IRRIGATION MANAGEMENT IN NEPAL: RESEARCH PAPERS FROM A NATIONAL SEMINAR

National Seminar on Irrigation Management in Nepal: Research Results

Bharatpur, Nepal
4-6 June 1987

Sponsored by the International Irrigation Management Institute (IIMI), the Institute of Agriculture and Animal Science (IAAS), and Winrock International. Edited and published by IIMI, PO Box 3975, Kathmandu, Nepal.

Cover photo: V-notch weir being used to measure accuracy of water distribution by a saacho (proportioning weir) in Saili Kulo, Argali, Palpa. Courtesy of Robert Yoder.

Citation: IIMI pub 88-07

International Irrigation Management Institute (IIMI). 1988. Irrigation Management in Nepal: Research papers from a national seminar. Kathmandu, Nepal: IIMI Pub.

/ case studies / farmer-managed irrigation systems / farmer participation / government-managed irrigation systems / irrigation / management / methodology / Nepal / research / resource mobilization / property / water allocation / water rights /

DDC 631.7

Summary: Numerous field etudies related to irrigation management have been conducted in Nepal since the last national seminar on irrigation issues in 1983. The relationship between organizational structure and resource mobilization was the topic of several. Another examined changes in organization and resource mobilization as property relationships and water rights changed when systems expanded and allowed new members. Concern for improving intervention strategies to existing farmer-managed irrigation systems has stimulated work on finding methods for quickly collecting data for identification and assessment of systems where substantial gains can be made by giving assistance. Numerous case studies have expanded the information available on management of operation and maintenance in both farmer- and agency-managed systems. These seminar papers report the findings of eleven of the studies.

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PURPOSE AND BACKGROUND

Holding a national seminar in Nepal with the title "Irrigation Management in Nepal: Research Results" suggests that substantial research requiring dissemination of the findings has been completed. This indeed was the case in mid-1987 when the Institute of Agriculture and Animal Science (IAAS), the International Irrigation Management Institute (IIMI), and the Human Resource Division of Winrock International decided to collaborate in sponsoring a national seminar.

IAAS had formed an interdisciplinary "Irrigation Management Systems Study Group" among its faculty in 1986 which immediately undertook several field studies in the Chitwan Valley. The results of this effort were available by mid-1987. The Water and Energy Commission Secretariat (WECS) had completed the first phase of a project it is implementing to identify effective ways to assist existing farmer-managed irrigation systems and had results to share. Winrock International had given a number of small grants to support and encourage young professionals to become active in field research. Four of the completed studies focused on irrigation. In addition a number of Nepeli graduate students were conducting field research supported by IIMI and had results ready to present.

The primary objective for holding the seminar was to provide a forum for researchers from diverse backgrounds and projects to share the results **of** their work with each other for critical review and with irrigation professionals. In addition to bringing their findings into the mainstream of irrigation development and management it was expected that questions arising out of the discussion would stimulate further field research as past seminars had done.

Since about half of the seminar participants were directly involved with irrigation related research, irrigation research methods was made the subtheme of the seminar. Each person who presented a paper was requested to include specific information on the research methods used in the study being reported.

In 1978 a seminar on "Water Management and Control at the Farm Level in Nepal," and in 1983 a national seminar on "Water Management Issues" were held in Kathmandu. In the 1983 seminar some time was devoted to reporting of field research findings but in both seminars the major emphasis was examination of irrigation management experience by different agencies in Nepal and discussion of issues that required further examination. Many questions of a policy nature emerged that could not be satisfactorily addressed with the limited information available on existing irrigation management practices. Such issues ranged from water rights of beneficiaries, and capacity of farmers to mobilize resources, to the identification of organizational and policy support necessary to expand and improve irrigation delivery. Lack of satisfactory methods for (collecting information from farmers was also noted as an area needing (development. One recommendation of the 1983 seminar was to increase emphasis on field studies to fill this gap.

Although there was no organized effort to promote field research to follow up on the questions raised in the 1978 and 1983 seminars, they certainly stimulated increased research activity. By 1987 many individuals and groups including graduate students and faculty from the academic community in Nepal had completed field work. All of this work was field based making valuable observations with implications for irrigation policy, design, implementation, and operation and maintenance. Eight out of the eleven papers report on work carried out by groups rather than individuals. The interdisciplinary character of the field work improved the quality of the observations and added value to analysis of the results.

Since initiative and support for the work came from many sources there was no predetermined forum for making the results available to the larger community of irrigation professionals and policy makers. Realization of this situation prompted the June 1987 "Irrigation Management Research Results" seminar.

The 65 persons who participated in the seminar represented three distinct groups: researchers, irrigation professionals, and farmers. Eleven farmers from eight different farmer-managed systems were invited to participate in the seminar and present a panel discussion. This was successful beyond all expectation as the farmers entered into discussion in all sessions, and interacted informally between sessions. Their presentations which stressed the solutions they have found to management problems carried the weight of many years of active irrigation experience and provided much stimulating deliberation. Their presence and participation added significantly to the seminar as it became clear that they were indeed among the most experienced irrigation managers present at the meeting.

