddy. Larger landholders prefer to grow only late paddy.

The main and branch canals have been poorly located so that much of the potential area is not commanded. However, the Tharus apparently do not see this as a problem, since they are satisfied with the production of many non-irrigated upland crops. Economic pressure to produce paddy may change this viewpoint in the future.

In general, there were field channels to all fields, or direct inlets to individual fields from the secondary canals through wooden pipes. There was very little field-to-field flow.

Historically, there has been sufficient water for all farmers who wish to grow early paddy to do so, and the hill farmers said that they receive plenty of water. However, farmers recognize that the entire command area could not support early paddy production if the large landowners who are not currently growing early paddy decide to grow this crop.

The use of irrigation water is on demand. There is no rotation or other scheme of water allotment. All farmers have direct control of water application.

2. Maintenance

At the beginning of the irrigation season, the Committee chairman has the peons notify all households within the irrigation scheme of the dates that labor will be required to repair the head-works and clean all main and secondary canals. Maintenance last year required 150 men for one or two days. Apparently, labor requirements change little from year to year.

3. Conflict Management

There have been few serious conflicts within the system. Having sufficient water for most of the time and water available on demand contributes to the lack of conflict. The potential for conflict exists primarily with the newly arrived hill people. The Tharus look upon these people as outsiders. Conflicts between these groups may result from questions of labor distribution.

4. Water Adequacy, Reliability, and Equity

Currently, water appears more than adequate to meet the irrigation needs of the farmers. It is also reliable in that water is available on demand in all canals throughout the entire irrigation season. All who wish to receive water for early paddy do so. However, this is only because the larger landholders prefer not to raise early paddy. The larger landholders refrain from growing early paddy to enable the smaller landholders to produce early paddy and be more economically self-sufficient. Thus, the small landholders are, in a sense, at the mercy of the larger landholders. All individuals interviewed considered the system equitable.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

The agricultural system of Surtan is similar to the nearby farmer-managed Lothar irrigation system with the exceptions of land use, crop intensification, and fertilizer use. Contrary to the Lothar system farmers, Surtan farmers grow little early paddy and take only two crops annually. Late paddy and wheat is grown extensively, and 15 to 25 percent of the area is devoted to lentil, linseed, maize, and lathyrus. Large landholders usually do not grow an early paddy crop. They argue that labor is unavailable to harvest the crop, there is little time for intercultural operations, and the paddy shatters and germinates in the field. Surtan farmers do not use manure, and mostly depend on chemical fertilizers. Large landholders and some small farmers use tractors and draft animals to prepare land. Surtan irrigation system farmers are much more dependent on an external supply of labor than Lothar system farmers.

A wide range of crops are grown in Surtan besides the vegetables and potatos that are used primarily for consumption. Few farmers grow vegetables for commercial use. The most widely grown crops are paddy, wheat, maize, mustard and linseed. The wheat crop appeared to be very good during the rapid appraisal. Mixed cropping of mustard and linseed is also practiced in the area.

For some time, farmers in Surtan have participated in the seed multiplication program of the Agricultural Input Corporation (AIC). During the last two years, farmers have suffered because the AIC has refused to accept the farmers' seed, which has been below standard due to untimely rain during the harvest.

Farmers adjust their cropping patterns as the situation demands. The most important cropping patterns adopted by the farmers follow:

Area	Cropping Pattern
Irrigated flatland	Early paddy - late paddy - wheat
	Early paddy - late paddy - mustard/lentil
	Late paddy - mustard - wheat
Lowland	Late paddy - wheat - fallow

A survey conducted in 1984/85 by the local government extension unit in a 273-hectare production block gave the following land pattern use:

Crop	Area (ha)
Early paddy	56.6
Main paddy	273.0
Wheat	49.7
Spring maize	20.0
Mustard	72.8
Lentil	29.7
Linseed	6.6
Lathyrus	1.6
Cropping Intensity = 187%	

Surtan farmers contacted reported the following range of land use.

Crop	Area (%)	
Late paddy	90-100	
Early paddy	10-20	
Wheat	15-60	(Lowland)
Mustard	30-50	
Lentil, linseed	10-20	
Spring maize	3-5	
Maize	50-60	(Upland)

While large landholders usually devote more land to late paddy and wheat, the small landholders usually plant early paddy.

2. Production Inputs

Paddy and wheat are the only crops that use improved varieties. Intercultural operations in these crops are strictly followed. Line sowing of wheat behind a plough could be seen in some areas. Fertilizers are applied as a basal dose and also as top dressing. Wheat usually received two irrigations.

Farmers of the command area usually do not use farmyard manure. Chemical fertilizers are commonly applied in varying doses in different crops as follows:

Crop	Complex (kg/ha)	Urea (kg/ha)
Early paddy	--	75-150
Late paddy	150	75
Wheat	150	75
Mustard	100	50
Linseed	--	--

Balanced fertilizers are used by large landholders, whereas urea is favored mostly by small farmers. Decreasing soil fertility is reported by most farmers. Farmers, especially large landholders, are familiar with pesticides. However, pesticides are often unavailable at the right time. Seeds and fertilizer can be obtained at local cooperatives or at the market in the nearby town of Tadi. Credit can be obtained for seed, fertilizer, and livestock.

The area is well served by the Agriculture Department sub-center at Khairani. Improved technologies for paddy, wheat, and maize are within reach of the farmers. Since no improved technologies or varieties are available for mustard, lentil and linseed, farmers depend on local cultivation practices for these crops. The 184 farmers in the production program usually receive agricultural advice and demonstrations from the local extension office. Inputs such as fertilizer and credit are made available to the farmers in this production program.

3. Yields

The yields of various crops are similar to the nearby Lothar farmer-managed irrigation system. Farmers report yields of 3.5 to 4.0 mt/ha for early paddy, 3.0 to 4.0 mt/ha for late paddy, and 2.0 to 3.5 mt/ha for wheat. Farmers also reported declining yields in almost all crops when fertilizer applications are withheld. They also complained that the soil structure is deteriorating, probably because farmyard manure is not used.

The existing market structure and the low prices for produce appear to be a growing concern of the farmers. The increasing prices of most agricultural inputs including labor is also affecting the farmers.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) The Surtan irrigation system is controlled by a homogeneous Tharu community which is cooperative and well-organized internally.

b) There is sufficient water available for at least two crops, and the source seems secure. Additionally, since a spring feeds the system, there are no potential flood problems.

c) Considering that this is an indigeneous, farmer-managed irrigation system, the semi-pucca intake structure is good.

d) Surtan has very deep, well-drained soils. They are well-suited for irrigated agriculture.

e) Larger Tharu landowners claimed that they limit the land they crop in early paddy season, so that more water will be available for smaller farmers. The larger farmers say they want the system to operate equitably.

f) There is a large potential for agricultural improvement in view of the stable water source and the comparatively little land cropped.

g) There is very little crop damage from animals at Surtan as compared to other nearby irrigation systems in Chitwan.

2. Weaknesses

a) The farmers could crop much more land, particularly under early paddy. There is relatively little early paddy grown in Surtan compared to other nearby irrigation systems.

b) Additionally, the canal system hasn't been put in properly, so much of the command area that could be irrigated is not. Much of the land is dryland.

c) The system is monopolized by one or two families. The irrigation committee is largely ineffectual because the larger landowners control the committee behind the scenes.

d) Though providing employment to a great number of people, some of the Surtan farmers have become dependent on large influxes of outside agricultural labor.

e) There is potential for future conflict with the more recently arrived farmers from the hills.

f) Surtan farmers are damaging the soil structure because they do not apply manure to their fields.

3. Summary and Conclusions

Three hundred fifty ha of land in the Surtan irrigation system are irrigated by a 2-kilometer long main canal from Dhungre Khola, which is fed by a spring. The canal systems are functioning well. There is a semi-permanent intake made of gabion wire to divert water into the main canal. Enough water is available for late paddy, winter crops, and some early paddy.

Surtan irrigation system appears to be effective. However, the issue of what should be the criterion for determining the level of labor contribution may become increasingly serious. The lack of representation for the hill farmers could also cause organizational problems in the future.

The committee appears functional, although a few large landholders possess the real power behind the committee. No major problems in water distribution have emerged since water is adequate, and during early paddy season, the big Tharu landlords "voluntarily" do not cultivate all of their land. They say that they do it for the sake of the small farmers. However, they probably keep land fallow because they have no pressing need for extra production. The Tharus' employment of outside agricultural labor may reflect their affluence, but may also indicate the traditional taboos against doing some kinds of fieldwork. The large Tharu landowners' dependency on outside agricultural labor may create a problem for other Tharu landless

laborers who live outside the command area. This may adversely affect the Tharu's communal irrigation system.

The surplus of water available at Surtan and the preferred cropping pattern of the larger landholders, have contributed to the successful operation of Surtan. Much of the potential cultivable area, however, is not commanded due to the placement of main and secondary canals. Farmers contacted were not aware of this and, therefore, did not consider it a problem.

The system appears to operate harmoniously, with all farmers feeling that it is a good system. While the system may not be efficient in water use, it is adequately meeting the needs of the farmers.

3. AURAHA IRRIGATION SYSTEM

A. INTRODUCTION

Auraha is a farmer-managed irrigation system in Bara District about 1.0 km east of Simara Airport (Figure 16). This system irrigates Auraha, Faradhawa and Bathanaha Matiya of Simara Village Panchayat and Bisaulia Matiya of Jeetpur Village Panchayat. The total command area of this system seems to be about 260 ha.