ORGANIZATION OF THE PAPERS

The papers have been organized into four sets of related topics. The first are those dealing with rapid collection of field information about existing irrigation systems. These are methods for collecting data pertinent to identification of a system's strengths and weaknesses. In one paper examples of the information collected are presented. The second set of papers are case studies of individual systems. One describes the evolution of the organization, and the other describes a unique organization whose primary function is not irrigation. The third set of papers are comparative case studies of two systems each. Two of the final set of papers provide analysis of organizational structure in relation to capacity for resource mobilization and another paper analyzes issues of water rights and property relationships as irrigation systems expand and accept additional beneficiaries.

A brief summary of the presentations made by the farmer participants during their panel discussion is also included. It provides a glimpse of the background and experience that made their input so credible.

ACKNOWLEDGEMENTS

Dean K. N. Pyakurel and the members of the Irrigation Management Systems Study Group from the Institute of Agriculture and Animal Science, Rampur, deserve all the credit for arranging the logistics and smooth organization of the seminar. They also led a valuable and informative field trip to farmer-managed systems of the Budhi Rapti River. This gave visual support to the information they presented in one of their reports at the seminar.

Dr. Mike Wallace and the staff of the Human Resources Development Division of Winrock International deserve recognition for the support they gave to four of the field studies presented at the seminar. They also provided valuable assistance with the planning and Winrock contributed financial support for the seminar.

IIMI's resident scientists based in Nepal, Dr. Prachanda Pradhan and Dr. Robert Yoder were responsible for contacting researchers and encouraging the preparation of papers. IIMI Kathmandu staff was also responsible for preparing the summary of the farmer's panel discussion. The papers were edited by Mrs. Juanita Thurston.

Roberto Lenton
Director General
IIMI

LESSONS FROM INVENTORY PREPARATION OF IRRIGATION SYSTEMS OF BUDHI RAPTI RIVER, CHITWAN, NEPAL[1]

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S.N. Tiwari, G.P. Shivakoti and
A. Shukla[2]

INTRODUCTION

Irrigation can contribute to agricultural production if it is properly integrated into an agricultural development package. Realizing this vital role of water in increased potential production, the Department of Irrigation, Hydrology and Meteorology (DIHM), His Majesty's Government of Nepal (HMGN), has begun to design and construct irrigation systems in different parts of the country.

The Chitwan Irrigation Project (CIP) is a huge irrigation undertaking which started in 1974 with a loan for US$ 19.5 millions signed by the Asian Development Bank (ADB) and HMGN. The project comprises three schemes covering an estimated area of 12,000 hectares (ha). Big projects like this have been criticized for not being able to ensure timely, reliable, and adequate supplies of irrigation water, and have been blamed for not being able to reduce the farmers' production risks.

In addition to the CIP, there are many farmer-developed and managed irrigation systems operating in the Chitwan valley. The farmers' efforts have been very encouraging. In the Chitwan valley alone, the estimated total irrigated land is 17,530 ha (WECS 1985), of which a substantial area is under farmer-managed irrigation systems.

Wherever there is a farmer-managed irrigation system, there needs to be effective management to assure the timely delivery of water to the farmers' fields to meet the crop water requirements. However, the lack of technical knowledge and resource constraints such as limited finances or lack of construction materials, or natural occurrences such as changes in river course, are some of the major problems associated with the operation and maintenance of such systems. Limited outside assistance to improve these systems has a tremendous potential for increasing agricultural production in the valley.

The Farm Irrigation and Water Utilization Division (FIWUD) of the Department of Agriculture (DOA) is working in the District to provide assistance to farmer-managed irrigation systems in order to improve water utilization. Eight irrigation projects covering a total command area of 640 ha

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[1] This material is based upon the work supported in part by the International Irrigation Management Institute (IIMI) and Institute of Agriculture and Animal Science (IAAS) for a project entitled "Water Resource Inventory of the Chitwan Valley Irrigation Systems with Emphasis on Issues and Problems in Irrigation Management".

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SECTION I: INVENTORY AND RAPID APPRAISAL METHODS

are presently (February 1987) under improvement in the East Chitwan valley with FIWUD assistance (FIWUD office, Hetauda). The Ministry of Panchayat and Local Development (MPLD) also provides financial and technical support to local small-scale irrigation systems for effective operation of the systems.