The command area of this system begins at the end of the forest called Char Kose Ghadi. On the east side of the command area is the Dudaura River, and the Bahune River is on the west side.

The command area is connected to the north-south Birgunj-Hetauda highway by a road which is being constructed by the sugarcane development project. About 66 ha of land within the command area belongs to the sugar factory.

An interesting feature of the Auraha irrigation system is the prevalence of very powerful, large landholders. Many of these landholders have families who are very involved in national politics. Thus, some of the larger farms have managers who operate the farm, while the landowners live in Kathmandu.

Another interesting aspect of Auraha is that it is not really an irrigation "system," but simply a network of canals. The "system" is very loose, socially, organizationally, and physically.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The source of the system is called Dumeni Pani, which is a spring. There are many springs irrigating other nearby areas. Some farmers reported that the discharge of the spring depends on the frequency of rainfall. Hence, the discharge of this spring is not dependable during the dry season. The discharge during the summer wet season seems to be about 2.0 m^3/s and about 30 to 40 l/s during the dry season.

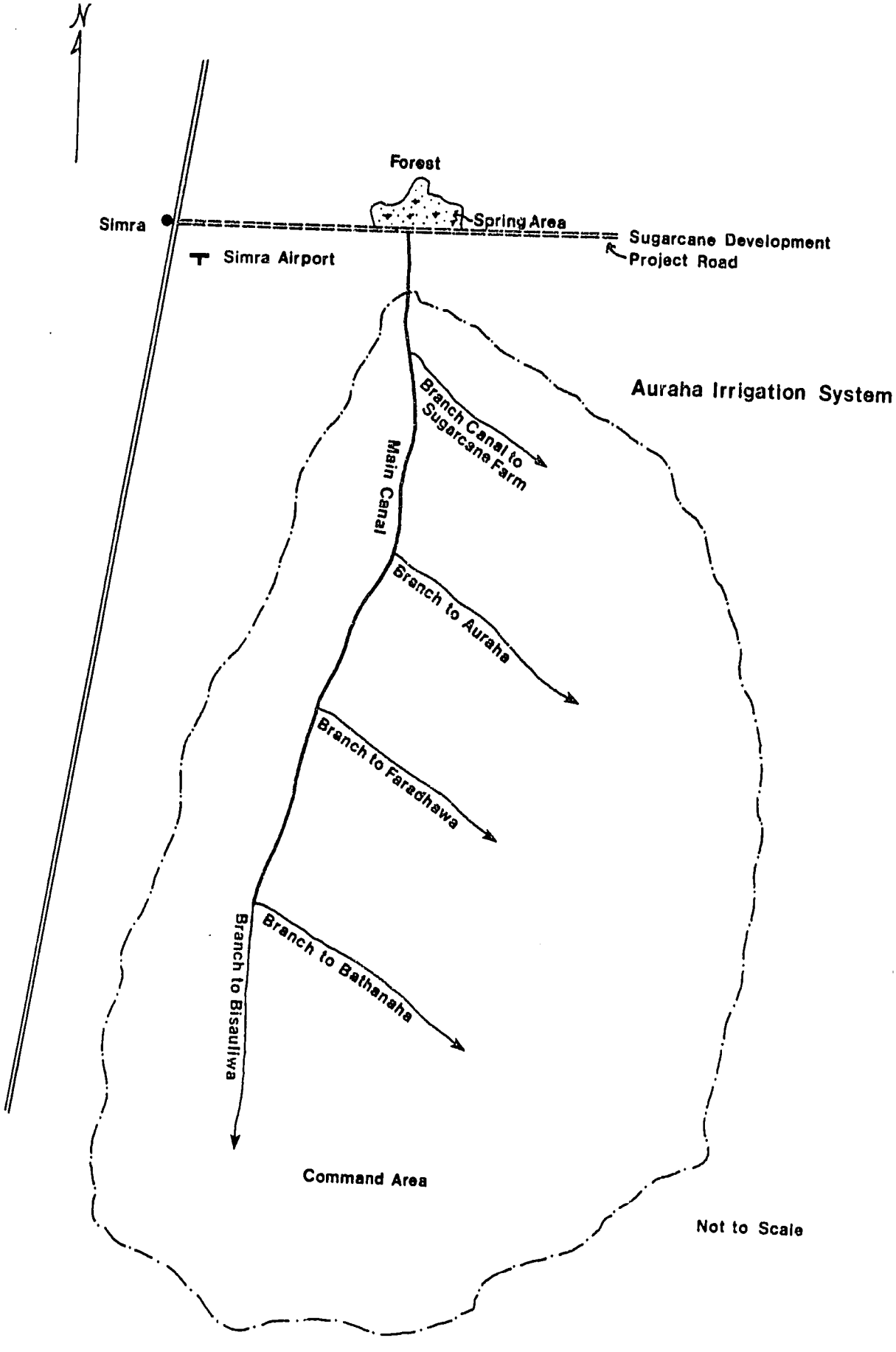

Figure 16. Auraha Irrigation System

2. Canals and Structures

Auraha system does not have an intake. The spring itself functions as the intake and its stream bed functions as the main canal. The total length of the main canal is about 2.0 km. The main canal is about 1.5 m wide and 30 cm deep; large enough to draw all of the spring water.

Auraha system has five branch canals. The first branch goes to the sugarcane farm of the Birgunj Sugar Factory. The other branch canals go to Auraha, Faradhawa, Bathanaha and Bisaulia Matiya. All of these branch canals are about 300 to 500 m long. There are no pucca structures, measuring structures, or cross drainage in the system.

3. Soils

The soils at the Auraha irrigation system vary in texture from loam to sand. The eastern portion of the command area is poorly drained. There are natural springs in that area and possibly some seepage from the nearby irrigation canals contribute to the drainage problem. Several wheat fields observed in the area had severely reduced yields or complete loss of yield due to the poor drainage. The fertility of most of the command area soils is generally poor. However, soils at slightly higher elevations in the western part of the command area are far superior and suitable for irrigation.

Due to the high watertable, soils in the eastern portion of the command area are suitable for only paddy production. However, the potential exists for establishing open field drains, which would probably permit subsurface irrigation.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

Within the approximately 150 to 200 families in the Auraha farmer-managed system, there appear to be four socio-economic classes of farmers: large farmers, smallholders, tenant farmers, and landless laborers. Auraha is characterized by a disproportionate number of large and powerful landowners. Although farmers identified only three or four families owning up to 25 bighas (16.5 ha), there are likely more. In the local language, this area is known as Generalgunj or "place of the generals," because of the many powerful people from this area now living in Kathmandu. All the farmers mentioned the large power and land that these families possess. Nevertheless, one Panchayat official commented that if a farmer owns 10 bighas, and desperately needs agricultural labor to help him harvest those 10 bighas, then the agricultural laborers have power, however momentarily.

The smaller farmers own one or two bighas (0.66 - 1.3 ha) of land. A Brahmin farmer who moved to Auraha from the hills five years ago said that at that time he bought 1 bigha of land for Rs. 30,000. He said the same land now costs Rs. 40,000. He claimed that the produce from 1 bigha could feed himself, his wife, and his seven children.

An extremely large group of farmers are tenants. Approximately 60 percent of the land is under some form of tenancy. In a village in the middle of the command area, a tenant farmer claimed that only two or three farmers in the entire village owned land.

The legal rate for tenancy is for the tenant farmer to pay the owner either 15, 12, or 8 maunds (1 maund = 40 kg) of paddy per bigha depending on the quality of the land. One tenant farmer said, however, that a different rate exists at Auroha. For example, if a tenant is renting 1 bigha of land, he may need 1 maund of seed to sow in that bigha. The landowner will lend the tenant 1 maund of seed, but at the end of the season, the tenant has to repay 1.5 maunds of seed to the owner. In addition, the crop's production is shared 50:50, with the tenant supplying all the other inputs.

Tharus are the majority at Auraha and are usually tenant farmers or agricultural laborers. Unlike Chitwan, Tharu farmers in Auraha do not appear to have much land or power. The landless laborers are paid about Rs. 10/day with no food, compared to the Rs. 15 to 20/day reported in Chitwan. There are a few Brahmins and Chettris in the area, but they appear to own small parcels of land.

2. Irrigation Organization

It is not clear when this system started. The continuous and adequate water flow from the Dumeni Pani has contributed to the spontaneous growth of the command area.

There is no irrigation committee at Auraha. Instead, during an annual meeting usually held in April, the farmers appoint an honorary manager and two members for a single term (i.e., one year). The incumbent manager is reported to have 1.5 bighas (1.0 ha) of land.

Based on the farmers' decision, the head area and the main canal are cleared and maintained. However, the individual farmer takes care of adjoining canal networks whenever the network is tampered with, breached, damaged or eroded.

The system manager sends messages to farmers through four chowkidars, who tell the farmers about the work, dates and places for labor contribution. The chowkidars annually harvest the first row of

all the monsoon paddy crops in their respective part of command area as their salary.

The labor contribution (called kodalo) is in proportion to one's landholding size i.e., a farmer owning 1 bigha would contribute one kodalo, or "hoe," for digging the land. Last year, 400 farmers (400 kodalos) contributed to the maintenance and clearing activities. If a farmer has to provide five kodalos, he may contribute one kodalo in cash by depositing Rs. 10 (or the current day's labor wages) with the manager and 4 kodalos of labor. Water is denied to farmers who do not contribute labor. The farmers enjoy a feast after the labor contribution work.