In bringing about modifications in the existing systems or in planning a new system, a thorough knowledge of the existing systems and the extent of water utilization is needed. The Water and Energy Commission Secretariat (WECS 1985) has carried out a water resource inventory of the Chitwan District. A fessibility study of the East Rapti Irrigation Project (DIHM/ADB/Nippon Koei Co. Ltd. 1986) has included a comprehensive list of both government as well as farmer-built irrigation systems. However, these reports were incomplete. It was therefore considered appropriate to prepare a complete resource inventory of the irrigation systems from the Budhi Rapti river. Such an inventory is expected to develop a picture of the numbers, sizes, and types of systems in terms of the physical structures that exist for conveying, distributing, and draining water. The inventory also proposes to survey the social structure that exists for determining rules and regulations for allocating water, for repair and maintenance of the physical structures, and for resolving conflicts over water matters. It is also expected to identify the present farming systems along with possible modifications within the command area of some of the new or rehabilitated systems. Further, the study is visualized to generate lessons for future directives on issues such as the operation and maintenance of the irrigation systems in general.

BACKGROUND

The Chitwan District is located at the southwestern corner of the Central Development Region, between longitudes 85 degrees 55 minutes to 85 degrees 35 minutes east and latitudes 27 degrees 21 minutes to 27 degrees 46 minutes north and covers an area of 2,510 square kilometers (km^2). About three-fourths of the total area of the District is flat to almost-flat plain with high agricultural potential and is known by the name of the Chitwan valley. The valley floor was formed mainly by detrital depositions from the lower slopes of the enclosing Mahabharat Lekh in the north and northeast and Chure range in the south. The average altitude of the valley is about 244 meters (m) above mean sea level.

Physiography, Natural Drainage and the Soil

The Chitwan valley is made of terraces of various ages created by the Narayani and Rapti River systems. The valley is divided into an eastern area and a western area by the Khageri river, a tributary of the Rapti running from north to south in the valley. The area south of the Rapti river is called Madi valley.

The principal features seen today in the East Chitwan valley are the alluvial plains dissected into a mosaic of land types by the action of the tributaries of the Rapti and Narayani river systems. The general slope of the valley floor is south and southwest with many streams flowing into the valley from the Mahabharat Lekh. Most of these are either ephemeral in character or the volume of water declines heavily during the dry season. The section of land north of the East-West Highway usually suffers from the shortage of water. Physiographically depressed areas with poorly drained to swampy floor beds are also occasionally encountered. Perennial rivers like the Manahari and Lothar flow from the eastern boundary of the valley and become the part of the Rapti River which again flows from the northeast to southwest and ultimately loses itself in the Narayani river system.

The Dhongre Khola originates from the Lothar river and the Budhi Rapti river from springs in the jungle of Kuchkuche which is being rapidly deforested. Both of these rivers flow from east to west parallel to the Rapti river and are perennial in nature. Unlike the Nerayani river, the Rapti and its tributaries flow at levels almost equal to the average level of the valley floor and, as such, have large flood plains. The water from these streams is utilized for irrigation. The Narayani river flows at a lower level than the average level of the valley floor.

The soils of most of the valley are young without much differentiation into horizons. However, the soils developed on the old terraces have weakly to moderately well-developed horizons. Most uplands and well-drained khet (paddy) lands have an acidic reaction (pH ranging from 4.2 to 7.0). Soils deposited on depressed areas and where drainage is impeded are alkaline (pH <8.5). Generally the soils developed on the terraces of the Rapti river and its tributaries tend to be alkaline. Sandy loam and loam are the most dominant textural classes of the surface soil with a few patches of sandy clay loam and silty clay loam as well. East Chitwan valley soils tend to be heavier in texture than those of the west. A relatively high content of organic matter (1.1 to 6.8 percent, with an average of 2.8 percent) reflects the recent agricultural history of the valley (Khatri-Chhetri 1982). With proper management and adequate inputs including irrigation water, the soils of the Chitwan valley can be highly productive.

Agro-climatic Conditions and Agricultural Development in the Valley

In the early fifties the valley was inhabited by Tharus and Darais (ethnic groups of Nepal) whose settlements were scattered. After the introduction of the resettlement program in the mid-fifties, settlers came into the valley from various parts of the country. The new settlers were more willing to adapt new technologies and hence were more advanced and cooperative. As a consequence, intensive agriculture including livestock raising and plantation crops are practiced in the valley and it is the area with the most potential for producing surplus food grains, oil-seeds, fruits, and animal products in the country. Various agricultural agencies located at different parts of the valley have given impetus to its agricultural development.

The agro-climatic conditions of the valley are most favorable to the tropical and sub-tropical crops and fruits. The major crops grown are rice, maize, mustard, and wheat. Other crops are also grown but on a small scale. Rice followed by wheat or spring maize is a common rotation in lowlands. Wherever water is available double crops of rice are grown. In the uplands maize-mustard is the favored rotation. Maize after maize is also grown. Seasonal vegetables and fruits such as banana, pineapples, guava, mango, and litchi are commonly grown in the valley.

The following is a summary of the meteorological features at Rampur, which can be generalized to the valley. The hottest months are April, May, and June when the average maximum temperature rises to 35 degrees Celsius (°C). with extremes as high as 42°C. The winter temperature goes down as low as 7°C. during December and January. Over 75 percent of the annual rainfall (average annual = 2,000 millimeters) falls during June through September. July and August are the wettest months. Heavy dew is seen during winter months but its contribution to the water requirements of the wheat crop is negligible (Sharma, et al. 1984).

June through September appear to be the water surplus months. The major crops of this season are monsoon paddy and summer maize. If the crops cannot be planted on time due to the erratic nature of rainfall regarding the arrival, amount, and the number of rainy days in each monsoon, the productivity declines. If rainfall is not regular in early June, water stress may adversely affect the paddy nursery beds. Similarly, the early-sown summer maize crops are severely affected by drought. However, the late-sown crop usually does better.

October through May are water deficit months. The major crops grown during these months are: mustard, winter maize, wheat, spring maize, and spring paddy. The winter and spring showers are also erratic with respect to time and amount. If there is no rainfall during February and March the wheat crop is seriously affected. The spring maize crop is a complete failure if it is affected by drought at the tasselling stage. Observations of the partial or complete failure of spring maize due to drought are numerous in the valley. Similarly, there has been evidence of reduced yields of mustard and winter maize due to drought. The spring paddy is commonly grown in the valley where there is dependable irrigation. It is therefore clear that the value of water in the valley for agricultural production lies in its timely availability.

METHODOLOGY

The inventory data collection methodology was divided into two parts: the preparation for the field survey and the field work.

Preparation for the field survey

Preparation for the field survey required the collection of information about the area with reference to agricultural land-use, geology, and soil geomorphology. In order to understand the area and the mapping of the drainage pattern, the previously published works of WECS (1985) and DIHM/ADB/Nippon Koei Co. Ltd. (1986) were carefully reviewed. The agro-meteorological information helped to visualize the need for irrigation water in the area.

Preparation of questionnaire. To collect sufficient factual and reliable information about the farmer-managed irrigation systems, an inventory checklist and questionnaire were prepared. The questionnaire was designed to probe for a brief historical background of the system, characteristics and performance of the physical systems and the farmers' organizations, and agricultural services and production.

The base-map. An appropriate base-map with details including the river systems, villages, village to village footpaths, panchayat boundaries, plantations, and other physical features of the area was needed. A topographical map (1:25,000 scale) of the District prepared by the Survey Department, Topographical Survey, HMGN was used as the base-map.

Field work

With the help of the information collected from secondary sources, field visits were planned to conduct interviews with key informants and observations of the irrigation systems. The study group consisted of an interdisciplinary team with backgrounds in agronomy and soil science, agricultural engineering, agricultural economics, and agricultural extension.

Interview. The questionnaire was designed to elicit detailed information on selected topics. The key informants selected included members of the local water users' organization (i.e. members of the Kulo Samiti), village leaders, and local farmers.

The information was used to provide background information on the systems and was also used to investigate problem areas in the community and in the operation and maintenance of the irrigation system. The data gathered from key informants were checked and cross-checked with other key informants. At the same time the minute books of the canal committees were used to verify the data wherever possible.

Observation of the irrigation system. Field observations of each and every system were done either before or after the interviews. The field observations included the inspection of the source and the intake points, the head-works and types of diversion structures, the network of canal systems, and measurements of the cross-section of the main canal to evaluate its carrying capacity. The devices used for distributing water among lower order canals and into the field were also noted.

After the completion of the field work the information was compiled by the authors. No statistical analysis was involved.

RESULTS AND CONCLUSIONS

Irrigation Systems of the Budhi Rapti River

The Budhi Rapti river originates from springs in Kuchkuche forest in the southeastern Chitwan valley and has a perennial flow of water. The river meanders in the southern part of the East Chitwan valley almost parallel to the main Rapti river. The total length of the river is about 4.5 km and there are 11 independent farmer-managed irrigation systems with a year-round irrigation command of over 1,800 bighas (1,200 ha). Due to the recharging capability of the Budhi Rapti river there has been no complaint of water shortage. The Budhi river is called an Amrit Khola, or "life-saving river" in the area. All irrigation systems from the Budhi Rapti are gravity systems, run-off-the-river diversion types. The systems are simple, indigenous, labor-intensive, and have temporary diversion structures.

A sketch of the river course and the irrigation systems follows (Figure. 1) so that the relationship between the systems is apparent at a glance. Arrows indicate the direction of flows and the number of each system corresponds with the names given in Appendix 1.

Some of the systems are very old. Chronologically, the systems are arranged as Kathar (over 100 years), Tin-Mauje (1915), Janakpur (1920), Kapiya (1948), Jiwanpur (1952), Kusuna Gathauli (1957), Kharkhutte lower (1957), Kharkhutte upper (1961), Khairgahari (1967), Sathi-Bighe (1984), and Budhi Rapti Community Irrigation Project (1984).