No manager so far has imposed a penalty for tampering with the canal networks. Nevertheless, during the annual meeting, farmers have supported the idea of monitoring system tampering.

During early paddy, the farmers agree to rotate water. But strict rotation is not necessary, since not everyone grows early paddy. Because of the perennial springs, farmers also have the option of exchanging water at one time for water at another time.

There are no written rules and regulations. Some tail and middle farmers complained that some of the large farmers monopolize the water for their own agro-industrial purposes.

Two years ago, the farmers' meeting decided to afforest the head area. This decision has not been implemented yet.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

The Auraha irrigation system is spring-fed. Water is usually abundant and there has been no need to allocate water. Water is essentially received on demand, though there have been some problems with larger landholders at the head of the system diverting all of the flow for fish production or for their own fields. This does not happen regularly, or continue for long periods of time. The other farmers, while irritated, do not appear extremely upset.

All of the farmers use level basins, and it appears that the entire area is commanded. The canals appear to have been located properly.

2. Maintenance

All farmers in the system are required to donate one laborer per bigha (0.66 ha) owned to clean and repair and main channels. The labor required during the 1986 season was 400 man-days. The canals in the poorly drained eastern portion appeared to be poorly maintained. The eastern Auraha irrigation system is not a real system at all. Indeed, the natural springs and high watertable make irrigation unnecessary for most of the year. The western portion of the irrigation system is quite different: canals and field channels appeared well-maintained.

An interesting feature of the Auraha system is that individual farmers are responsible for maintaining the channels that flow through their land. Apparently, there have been no problems with this arrangement, although the committee could fine and/or refuse water to any individual who did not maintain the channels properly. However, the farmers stated that penalties had not been necessary.

3. Conflict Management

There have been few conflicts within the irrigation system, with the exception of farmer resentment towards the large landholders for detaining water for their own purposes.

4. Water Adequacy, Reliability, and Equity

The amount of water available for irrigation appears to be more than adequate as rotational systems of allocation have not been required. Apparently, there is some mutual sharing of water between farmers. The circumstances surrounding this sharing were unclear. For the most part, however, water is available on demand in adequate quantities. Most farmers that we contacted seemed to be satisfied with their system and felt it was equitable.

D. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

The command area farmers are currently changing from subsistance to irrigated agriculture. Communication is easier in the presence of the educated, large landholders; and exposure to improved agricultural technology, the means to obtain input delivery, and credit availability has showed the farmers good results. The large farmers have not shown the expected results, so the small farmers try to intensify their agriculture on their holdings.

A wide range of crops can be grown in the area. However, the most important crops in the lowland appear to be paddy, wheat, and

sugarcane; and in uplands, maize and mustard. Spring maize is becoming popular in the area as it gives good yields and may easily replace wheat because of wheat's low market price and high cost of cultivation. Sugarcane is extensively grown by large landholders, and crop rotation is also practiced in some of the area.

Paddy is cropped throughout the command area during the main growing season, except the upland where irrigation is not available. In spring about 20 to 30 percent of the area is devoted to early paddy and 5 to 10 percent to maize. In winter about 40 to 60 percent of the area is reported to be cropped with wheat. The upland is covered with maize, lentil, mustard, and sugarcane. Sugarcane is grown in about 10 to 30 percent of the land depending on mill requirements, price, and landholding.

The following cropping patterns have been adopted by the farmers.

Early paddy - late paddy - wheat

Early paddy - late paddy - lentil/linseed

Late paddy - wheat - fallow

Late paddy - lentil/linseed

Late paddy - sugarcane + linseed

Late paddy - wheat - green manure/mung

Mixed cropping of sugarcane and potato, sugarcane and linseed, and sugarcane and coriander are practiced. In late paddy, if wheat is not grown, linseed, lathyrus or lentil is broadcast in the paddy field about one month before paddy harvest. Farmers reported that they determined their own cropping calendar.

2. Production Inputs

More than 95 percent of the farmers grow C1145, an early improved variety of paddy, on about 20 percent of the land. Almost all the wheat area is covered with improved varieties, and 50 to 80 percent of the area grows improved varieties of paddy in the main season. Spring maize is improved and usually hybrid. Sugarcane varieties are also improved. Large farmers usually bring some improved varieties of different crops from India for their own use.

Almost all the farmers use chemical fertilizers on wheat, paddy, sugarcane and maize. Very little fertilizer is used for mustard, lentil, linseed, and lathyrus. Some farmers use crude zinc sulphate. The range of fertilizers used is as follows:

Crops	Complex (kg/ha)	Urea (kg/ha)
Paddy	60 - 120	60
Wheat	90 - 120	90
Sugarcane	120 - 160	120

Some large farmers use potash. Small farmers usually apply lesser doses of fertilizer.

Pesticides are used in the command area for insect control. 2-4D weed killer is also used.

Agricultural extension, credit and inputs are within the reach of the farmers. One junior agricultural assistant is permanently assigned to the area and is supervised by the Agricultural Service Center. The training and visit system of extension operates in the command area, which includes training programs, demonstrations, and minikits. Research institutions like the Sugarcane Research Station and the Parwanipur Agricultural Station, are within the reach of the farmers.

3. Yields

According to farmers, paddy yield varies from 2.5 to 4.5 mt/ha. Similarly, wheat yield varies from 2.0 to 3.5 mt/ha. Sugarcane yields 7.0 to 12.0 mt/ha, and spring maize hybrid yielded 5.0 to 8.0 mt/ha. Yields of mustard, lentil, and linseed, as reported by the farmers, are low -- ranging from 0.5 to 0.8 mt/ha.

There does not appear to be a problem with marketing produce. Large landholders usually store cereals for 2 to 3 months and sell the produce for higher prices then. However, small farmers have to sell as soon as they harvest, usually getting a lower price. Small farmers are slowly giving up sugarcane cultivation due to fluctuations in price, transportation difficulties, and the time the mill requires to take delivery.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) There seems to be an adequate water supply available at Auraha. Since Auraha is a spring-fed system, there are no flood problems.

b) As the system lies just downstream from a nearby forest, the watertable is high. There are a number of springs throughout the area.

c) At the field level, there seems to be relatively equitable water distribution.

d) Agricultural production is quite high. Agricultural technology is readily available from the nearby Parwanipur and Jeetpur agricultural stations, and farmers use this technology.

e) The physical system is relatively trouble-free; in essence it operates itself.

2. Weaknesses

a) Power and priviledge are highly skewed at Auraha. The area is dominated by a city-based, ruling elite.

b) There is no real irrigation organization at Auraha. Unlike other farmer-managed systems studied, farmers here do not identify with the system's manager.

c) The larger landholders in the area often neglect the system. Much of their land is being converted to sugarcane and left to manage itself.

d) Auraha is really a spontaneous network rather than an irrigation system. Water is not controlled. Much of the Auraha land is low-lying and wet.

e) The system does not really have a main canal or a drain. There is a canal-cum-drain which results in large, poorly drained areas, particularly in the eastern portion of the command area.

3. Summary and Conclusions

About 260 ha of land in Simara and Jeetpur Village Panchayats of Bara District are irrigated by a 2.0 km long main canal. As the source is a spring, there is no intake. The drain of the spring functions as the main canal. Water is available for a summer crop.

The area is heavily dominated by large farmers. Auraha irrigation system essentially seems to serve the interests of some city-based landed elites. Auraha has no real organizational base. It appears that the manager's position may have been created by the landed elites for their own farm estate management. More than 60 percent of the land is under tenancy. Though the farmers select the manager, the tenant farmers are in no position to select a manager who would not suit the landlords' interests. Perhaps this is why the farmers have a manager and not a system committee -- a committee might be more representative of farmers interests. Despite these organizational drawbacks, the farmers have shown cooperation and skill on their farms. They have better maintained, aligned, and regulated their field channels than what has been done at the main canal.

The irrigation system appears to provide a reliable supply of water which is adequate and usually equitably distributed. A major weakness of the system is the poor drainage of the eastern half of the command area.

4. KERABARI (KHADAM KHOLA) IRRIGATION SYSTEM

A. INTRODUCTION

The Kerabari irrigation system is a farmer-managed irrigation system in Morang District. Kerabari system irrigates Kerabari Village Panchayat of Morang District in the Kosi Zone. This irrigation system is accessible by a 11-kilometer fair weather road north of Khursani Bari on the East-West highway, 15 km east of Itahari. The link road between Khursani Bari on the East-West highway and the command area passes through forest.

The project area lies at the foot of the Chure hills. The slope of the command area is about 4 percent towards south. The main canal runs along the Chure hills.

For Wards 1, 2, 3 and 4, there are two parallel canals from the same source. The upper canal is called Sarbajanik Kulo or upper Khadam, and the lower canal is called Janasahayog Kulo or lower Khadam. The upper canal was constructed in 1970 and irrigates about 150 ha. The lower canal was constructed in 1977 and irrigates about 200 ha. For the rapid appraisal, only the lower canal, Janasahayog Kulo, was observed in detail (Figure 17).

Kerabari was one of the most impressive farmer-managed irrigation systems we encountered in Nepal. It possesses a tight, well-managed irrigation organization which seems to operate effectively. Additionally, the farmers have constructed a very impressive physical system, including a main canal which is quite an engineering feat.

B. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The source of the system is the perennial Khadam Khola. The Khadam Khola carries a high sediment load during floods. The average width of the river is about 500 m. The minimum discharge does not seem to be less than 0.2 m^3/s in May, whereas the maximum discharge may be more than 500 m^3/s. Some farmers reported that during the dry months of April and May they have to share the water with another nearby system on an hourly rotation.

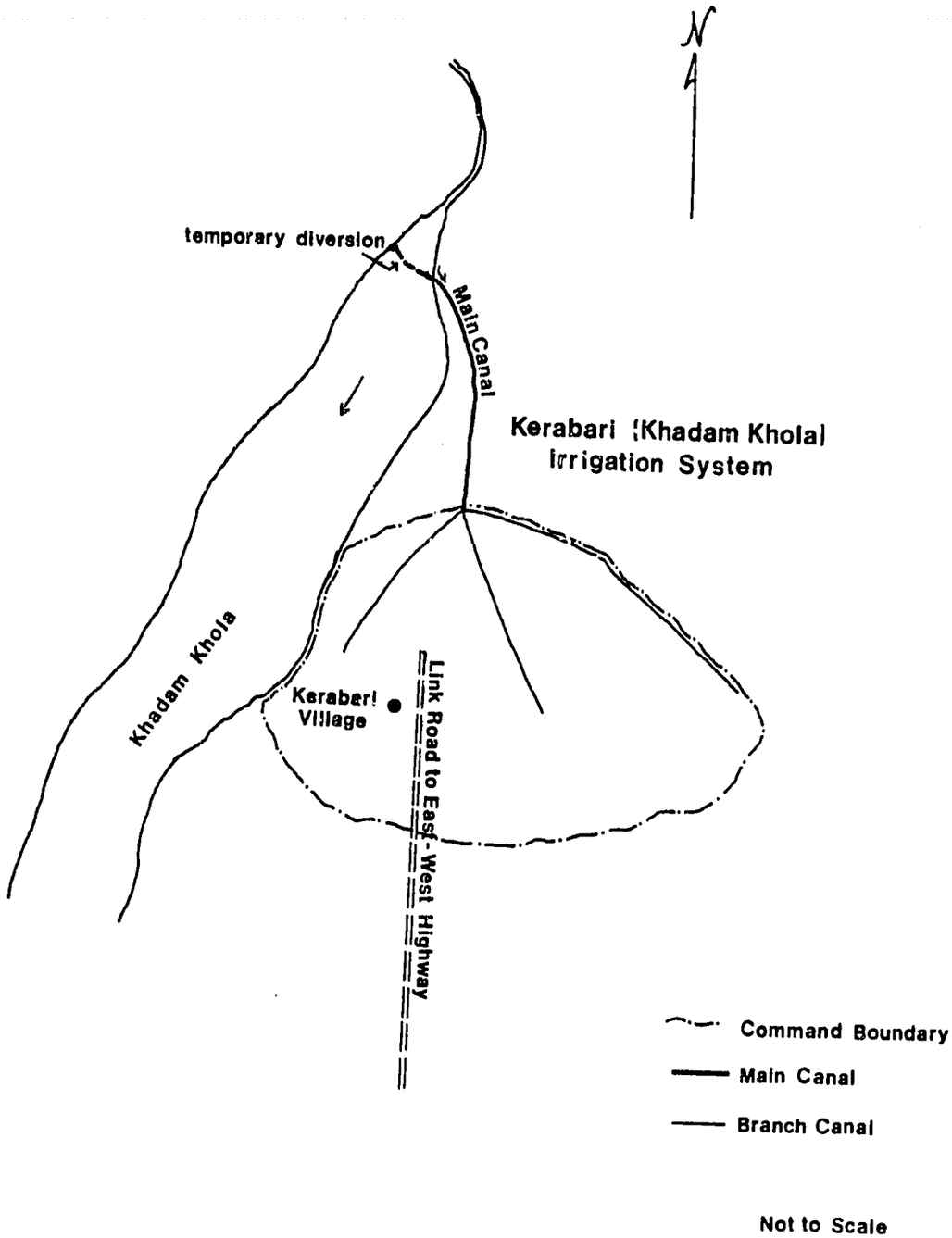

Figure 17. Kerabari Irrigation System

2. Canals and Structures

There are two major problems at the intake of the Kerabari system: flood control, and landslides into the head reach of the main canal. The Khadam Khola carries a large amount of sediment, and in the monsoon the river often destroys the farmers' intake and damages portions of the main canal. The monsoon rains also cause landslides on the steep banks above the main canal. A few years ago an intake structure made of cement concrete with a timber regulator was constructed with the financial assistance of DIHM and voluntary labor. However, that structure washed out within three years after it was built.

To solve the intake problem, DIHM provided Rs. 64,000 in 1983/84 and another Rs. 54,000 in 1984/85 for construction material. Farmers contributed labor worth Rs. 825/ha and collected Rs. 600/ha in cash. Even so, the intake problem has not been solved.

During the last monsoon, about 100 m of the main canal in the head reach washed out. One hundred fifty farmers had to work for 15 days to repair the canal. Every year a large amount of laborers and financial resources have been needed to keep water flowing in the main canal.

The main canal of this system is about 1.5 km long. The first 300 m of the main canal is cut across a steep cliff. The soil above the canal is unstable and is always susceptible to landslides. Except for this initial stretch at the head that is always affected by floods and landslides, the canal seems to function very well. About 300 m of the canal has been lined by cement concrete by the farmers. There is one wooden passage over the main canal.

The main canal is about 2.0 m wide and has a water depth of about 0.40 m. The maximum discharge of the canal seems to be about 0.6 m^3/s. Though the main canal runs on steep hills, the lower power of the main canal seems to be quite stable, with good banks on the valley side. The main canal splits into three branch canals and several field channels when it reaches the command area.

No water control structures were observed within the command area. All fields are level basins, with temporary earthen dams used as check structures. While there are many field channels, (an unusually high proportion considering other observations in Nepal), there is some field-to-field flow which decreases the efficiency of the irrigation system.

3. Soils

Soils of the Kerabari irrigation system appear to consist of rather deep, well-drained silt loams and loams. Because these soils directly abut the hills, they are underlain with sand and gravel deposits. While the villagers stated that the soils are deep, they probably vary in depth considerably. The average depth of the soil varies from 30 to 100 cm.

The soils of Kerabari should be highly fertile and suitable for irrigated agriculture and growing a wide range of crops. No well was found in the command area but from local information the watertable may be lower than 30 m.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

The Kerabari bazaar consists of a number of large well-kept houses. The land immediately surrounding the houses is clean, and numerous outdoor latrines were observed. The village itself seems to be relatively affluent.

According to the 1985 Rajbhandhu Engineering Feasibility Report, land is distributed equitably at Kerabari. Their figures roughly correspond to the information obtained by the rapid appraisal team:

Land Size	Percentage of Farm Families
Below 1.0 *bigha* (0.66 ha)	38
1.0 to 2.0 *bighas* (0.67-1.34 ha)	28
Above 2.0 *bighas* (1.35 ha)	34

Although most farmers claimed that the largest landowners in the area owned only 6 or 7 *bighas* (4.0-4.6 ha), a few farmers claimed that one or two farmers owned 15 or 20 *bighas* (9.9-13.2 ha). There were no reports of tenancy at Kerabari. All farmers appeared to be owner-operators.

Most of the people at Kerabari were originally from the nearby hill areas and have immigrated to the Terai in the past 20 to 30

years. Chettris are the most populous ethnic group in the area, though there are also significant numbers of Brahmins. Newars, Magars, Limbus, Rais, Sarkis and Kamis are also found at Kerabari.

An interesting feature of Kerabari is the apparently harmonious, multi-ethnic mix in the area. All ethnic groups seem to be well integrated into the community. For instance, Brahmins, Chettris, and Limbus accompanied the rapid appraisal team on a tour of their canal system and all groups answered our questions during this tour. Additionally, there are representatives of most ethnic groups on the local irrigation committees.

It did appear, however, that Brahmins dominate the community. The pradhan panch and the chairman and vice-chairman of the irrigation committee are all Brahmins. We also suspect that some of the larger landowners in the area are Brahmins.

Another interesting feature of Kerabari is the community's emphasis on education. There are, for instance, one high school and two lower secondary schools in the immediate area. We were told that almost one-third of the farmers in the area have a School Leaving Certificate-pass (high school diploma).

Farmers also claimed that at Kerabari, size of landholding is not necessarily directly related to power. They said that a person's "experience" and education would be good indicators of a farmer's power. If this is true, it would begin to explain the Brahmins' predominance in the community, as Brahmins have particularly stressed the importance of education.

Other farmers also appear to yearn for upward mobility, at least for their children. More than one farmer expressed the desire that their children leave farming and obtain office jobs in larger cities.

2. Irrigation Organization

Kerabari irrigation system is a new farmer-managed system. It has two subsystems: upper Khadam and lower Khadam. Upper Khadam subsystem was built in 1970 and lower Khadam subsystem in 1977. While digging the main canal on the steep hills for the lower Khadam subsystem, two farmers, one Limbu and one Newar, were buried under a landslide. The two farmers were given heroic honor, and the Kerabari village square was named after them.

The Kerabari irrigation organization originally consisted of one committee. Later on, the lower Khadam farmers felt that the upper Khadam farmers were less active and enthusiastic about system maintenance and operation. They divided the committee into the upper and

lower Khadam committees, but agreed to have one common chairman for both committees.