Figure 1. Map **of the Budhi Rapti irrigation systems.**

Since their construction, the performance of the systems has been excellent, although frequent problems of recurrent supply interruptions due to flood damages of diversions, washing away of canal reaches and branches, and subsidence of canals due to undercutting, were reported. Even with such difficult situations the farmers have demonstrated their capability to operate and maintain the nystems.

One of the most important considerations for the excellent performance of the systems might be due to the ownership feelings among farmers. The farmers have participated in all aspects from construction to the various repair and maintenance aspects of the irrigation systems. The systems have been crude and need intensive maintenance and management for their operation. Therefore, farmers have developed a mechanism to take care of the operation and the maintenance of the system which is based on need and problem resolution. This has played a crucial role in getting farmers to cohere and work together. It has ultimately led to the formation of management committees, locally called Kulo Samitis.

Kulo Samiti. The Kulo Samitis have been most effective in creating favorable impacts on water utilization. They have been very efficient in the operation and maintenance of the system, water allocation, and conflict resolution. The reason for such excellent performance of the Kulo Samiti is perhaps due to its leadership, which is accountable to the water users. If the responsibility fails to be fulfilled, the water users change the incumbent in the next annual meeting of the general body.

Another important feature of the Kulo Samiti is that its activity is kept away from the local power-politics and hence it is regarded as impartial. Farmers of the command area are of the opinion that once the irrigation water management is brought under or influenced by the local power-politics its effectiveness diminishes. For example, the Kulo Samiti formed at Kharkhutte lower irrigation system under the ward chairman in 1980 could not function. Since then the system is working effectively under the leadership of Mr. Rudra Bahadur Dhakal, one of the farmers of the syatem. One common disadvantage of the farmer-managed irrigation systems is that it is labor-intensive and has limited resources which prevent it from reaping the full potential of the project.

Agriculture

The agricultural productivity achieved in the command area of the Budhi Rapti irrigation systems is tremendous. Triple cropping is practiced with cropping intensities of 300 percent. The crop yields, common varieties used, and estimated area under major crops are shown in Table 1.

Liberal application of farmyard manure and compost is done by the farmers. The use of chemical fertilizers is an increasing trend. However, its use is limited to a few crops only. Rice, maize, wheat, and mustard are the major crops receiving chemical fertilizers. The doses applied were usually half of the recommended doses. Chemical fertilizers and improved seeds are available from local cooperatives. Information regarding the use of chemical fertilizers and improved seeds was obtained from innovative farmers and junior technical assistants and junior technicians of the District Agriculture Office.

Table 1. Estimated crop yields, common varieties and estimated area under major crop.

Crop (by varieties)	Ha cultivated	Yields metric tons/ha	Months grown
Paddy			
a) Main season (Mansuli)	960	3.0-5.0	June-Oct
b) Spring season (CH-45)	600	4.0-6.0	Feb-June
Maize			
a) Summer season (Rampur yellow, Khumal yellow)	---	2.0-3.0	May-Aug
b) Spring season (Arun-2)	300	2.0-2.5	Mar-June
c) Winter season	240	----	Oct-Feb
Wheat (UP-262, RR-21)	480	2.5-3.0	Nov-May
Grain legumes (Khesari, Lentil, etc)	---	0.5-0.8	----
Mustard (Chitwan local)	240	0.6-1.0	Sept-Jan

LESSONS TO LEARN

Based on the findings of the study on farmer-managed irrigation systems from the Budhi Rapti river the following conclusions can be drawn:

Methodology

Good base-maps. A large-scale, detailed base-map is essential to allow ample room for clear drawings of the canal systems. Without such a map it becomes difficult to clearly trace the command boundary of the irrigation system or the canal head-work and its network of canals in relation to the river system.

If air photos of the study area are available, mapping might be easier on them because they show topography, pattern of land-use and other features that can be easily correlated with the existing irrigation network. Results can be re-plotted on the base-map, area by area, as the work continues.

Well-designed questionnaires. Clear, precise, and concise questionnaires must be carefully designed. The arrangement of the questions should progress from general to specific. Such an ordering may add to the quality of the answers as well as increase the respondents' cooperation. Also, it is sometimes very easy to miss some of the most important information. Pre-testing of questionnaires may reduce such dangers.

Field Checks. Field checks are essential. If careful field checks are done mistakes such as "transposition of the direction of canal taking water out of the river" which appeared in WECS (1985) would have been corrected. Similarly, the order of the irrigation systems along the river course could be arranged as per the real situation of the river system. Further, it may decrease the danger of omitting the small systems altogether.

On the Performance of the System

Ownership feeling. One of the most important considerations for the farmer–managed irrigation systems to perform effectively is the feeling of ownership among its members. The farmers own the system. They work for it and get the water for their crops and themselves in return. They consider that the system is the hope for their well-being and prosperity. They operate and maintain the system so that the water supply is available as and when it is needed to meet the crop water requirements. They give examples of the government–owned systems such as Khageri where the water supply is not synchronized with the critical periods of crop water requirements.