The chairman, vice-chairman, secretary, treasurer, and members of the committees are elected during the farmers' annual assembly. It is usually a unanimous vote. Each command area (upper and lower) elects 10 committee members (including officials) plus the chairman. Thus, there are a total of 21 members on the irrigation committee.

When asked why one man chairs both committees, the farmers replied that the incumbent chairman, a Jaishi Brahmin (perhaps an offspring of a Brahmin father who had married a Chhetri widow) had land in both the commands. In addition, since both commands have a Chhetri majority, a Jaishi Brahmin may be culturally more acceptable to the Chhetris.

The committees appointed the mukhia (irrigation operator) and, chowkidar. The mukhia used to receive Rs. 500 as salary, and the chowkidar received Rs. 400. A room was rented for office purposes for Rs. 50/month, and the chowkidar was provided with two flashlights. The committees used to spend Rs. 1,200 to Rs. 1,500 on administrative costs each month.

These and other costs have discouraged the farmers. The lower Khadam farmers have already abolished the mukhia post as they could not pay him. They have also reduced the salary of the chowkidar to Rs. 250. They have assigned many of the responsibilities of mukhia to the individual committee members representing the different parts of the command. Now, as water operator, a committee member has to perform more supervisory and regulatory roles than in the past. In return, the farmers of his area plough his land free of cost.

Maintenance and operation costs at Kerabari are also high due to the geography of the area. The intakes for the two canals are at the foothills, almost on the river bed, and the main canals pass through unstable hillsides. Landslides and the uncontrolled river always threaten the Kerabari irrigation system. So far, the farmers' organization has been able to harness the system. Last year, Rs. 54,000 was invested in maintenance for the lower subsystem. Rs. 400/bigha was raised. Every year, about 150 farmers clean and repair the system. They carry kodalos (hoes), and contribute their labor for 15 to 22 days, sometimes in double shifts (morning and afternoon). A farming household must contribute 1 laborer for each 2 bighas owned. If someone does not contribute his labor share, he has to pay Rs. 8, or Rs. 16 if the farmers were working on double shifts.

The committees have no written rules, but all decisions made by the farmers' assembly are written down. These decisions constitute the water distribution and cost-sharing principles and procedures. Water distribution is based on a poorji (list). The poorji is

prepared by the committee and every owner's landholding size and name are recorded in an order. Each farmer receives water based on this order. Once the No. 1 farmer's land is irrigated, the water goes to the No. 2 farmer. Water is rotated every 24 hours. Therefore, a farmer can expect to get water after 24 hours. Farmers are fined Rs. 25 for canal breach and water stealing. For repeated crimes, Rs. 50 is fined. However, fines are rare.

The committees continuously need money to keep the system operational, so they borrow money from the village panchayat and repay it later. They currently have no village panchayat debt. While village panchayat officials advise the committee, they cannot interfere in committee works.

The committee received Rs. 20,000 when the government proclaimed 1974-75 as the Year of Agriculture in Nepal. This has been the extent of government support they have received. Last year, DIHM hired a consulting company to study Kerabari irrigation system. The farmers hope that DIHM will help them construct a pucca intake and modernize their system.

The committees have hired informal technical consultants to rehabilitate the physical system, as well as to aid system operation and maintenance. Years ago, Magars from the hill district of Bhojpur who were very adept at canal construction and maintenance came to Kerabari. They helped the farmers build the lower Khadam system and the farmers paid these Magar craftsmen Rs. 13,000. The original leader of this Magar group is now dead, but his sons continue this work. Almost every year these Bhojpur Magars will return to Kerabari and help the farmers with main canal rehabilitation.

The farmers have themselves laid the spur on the river and have tried to stabilize the sliding hill. For this purpose, Rs. 72,000 was collected on the basis of bighahaddi (each member paid a certain amount per bigha owned).

The frequent landslides adversely affect productivity and yields as farmers cannot perform their agricultural activities regularly. The committees have afforested the steep slopes above the main canal and the uncontrolled river zones with small trees, but technically sufficient protection is still lacking.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

During late paddy, there is no shortage of water. All farmers grow late paddy and receive water on demand. However, water shortages occur during early paddy season. Farmers are aware that there is

insufficient water for all to grow early paddy. Those wishing to grow early paddy notify their respective committees. Since few farmers want to grow early paddy, few conflicts have developed. Apparently, early paddy is restricted to farmers near the head. Most farmers prefer to grow upland crops instead of early paddy. The water requirements of winter upland crops do not appear to present a supply problem since all farmers receive approximately four irrigations for wheat.

An interesting aspect of the Kerabari system is that wheat plantings are staggered: fields near the head of the system are planted first. Thus, water requirements are, in a sense, rotated down the irrigation system.

Water in the lower main canal is divided into three branch canals. The total water flow is distributed alternatively into these three canals. Water is then rotated down the system with head farmers taking water first. Farmers not receiving water on the first day, have priority over head farmers the next day.

Water distribution in the past was handled by a mukhia and chowkidars, one chowkidar for each main channel or intake structure. The mukhia kept records of who had received water and who was to receive water next. The chowkidars who diverted water into the farm fields, were under the direction of the mukhia. The mukhia's position has been abolished.

Water appeared to be well distributed throughout the command area. Relatively few fallow fields were observed in February, and those observed had access to water. Thus, the initial alignment of the main and branch canals appears to have been excellent.

2. Maintenance

A major problem that the Kerabari irrigation system faces is maintaining the intake structures and main canals which cross a precipitious slope (45 to 50 degrees) before reaching the head fields. The canals are constructed of easily eroded gravel. Thus, the slopes are subject to frequent landslides. The upper canal is high on the steep banks of the Khadam Khola and is particularly susceptible to slope failure. The lower canal is more susceptible to landslides from above.

Maintenance costs to keep the two main canals operable are high and require much labor. Once the main canals reach the head fields, they are relatively trouble-free. The canals are cleaned once a year just before early paddy. The joint committee mobilizes the labor required for maintenance. One laborer is required for each two bighas owned. Those owning less than two bighas also contribute one laborer. Labor is contributed (or an equivalent amount in rupees)

until the entire system is cleaned. Individual farmers are only responsible for their own farm channels.

3. Conflict

Some conflict apparently exists with the maintenance of the main canals. Since the upper canal has been more expensive to maintain, the farmers fed by the lower canal are disgruntled at sharing the cost of repairs. The committee and the community appear to be working together to solve their joint problems. The committee has requested that DIHM help them improve their intake canals to lessen their financial burden.

Except for the financial burden of maintaining the main canals, there appears to be little conflict in the system.

4. Water Adequacy, Reliability, and Equity

During late paddy there is a surplus of water. During winter and early paddy water is short and must be rotated in the irrigation system. However, water appears to be adequate for the cropping pattern that has developed at Kerabari. That there is a cropping intensity of 280 percent demonstrates that there is an adequate, reliable source of water throughout the year. All of the farmers interviewed considered the system to be equitable, and our observations tended to confirm this.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

The farmers of the command area, have embraced irrigated agriculture within a short time. The uncertainty of depending on the mercy of the rain god and poor monocrop yields are being replaced by irrigated, multiple crops and better cultivation practices, which are resulting in higher yields. Effective and efficient water management appear to profoundly influence winter crop culture. When the rapid appraisal team visited Kerabari in February, almost 80 percent of the land in Wards 1, 2 and 3 was covered with wheat.

Many crops are grown in the command area. The most important are paddy, wheat, jute, mustard, maize, lathyrus, lentil, and finger millet. Potatos, onions, and other vegetables are grown for household consumption. If marketing facilities were available, potato and onion could be very good cash crops since the yield is high due to the sandy loam soil.

The following is the land pattern use as reported by the former mukhia from previous years' records.

Crop	Area (ha)
Paddy	200
Wheat	166
Jute	50
Mustard	50
Maize	66
Small millet	36
Lentil	16
Lathyrus	16
Other	10

Cultivation practices are clean and satisfactory. Draft animals and human laborers prepare the land. The soil is well pulverised for winter cultivation. Important crops are usually sown behind the plough. Improved intercultural operations are being done. Almost all the crops during the visit appeared very satisfactory, especially wheat.

Farmers have adopted different cropping patterns in the area. Little early paddy crop is grown. The following are the most important cropping patterns adopted by the farmers:

Maize - paddy - wheat

Paddy - wheat - linseed/mustard

Paddy - wheat - jute

Paddy - wheat - finger millet

Paddy - wheat - lathyrus

Jute - wheat - lathyrus

Farmers contacted in Wards 1 and 2 revealed the maize-paddy-wheat pattern to be the most prevalent in the command area. More than 85 percent of the farmers grow three crops (invariably paddy and

wheat) and leave no land fallow. Cropping intensity is greater than 280 percent, except in certain years when water flow in the canal is disrupted.

2. Production Inputs

Almost all the areas under wheat are growing improved varieties. Farmers usually do not save their own seed, but obtain it at local cooperatives. The area under improved paddy (especially Masuli) is currently 25 to 30 percent of the command. Farmers save their own paddy seed. The other crops are mostly local varieties, except for jute and some corn. Farmers often exchange seed with each other.

Several irrigations are given to rice. Wheat usually receives three to four irrigations, whereas maize, millet, mustard, lentil and linseed usually receive one irrigation.

Farmers use manure and chemical fertilizers extensively. The most popular fertilizers are urea and complex, although potash is also used. Complex fertilizer is used as a basal dose. Urea is applied in split doses as a top dressing. The average doses of fertilizer as reported by 18 farmers contacted are as follow:

Crop	Potash (kg/ha)	Complex (kg/ha)	Urea (kg/ha)	Manure
Paddy	--	60	30-60	adequate
Wheat	20	150	60	--
Maize	--	60	30	adequate
Mustard	20	90	45	--

Insecticides are used in paddy, maize, and jute.

An agriculture extension substation is located in Khursani Bari, 11 km from the command area. One junior technical assistant is stationed in Kerabari to serve the area. A special production program under the block approach organized in recent years operates in Kerabari. The block production program is intended to maximize production per unit of area by organizing farmers in order to hasten input delivery. It is also intended to intensify agriculture activities using training, demonstrations and minikits.

Inputs and credit are available through local cooperatives that appear to be functional. The agricultural research institution at Tarahara is within the reach of the Kerabari farmers.

3. Yields

Sampled farmers of the command area appear to be satisfied with the current yields. Considering that more than 90 percent of the area grows three crops, the total yield and yield per unit of land per crop are high compared to most other irrigation systems. The following are the yields of the different crops according to the farmers:

Crop	Yield (mt/ha)
Paddy	3.0-3.6 (in good conditions) 2.5-3.0 (normal)
Wheat	2.4-3.0
Maize	1.75-2.0
Jute	7.0-8.0
Mustard	0.3-0.6
Lentil, linseed, lathyrus	0.4-0.5
Potato	12.0-15.0

Most agricultural produce is sold in the local market to a middleman. Marketing (including wheat) is not currently a problem according to the farmers. However, farmers showed concern over the low and fluctuating price of wheat and jute.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) Kerabari possesses a strong, effective irrigation committee, characterized by a great deal of farmer participation.

b) There appears to be good cooperation among the many ethnic groups at Kerabari. Additionally, land seems to ' relatively equitably distributed, and there are no great disparities in wealth.

c) Farmers effectively use available water, particularly during water scarcity, due to proper irrigation management procedures.

d) The main canal is partially lined and has good banks. The good condition of the main canal is at least partially due to the committee hiring outside Magar "consultants" from Bhojpur, who help with canal improvements every year.

e) The Kerabari command area has well-drained soils and is perfectly suited for irrigated agriculture.

f) Kerabari has a very high cropping intensity and high total agricultural yields.

g) Because of the soils and irrigation in the area, farmers could grow an even wider range of crops than they already do -- including potatoes and onions.

2. Weaknesses

a) The uncontrolled river that feeds the Kerabari irrigation system carries large quantities of sediment during the monsoon. Also during the monsoon, the river washes out the head reach and intake of the main canal and creates landslides across the main canal.

b) The river is wide, about 500 m, making it difficult to construct an intake structure or weir.

c) Maintaining the irrigation system is costing more and more each year. Farmers are getting frustrated at the seemingly endless escalation of costs.

d) Farmers are beginning to depend on external assistance for irrigation improvements, instead of relying on their own resources.

3. Summary and Conclusions

Wards 1, 2, and 3 of Kerabari Village Panchayat are irrigated a canal called Janasahayog Kulo which was constructed by the ners in 1977. The command area is about 200 ha. The water source this system is the Khadam Khola, which is perennial. This system s not have a permanent intake. Flood control and landslides in the

head reach of the main canal are major problems. The main canal is about 1.5 km long and seems to function quite well.

A strong organization is evident in Kerabari irrigation system. The multi-ethnic farming community has an equitable distribution of land and a cooperative feeling that has allowed the committees to function effectively. Farmers feel that their well-being depends on one another's cooperation. So far, the system has been well maintained and operated despite high costs. This is because the farmers see the advantages of effective operation and maintenance, and also because they have been able to partially sustain the high costs through their organization. The farmers' organization is effective by all standards in its use of a salary system, contracting consultants, and renting an office.

The irrigation and agriculture at Kerabari appear to be a good example of what effective, indigenous irrigation management can accomplish in Nepal. Agriculture as a whole looks extremely good. Farmers have adopted, to a large degree, modern agricultural practices. Nowhere else did we see a planned, three-year rotation of crops, along with a mix of upland and paddy crops. The adoption of upland crops into the cropping rotation has contributed significantly to extending the command area and allowing equitable irrigation.

5. BUDHABARE (BIRING KHOLA) IRRIGATION SYSTEM

A. INTRODUCTION

Budhabare (Biring Khola) is a farmer-managed system. Budhabare system irrigates Budhabare Village Panchayat of the Jhapa District in the Mechi Zone. Budhabare irrigation system is accessible by the Charali-Ilam road about 8 km north of Charali, which is about 6 km east of Birtamod on the East-West highway (Figure 18).

The command area lies at the foot of the hills. The general slope of the command area is about 5 percent towards the south. The main canal runs along the steep hills of the Chure Range before coming to the command area.

Four parallel canals (Laxmi, Karki, Mool, and Subba) take water from the same source: the Biring Khola. Farmers reported the total command area of the four canals as hundreds of hectares.

The rapid appraisal team had the opportunity to examine the upper canal in more detail than the other three canals. The upper canal is named Laxmi Biring Pani. The command area of the upper canal is bounded by the Dama drain on the east, Biring River on the west, the Chure hills on the north and the lower canal on the south. The command area of this system seems to be about 125 ha of Wards 1, 3, 5 and 6.

The upper canal was constructed by the village panchayat in 1968. Special labor to excavate the canal was brought from Bhojpur. The total cost of the excavation was Rs. 16,000.

There are at least two unique features of the Budhabare irrigation system. First, Budhabare Village Panchayat has been a social laboratory for many government land reform and panchayat development schemes. Second, the command areas of the four canals often overlap which has resulted in some interesting organizational features, i.e., both panchayat officials and farmers are deeply involved in operation and maintenance, and decision-making is very decentralized.

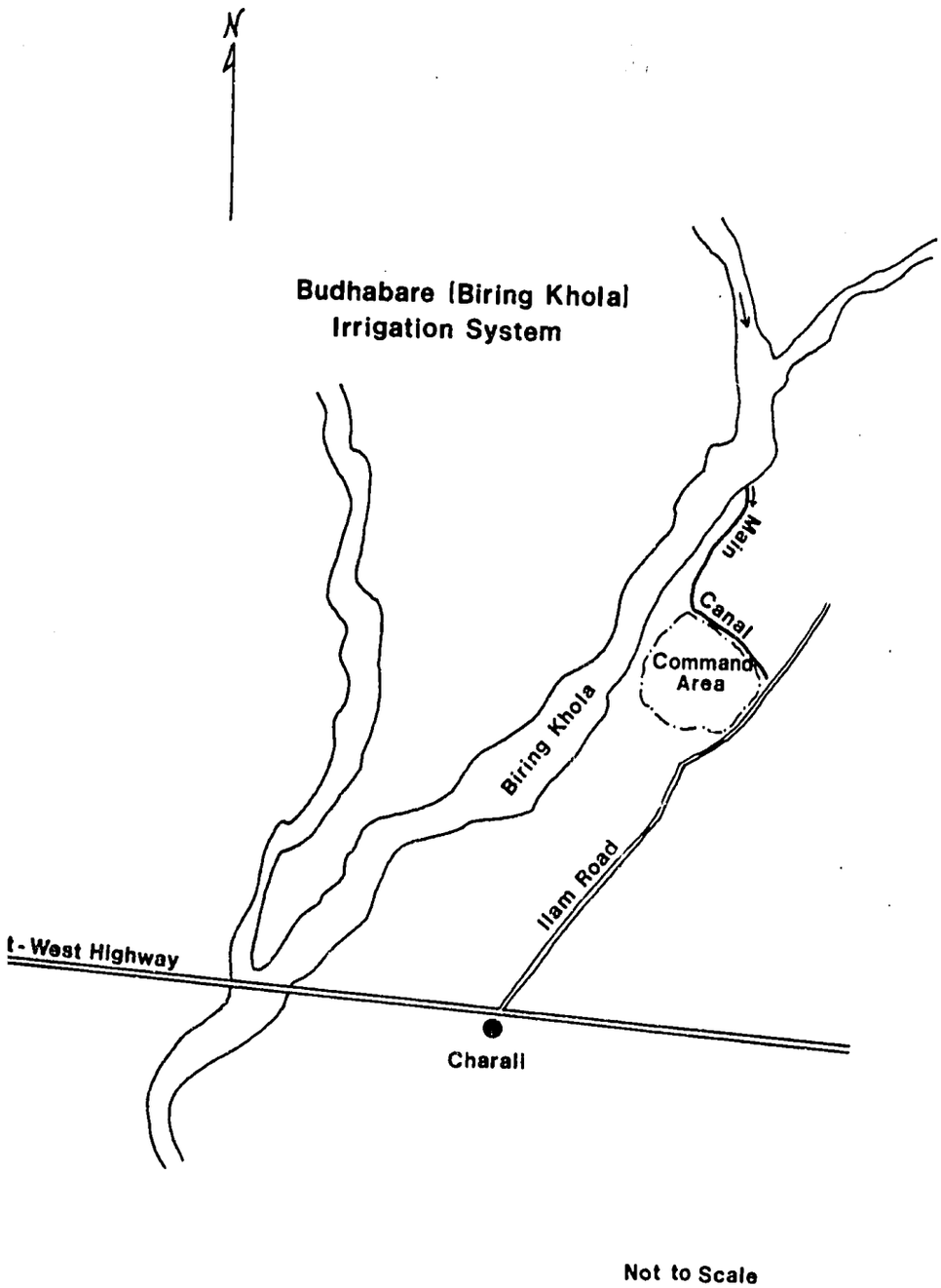

Figure 18. Budhabare Irrigation System

D. CHARACTERISTICS AND PERFORMANCE OF THE PHYSICAL SYSTEM

1. Hydrology

The irrigation source for the system is Biring Khola, which is perennial. The river carries a high amount of sediment during flood. The average width of the river is about 100 m, and the minimum discharge does not seem to be less than 0.5 m^3/s. The maximum discharge may be more than 500 m^3/s. There are several intakes on this river on both banks, but no farmers reported a shortage of water.