Effective organization. The Kulo Samitis of the farmer–managed irrigation systems have excellent performance in terms of water allocation, conflict management, organization, and management of the resources for repair and maintenance of the systems. Leader farmers with a high commitment to work are selected to serve in the Kulo Samiti. The Kulo Samiti is kept away from the local power politics and thus its decisions become unbiased and acceptable to all the water users. Because it serves the needs of the farmers and helps them to resolve their problems, it receives the strong support of the users.

External assistance. Farmers have done their utmost to bring water to their fields. The operation and maintenance cost of these farmer–managed systems is usually high, and improvement in physical systems is generally needed. Because the farmers have limited resources not all aspects of irrigation system improvements can be borne by them. Therefore, there is ample opportunity to improve and expand the irrigation systems at relatively low cost. In some of the systems only lining with concrete at critical canal reaches may improve water distribution considerably. The FIWUD approach of assisting farmers appears to be effective. FIWUD projects are implemented on a cost-sharing basis and it demands the farmers' participation at all stages of development. This type of involvement makes farmers feel that the project is theirs, which is the most important aspect to be considered.

Kuchkuche forest needs conservation. The Budhi Rapti river originates from springs in the Kuchkuche forest which is being rapidly deforested and encroached upon. If this continues, there is a grave danger of not only drying up the source of the Budhi Rapti river but also it is likely that the main Rapti river may branch into the Budhi Rapti river and damage the whole system, endangering the lives and property of the settlers there.

ISSUES TO BE ADDRESSED

A comparative study of the systems constructed with external assistance and those with farmers' endeavour might be very useful to evaluate the needs for external assistance in the farmer–managed irrigation systems of the area. Operation and management, resource mobilization patterns, and water use efficiency are some aspects that should be examined.

The post–operational changes in cropping pattern, cropping intensity, socio–economic status, and management rules and policy are relevant issues which need to be studied in order to obtain information critical to the evaluation of the systems' productivity.

In order to develop and manage irrigation systems, a number of issues were raised in a seminar on "Water Management Issues" organized jointly by MOA/APROSC/ADC in 1983. The issues raised and presented in the proceedings of the seminar need to be addressed as well.

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System name: Kusuna GathauliMap symbol: 1.1
Type of Headworks: Temporary diversion structure at Kuchkuche forest
Length of main canal: 2 km with 9 branches
Villages served: Kusuna and Gathali of Kather Village Panchayat and Ward No, 9 of Bhandara Village Panchayat.
Command area: 160 bigha[3] (107.2 ha)
Water user organization: Five-member Kulo Samiti
Remarks: The system was first constructed in 1957 and rehabilitated in 1975 after flood damage. The Water Users Organization (WUO) of Gathauli and Ward No. 9 of Bhandara assisted in the repairs. The system is desilted twice a year due to the high silt load from the main Rapti River which is mixed with this system from Janakalyan Ka Kulo.

System name: Kharkhutte Upper System Map symbol: 1.2
Type of headworks: Temporary diversion structure at Kuchkuche forest
Length of main canal: 8 km with 9 branches
Villages served: Ward No. 7 of Kathar Village Panchayat
Command area: 181 bigha (121.27 ha)
Water user organization: Nine-member Kulo Samiti responsible for all operation and management (O&M) of the system.
Remarks: The system was first constructed in 1961 and had a command area of 32 bigha. It was expanded in 1967 to 62 bigha with grant assistance of Rs 7,000 from the Local Development Office. In 1975 it was damaged by flood and rehabilitated in the same year. The FIWUD-constructed Janakalyan Ka Kulo from the main Rapti river mixes with this system since 1985 and covers an additional 70 bighas, consisting of three sections each 50 m long. There are unstable and critically vulnerable points at the canal dikes which need continuous repair and maintenance.

System name: Kathar Irrigation System Map symbol: 1.3
Type of headworks: Temporary diversion structure at Kuchkuche forest
Length of main canal: 2 branch canals; ends at Budhi Rapti for drainage
Villages served: Wards No. 2 and 5 of Kathar Village Panchayat
Command area: 95 bigha (63.65 ha)
Water user organization: Nine-member Kulo Samiti which is responsible for all O&M of the system.
Remarks: More than 100 years old.

System name: Khairghari Irrigation system Map symbol: 1.4
Type of headworks: Temporary diversion structure at Kuchkuche forest
Length of main canal: 1 km main canal; irrigation is direct from main canal
Villages served: Ward No. 3 of Kathar Village Panchayat
Command area: 11 bigha (7.37 ha)
Water user organization: No formal WUO. Being a small system, all the farmers gather and resolve problems as and when there is need.
Remarks: First constructed in 1967. In 1972 the intake point was moved 200 m upstream from the common intake point with Kharkhutte lower system.