2. Canals and Structures

Even though the river is about 100 m wide, the intake of the system is relatively easy to construct because the river flows alongside the canal during low flow. There is a temporary diversion across the river about 15 m long made of boulders and sand. Even though maintenance of the intake has to be done quite often, there are few other problems at the intake.

The upper canal of Budhabare system is about 1.5 km long with a capacity of about 500 l/s. Flooding is a problem in the head reach of the upper canal. For about the first 200 m, the canal runs along the river, almost next to the riverbank itself. This portion is always affected by flood. One flood control spur made of gabion and one gabion retaining wall about 30 m long have been constructed with the financial assistance of DIHM to protect the canal.

The head reach of the upper canal is in very poor condition. It has a weak bank on the valley side that is about 50 m wide and about 30 cm deep. More than 25 percent of the irrigation water leaks through this portion of the upper canal.

The hill above the upper canal is very hard soil, so there are no landslides. In some places, farmers have tried to excavate into the hill to widen the canal, but could not do so without explosives.

There are two drainages across the main canal called Jhilke and Chisapani. These drainages are seasonal. There are no structures in these drains.

The upper canal runs from west to east, and there are four branch canals which run from north to south. Each branch canal is about 500 m long.

3. Soils

Soils of the Budhabare irrigation system vary in texture from loam to sand. The first layer of soil in the command area consists of silty clay loam to sandy clay loam. Soils in the eastern portion of the command area tend to be extremely sandy with very high infiltration rates and low waterholding capacities. Soils of the western portion tend to be finer textured with much slower infiltration rates and higher waterholding capacities.

Because of the variation in soil texture, one would expect to see similar variations in soil fertility, with the western soils being much more fertile.

The average depth of the soil is about 20 to 30 cm. Below this soil is gravel mixed with sand. Small stones and gravels are visible in the banks of paddy fields and also along the branch canals. No well was found in the command area, but from local information the ground watertable may be lower than 30 m.

C. CHARACTERISTICS AND PERFORMANCE OF THE SOCIAL/INSTITUTIONAL SYSTEM

1. Social Structure

Two important historical features characterize Budhabare Panchayat. First, Budhabare was settled in the early 1950s when people began moving there from the eastern hills. In 1950, lawlessness broke out between the Limbus and Brahmins in the hills of Panchthar District, and many Brahmins left Panchthar to settle in the Budhabare area of the Terai. Thus, is was more than just economic opportunity which caused the Brahmins to move to Budhabare.

Second, Budhabare panchayat is considered a "model" in the development literature of the panchayat system. Budhabare has been used as a social laboratory to experiment with various economic and political schemes. In 1965, His Majesty's Government of Nepal used Budhabare Panchayat to implement land reform, land taxes, and panchayat development schemes. Here the Panchayat Development and Land Tax (PDLT), a substitute for malpot (land revenue), was introduced. In addition, Budhabare's local panchayat leadership and the functioning of the village panchayat were studied. Therefore, Budhabare may not be typical of a number of other Terai panchayats. Indeed, the panchayat has a well-kept pucca office building to conduct its affairs. Many in the rapid appraisal team had never seen such a well-appointed panchayat office in Nepal.

There is fairly equitable land distribution in the command area, perhaps due to the land reform schemes. The largest landholding seems to be about 5 or 6 bighas (3.3 to 4.0 ha). The average landholding is about 1.5 bighas (1.0 ha), with some small farmers

owning as little as 1 or 2 katthas (0.03 to 0.06 ha) of land. There is, however, a very high rate of landlessness in some portions of the command area. Farmers said that in some wards of the panchayat, half of the people were landless. In other wards, landlessness was estimated to be from 10 to 20 percent of the families.

The largest ethnic groups in the area are Brahmins and Chettris. There are also significant numbers of Magars, Limbus, Rais, Newars, and Rajbangshis. It appears that a disproportionate number of Limbus and Rais are landless. Although a Brahmin has been the pradhan panch for 24 years, a Limbu, a Dhakel, and two other Brahmins have also been pradhan panch. Note that one former pradhan panch was a Brahmin woman. All of the past pradhan panches have their photographs prominently displayed at the panchayat office.

Much of the power in the area is held by the current pradhan panch, who has a swivel chair (a status symbol) in the panchayat office. The current pradhan panch was always dutifully followed by a number of other farmers while he showed us the irrigation system. Most decision-making power, however, has been decentralized and has filtered down to lower levels in the irrigation system.

2. Irrigation Organization

Budhabare is a relatively new irrigation system. Its construction was started in 1968, and the system became fully operational in 1971. Each of the four canals serve commands that sometimes overlap near Budhabare Village Panchayat.

Budhabare irrigation system was constructed with massive people's participation. The fund came from the village panchayat's Panchayat Development and Land Tax (PDLT). The village panchayat could use 55 percent of the PDLT, with the remaining 45 percent going to the Central (35 percent) and District Panchayat (10 percent) treasuries. Budhabare farmers came to depend on money from the PDLT. The PDLT program has been suspended, however, and farmers no longer have such ready access to money for local development programs. Panchayat officials and farmers feel that without this money, their development activities are severely restricted.

The organizational structure of Budhabare irrigation system consists of different ward committees. Each village panchayat has nine wards, and each ward has a 5-member committee. Each committee has a ward chairman. The pradhan panch is chairman of each of the four committees. Laxmi canal has one committee under a ward chairman. Karki and Mool canals have a joint committee under one of two ward chairmen, and the two commands overlap. Subba canal has one committee under a ward chairman.

It appears that the chairmanships of these committees are almost ex-officio. Besides the chairman, who is a panchayat official of the lowest unit of the panchayat, there are 11 other members on each committee. These members are usually unanimously elected during the annual meeting of the command area farmers.

Each committee employs a chowkidar. He is the water operator and regulator. He conveys the committee's decisions to the farmers and brings to the committee the farmers' grievances. He is authorized to rotate water on a weekly schedule. He can even fix the time for giving water when less water is available. He also determines the nature of the soil in a particular command area and provides water accordingly. In addition, the chowkidar is responsible for turning water into the farmers' fields. The chowkidar gets 12 kg of paddy from every bigha of land in his command as his salary. The committees do not usually like to deal with finances. Even those who do not contribute labor on fixed dates are not fined cash. Instead, the absentee laborer has to contribute "double labor" next time.

Every year, the committees mobilize resources for operation and maintenance of the system. Annually, for Laxmi canal alone, Rs. 5,000 to 6,000 are invested. Finances are raised through bighahaddi (Rs. 50/bigha). Labor is mobilized continuously for three months. Each household contributes almost 30 days of labor. (There are about 150 households in the Laxmi canal command area.)

Budhabare has an organizational structure that is fairly decentralized. Such an organizational mix of panchayat officials and water users is unique. Perhaps, this is due to the "model" character of Budhabare. However, since the PDLT was suspended during the referendum year of 1980, the panchayat officials are finding it increasingly difficult to finance the system's operation and maintenance.

D. CHARACTERISTICS AND PERFORMANCE OF SYSTEM OPERATION, MAINTENANCE, AND WATER DELIVERY

1. Water Allocation and Distribution

The Budhabare system has four intake structures coming off the Biring Khola. Water is abundant during late paddy season, with water shortages occuring during winter and early paddy seasons. Thus, all farmers within the irrigation system receive all the water they need during late paddy season. Each intake structure feeds its own command area. However, all of the command areas are connected in that excess water from the upper canals is distributed to the lower canals and command areas.

There are few field channels, so water is often distributed from field to field. The upper field is most likely to be over-

irrigated so that lower fields receive adequate moisture. All fields are level basins, laid mostly on contours due to the slope of the land. An increase in farm channels would improve the efficiency of the system considerably, particularly during winter and late paddy season when water must be rotated down the system to each field inlet.

The committee decides how much water should be distributed to the different areas within the command. Differing soil types mean that water requirements vary widely. Thus, farmers must request water from the committee before planting in winter or early paddy season. The committee decides whether or not enough water is available to honor the farmer's request, giving consideration to the soil type. Allocations are supposed to be done equitably.

One of the major problems of the system is severe silting at the tail of the system. Floods have deposited sand and silt on these lands, damaging the crops. Severe silting seems to occur only during the monsoon season.

2. Maintenance

Prior to early paddy season the committees organize the labor required to clean the canals. Labor requirements are one laborer per bigha (0.66 ha) owned. Farmers are also required to contribute a certain amount of money per bigha owned.

3. Conflict Management

There appear to be relatively few conflicts. However, there may be considerable frustration on the part of farmers at the tail of the system, who have seen their land virtually destroyed. Maintenance conflicts are few, largely because local revenues from the panchayat are partly used for maintenance.