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[3]Bigha is a local unit of land measurement. One bigha equals 0.67 hectares.

System name: Kharkhutte Lower SystemMap symbol: 1.5
Type of headworks: Temporary diversion structure at Kuchkuche forest with a gabion-type structure since 1980.
Length of main canal: 2 km main canal delivering 150 liters/sec, and 5 branches. The tailend of the canal drains to Gaida Ghole.
Villages served: Ward No. 7 of Kathar Village Panchayat
Command area: 150 bighas (100.5 ha)
Water user organization: No formal WUO. Rudra Bdr. Dhaka, a local farmer, is mobilizing the users for the O&M of the system.
Remarks: First constructed in 1957. In 1975 the diversion was washed away in a flood. Major rehabilitation with a gabion diversion structure and canal dikes was completed in 1980 with grant assistance of Rs 7,000 from the Local Development Office.

System name: Jiwanpur Irrigation System Map symbol: 1.6
Type of headworks: Temporary diversion structure near Budgaon village
Length of main canal: 4 km main canal delivering 200 liters/sec; 11 branches
Villages served: Ward No. 5 of Kathar Village Panchayat
Command area: 56 Bighas (37.52 ha)
Water user organization: Five-member WUO supervises O&M of the system
Remarks: First constructed in 1952. In 1975 a semi-permanent gabion-type diversion structure was built with grant assistance of Rs 7,000 from the Local Development Office, but it was later washed away.

System name: Janakpur Irrigation System Map symbol: 1.7
Type of headworks: Permanent structure gated with a head regulator
Length of main canal: 3.78 km main canal delivering 200 liters/sec; 10 branches
Villages served: Bhatihani, Sattisal. Gorkhela, Dharampur, Janakpur Kumroj of Kumroj Village Panchayat
Command area: 283 bighas (189.61 ha)
Water user organization: A formal Kulo Samiti looks after the O&M of the system.
Remarks: First constructed in 1920, having a command area of 278 bigha. Rehabilitated in 1985 and the command area was increased to 283.

System name: Kapiya Irrigation System Map symbol: 1.8
Type of headworks: Temporary diversion structure
Length of main canal: 3 km main canal with 4 branches
Villages served: Kapiya village Ward No. 8 of Kumroj Village Panchayat
Command area: 113 bighas (75.71 ha)
Water user organization: Nine-member Kulo Samiti responsible for O&M
Remarks: First constructed in 1948. In 1960 a masonry flume was constructed over the main canal of the Kumroj-Dharampur-Sishani Irrigation System with Rs 5,000 from the Local Development Office. Recently a new concrete flume was constructed by the Small Farmer Development Project/CARE, Nepal (SFDP/CARE) over the canal of Naya Simalghari Sathi-Bighe Irrigation system to guide the tailend branch to the Kapiya system.

System name: Tin-Mauja Kulo Map symbol: 1.9
Type of headworks: Gabion-type diversion
Length of main canal: 2 km main canal delivering 400 liters/sec; 3 sub-systems
Villages served: Kumroj, Dharampur, and Sishani of Kumroj Village Panchayat
Command area: 183 bighas (122.61 ha)
Water user organization: Three WUO, one for each sub-system
Remarks: First constructed in 1915. Water is equally distributed among the sub-systems through proportional weirs. There has been no change in the canal alignment since the system was first constructed.

System name: Naya Simalghari Sathi-Bighe Map symbol: 1.10
Type of headworks: Permanent diversion structure, overflow type; gated weir and nearly 50 km lined approach canal with gated head regulator
Length of main canal: 2 km main canal delivering 400 liters/sec; 5 branches
Villages served: Jholiya and Sishani villages of Kumroj Village Panchayat
Command area: 60 bighas (40.2 ha)
Water user organization: 13-member Kulo Nirman Samiti may be converted into a WUO after completion of construction work.
Remarks: Construction work first started in 1984 with the technical assistance of SFDP/CARE, Nepal. Estimated completion date was April 1987. Budget: 1984, SFDP loan = Rs 30,000. 1986, SFDP loan = Rs 16,200. A second SFDP loan = Rs 85,000. Grant assistance from CARE, Nepal: 1,000 bags of cement, 300 kg steel rods, 500 kg gabion wire. Labor contribution of the farmers = 6,600 man-days.

System name: Budhi Rapti Community Irrigation Project Map symbol: 1.11
Type of headworks: Gated weir. Reinforced concrete diversion. Gated head regulator at the intake point.
Length of main canal: 5.85 km main canal delivering 800 liters/sec with 10 branches. Earthen canal network. Reinforced concrete cross-drainage works. Main canal drains into the Budhi Rapti.
Villages served: Ward numbers 1, 2, 3, 4, and 7 of Kumroj Village Panchayat
Command area: 585 bighas (391.95 ha)
Water user organization:
Remarks: Construction work first started in 1984 with an estimated completion date of April 1987. Budget: Estimated cost = Rs 1,496,000, of which Rs 449,000 is a SFDP loan and Rs 748,000 grant assistance from CARE, Nepal. Labor contribution from the farmers amounted to Rs 2,299,000.