4. Water Adequacy, Reliability and Equity

The system supplies an adequate amount of water during late paddy season, but supplies are inadequate to irrigate the entire command area during winter and early paddy season. However, irrigation supplies appear to be adequate for the cropping rotations developed there. All farmers interviewed considered the system to be reliable and equitable.

E. CHARACTERISTICS AND PERFORMANCE OF AGRICULTURAL SERVICES AND THE PRODUCTION SYSTEM

1. Agriculture

The agricultural system of the command area and production patterns are similar to those reported for Kerabari farmer-managed irrigation system, with slight differences in land use, cropping intensity, and additional income through cash crops and animal husbandry. Because of the farmers' better management, improved technologies have been adopted for the major cereals and crop culture has intensified. Farmers have changed from monocropping to growing two or more crops and have adopted definite cropping patterns for different portions of the command area. Farmers are also applying fertilizers and manure, which has resulted in higher yield per unit of land and higher total yields annually.

A wide range of crops are grown in the area. These are paddy, wheat, maize, finger millet, buckwheat, mustard, lentil, linseed, potato, onion, and different kinds of vegetables. However, the most important ones are paddy, wheat, and maize. The other crops are usually grown for home consumption, although a small amount is sold at market. There are four important cash-earning crops that appear to be popular in the command area: bamboo, beetlenut, coconut and sajeewan (medicinal tree). The high cash value and ready market of these crops have improved many farmers' economic well-being. The land use pattern under different crops, as reported by the farmers are as follows:

Canal	Total Irrigated Area (ha)	Area Under Different Crops (ha)					
		Early Paddy	Late Paddy	Wheat	Maize	Jute	Other
Laxmi	100	40	100	50	40	25	10
Karki	120	80	120	70	50	20	5
Subba	800*	-	800	200	500	200	15
Mool	100	40	100	40	45	15	10

* Though farmers reported that the total irrigated area of Subba canal was 800 ha, the rapid appraisal team doubts that the command area is that large.

The general appearance of wheat, potato, buckwheat and vegetables during the visit were satisfactory. Seedlings were raised in pulversized seedbeds for early paddy. Land was thoroughly prepared

for maize. Animals as well as manual laborers are used for cultivation, sowing and land preparation.

Two definite cropping patterns have been adopted by the farmers depending on the availability of irrigation water and the topography of the land. These are:

Early paddy - late paddy - wheat

Maize/jute - late paddy

The first cropping pattern has been adopted by the farmers in areas where irrigation facilities are available throughout the season -- usually at the head of the Laxmi canal and the western part of the Karki canal command area. Cropping intensity not only varies from place to place, but also among the different canal command areas. In Laxmi command area, cropping intensity ranges from 230 to 260 percent, and in Karki command area from about 250 to 260 percent. Cropping intensity in Subba command area is only about 160 to 190 percent.

2. Production Inputs

More than 95 percent of the area under paddy, wheat and maize is covered with improved varieties of seeds. Early paddy is still a local variety. Recently improved varieties like CH45 are being introduced. Improved varieties of paddy (Masuli), wheat (RR21, UP261) and corn (Rampur yellow) are very popular. Farmers use high seed rates for wheat and maize. Sowing is done behind the plough. Intercultural operations are followed strictly using local tools. Farmers purchase some wheat and maize seeds from the local cooperative. Usually they maintain their own seeds and exchange them with one another.

Three irrigations are provided to wheat. No irrigation is given to maize, jute or other crops, including potatoes. Paddy receives several irrigations.

Farmers use manure in almost all the crops. Fertilizer use is limited to wheat and jute. The usual dose of fertilizer for wheat is 150 to 160 kg/ha of complex and 90 kg/ha of urea, whereas 100 to 120 kg/ha of complex and 60 kg/ha of urea are provided to jute. Complex is applied as a basal dose, and urea is used as a top dressing in two doses. Insecticides are used by the farmers.

Most of the farmers reported good service from the agricultural extension agent stationed in the area. Recently, an agricultural production officer was deputed. Training has been provided to some of the farmers. Few farmers have been given the opportunity to visit the Agriculture Station at Tarahara. The local extension unit is under the command of the agriculture center stationed near Charali.

The Agricultural Stations at Tarahara and the Kankai agricultural farm are the nearest research stations to the command area.

3. Yield

The following yield ranges were reported by the farmers.

Crop	Yield (mt/ha)
Early paddy	3.0 - 3.6
Late paddy	2.8 - 3.6
Wheat	1.8 - 2.0
Corn	1.5 - 1.8
Jute	7.0 - 9.0

Paddy yield appeared to be high when judged according to the fertilizer applied. It was said that floodwater usually brings fertile soil with it, and, also, that the use of adequate compost manure makes it unnecessary to apply chemical fertilizers. Most of the farmers interviewed confirmed the above yield.

Marketing cereals was reported to be a problem as the produce has to be taken to nearby markets. No middleman comes to the command area to purchase produce, as is common in other places. Marketing of bamboo, beetlenut and saiceewan is done on the spot of the produce, so marketing is not a problem. Most of the farmers were vocal about the low price of wheat and jute. They also complained that low prices hamper their cultivation in the command area.

F. SYSTEM STRENGTHS AND WEAKNESSES

1. Strengths

a) The Budhabare farmer irrigation system functions well. Their water distribution is usually effective, particularly in the winter.

b) Their water source is reliable and enough water is available to irrigate three crops in a year.

c) Except for the head reach, the main canal is in good shape, is properly sized, and has good banks. The hill above the main canal is stable, so landslides are not common.

d) Some of the soils in the command area are very fertile.

e) There is high crop intensification and diversification at Budhabare. Farmers are growing many cash crops.

f) The organizational structure at Budhabare is a unique mix of the panchayat and water users. The farmers appear to be well-organized, cooperative, and willing to help each other.

g) The organization is fairly decentralized, with farmers and low-level officials making many of the decisions. The chowkidar for instance, possesses wide decision-making powers and has a strong position.

2. Weaknesses

a) There are always problems controlling floods in the rivers. These floods always damage the head reach of the main canal.

b) There is excessive silting in the main canal. Additionally, much of the system (particularly at the tail) has poor drainage, which results in severe silting at the tail after floods.

c) Budhabare Panchayat was a model village panchayat in Nepal for many years. The people, therefore, have become accustomed to having large financial resources at their disposal. The model village panchayat program has been suspended, but the people still depend on large amounts of village panchayat funding.

d) Water could be used more efficiently at Budhabare if farmers rotated from tail-to-head instead of from head-to-tail. The field-to-field irrigation contributes to inefficient irrigation.

3. Summary and Conclusions

The upper canal of the Budhapare system was constructed by Budhapare Village Panchayat in 1968 to irrigate about 125 ha of land in Wards 1, 3, 5 and 6. The upper canal is about 1.5 km long and gets water from the Biring River, which is perennial. The system seems to function well. There is, however, a flood problem in the head reach

of the upper canal. Some work has already been done with the financial assistance of DIHM to protect the canal from flood.

Water distribution and allocation appear to be handled equitably in that all farmers seem to have a voice in system operation. Many of the soils are poor, and many agricultural practices could be improved. However, an overiding factor that should be noted about this system is that a complex organization has formed to deal with the water acquisition and distribution problems faced by the Budhabare farmers.

V. GLOSSARY OF ACRONYMS AND TERMS

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A. ACRONYMS

DOA	Department of Agriculture
DIHM	Department of Irrigation, Hydrology and Meteorology

B. TERMS

amin	DIHM official who collects water cess and keeps landholding records.
bahidar	Clerk
bigha	1 bigha = 0.66 hectare
bighahaddi	Fixed number of laborers or rupees contributed per bigha owned
chitaidar	Irrigation official appointed by District Land Revenue Office to look after an irrigation system
chowkidar	Water operator and regulator
dhalpa	Gatekeeper
dhungro	Round, wooden pipe
ditha	Irrigation official appointed by District Land Revenue Office to look after an irrigation system. (Same as chitaidar)
guthi land	Trust land
hali	Landless agricultural laborer
haruwa	Lifetime servant to larger landowners; fieldworker
jamindar	Chieftain; large landlord

jimawal	Farmer assigned to manage an irrigation system; sometimes is a hereditary position or can be a government agent who collects land revenue.
kattha	20 katthas = 1 bigha
katwal	Assists chitaidar or ditha; receives renumeration in kind from landholders after paddy harvest
khola	River
kodalo	Hoe or long spade; labor contribution
kodo	Finger millet
kulo	Canal or stream
lakh	1 lakh = 100,000
malpot	Land revenue
mato muri	Old unit of land measure; 1 ha = 78.6 mato muri
maund	Forty kilograms
minikit	Small package of improved seed, fertilizer, and pesticides
mukhia	Clerk; irrigation operator
panchayat	Local administrative and political unit
pathi	1 pathi = 4.5 liters
poorji	A list of farmers to receive water
pradhan panch	Elected leader of panchayat
pucca	Improved
rabi	Dry, winter season
ropani	1 hectare = 20 ropanis
rupees (Rs.)	$1.00 = Rs. 21.00 (1985/86)
sadaysa	Elected leader of ward (9 wards in a panchayat)
sajeewan	A medicinal tree

sajha	Cooperative
tar	Small plateau
theka	Cash contribution for maintenance instead of labor
upa-pradhan panch	Elected leader of *panchayat* directly under *pradhan panch*