TOTAL COMMAND AREA OF ALL THE SYSTEMS: 1,817 bighas (1,217.39 ha)

RECONNAISSANCE/INVENTORY STUDY OF IRRIGATION SYSTEMS IN THE INDRAWATI BASIN OF NEPAL

Robert Yoder and S.B. Upadhyay[1]

INTRODUCTION

The first official recognition and estimate of the extent of farmer-managed irrigation systems (FMIS) in Nepal was made by the Water and Energy Commission Secretariat (WECS) in 1981. The size of systems ranges from a single farmer's plot consisting of a fraction of a hectare (ha) to the federation of several organizations and diversions into a system which irrigates as much as 15,000 ha. However, it is the sheer number of systems rather than their size that makes the greatest impact on irrigated agriculture. Farmers in Nepal have been active for many generations in pushing the technology available to them to its limit. They have tapped all easily accessible water and land resources to develop irrigated agriculture.

Excluding the systems in the tarai, simple extrapolation of the results shown in this paper along with information from the Land Resource Mapping Project (1986), indicates that there may be well over 17,000 farmer-managed systems in the hills of Nepal. The impact of FMIS in terms of subsistence living and hence the national economy has not been carefully studied. Martin (1986) and Yoder (1986) present data from several communities with perennial irrigation at elevations below 1,000 meters (m) which produce three crops per year. The net annual increase in cereal production with irrigation over that of nearby unirrigated land was found to be well over 6,000 kilograms per hectare (kg/ha). As a conservative estimate one can assume an average increase in production of at least 2,000 kg/ha through FMIS. Using this estimate of yield increase and the WECS estimate that roughly 390,000 ha are irrigated by such systems in all of Nepal, one can show that the incremental increase in production due to FMIS is providing the total subsistence level cereal production for at least 30 percent of Nepal's population. This calculation is based on the average cereal consumption of 164 kg/person/yr (Khadka and Gautam 1981). WECS is presently conducting a water-use inventory in the tarai districts which will give a better estimate of irrigated land area. Preliminary analysis indicates that the area irrigated by FMIS may be as much as double the earlier estimates. In this case the dependency upon FMIS for food production may be much higher than the above analysis indicates.

INTERVENTION IN FMIS

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The action research project reported on in this paper is administered by WECS and partially funded by the Ford Foundation. The views and interpretations in this paper are the authors' and are not attributable to the International Irrigation Management Institute, Water and Energy Commission Secretariat, or the Ford Foundation.

The appearance of most FMIS belies their potential performance. Brush/stone diversions and earth-lined canals leak and require frequent maintenance. This has led development agencies, and engineers in particular, to assume that structural improvements in the water acquisition and delivery system will improve the system efficiency. Further, that efficient operation will allow for more reliable, intensive irrigation of the existing command area, and expansion of the irrigated area where land is available.

Past efforts of intervention in FMIS to improve their agricultural performance have not been highly successful, This is partially due to misdiagnosing the cause of the shortcomings. FMIS are generally built with local materials that decay quickly when not in use. Inspection of systems by technicians responsible for intervention usually takes place in the winter and dry season. At that time many systems do not have water available in their source and farmers do not waste effort in trying to maintain a system that cannot be used for a season. Technicians often declare such systems to be in total disrepair without the understanding that they will be transformed into viable systems by the beneficiaries as soon as water is available. In some cases farmers are willing to invest as much as 50 person-days/ha/year in maintaining their systems (Yoder 1986).

Physical improvements in a system may be a necessary condition for better performance but making structural improvements alone seldom brings the desired results. The strength of an irrigation system with scarce resources that performs well, is its management. Improving the management capability of poorly performing systems may be equally important to making improvements to its physical system. In some cases assistance from outside the community has eroded local management and resource mobilization capability.

The magnitude and impact of resource mobilization by the beneficiaries is not well known or understood. The high performance of some FMIS is attributed to the capability to mobilize tremendous labor and cash resources for operation and maintenance (Yoder 1986). One system in Gulmi, two in Palpa and one in the Nawalparasi hills were intensively monitored for 18 months in 1982-83. In systems where the water source was adequate, all were producing three irrigated crops each year. Using crop cuts to estimate the yield, the system with least water--producing two crops--had a total annual production of 5,200 kg/ha and those with three crops per year ranged from 7,500 to 9,000 kg/ha. Such examples of intensive agriculture production in FMIS are not isolated cases (Pradhan 1986).

However, some FMIS are operating far below the production level that they could potentially achieve with the available water and land resources (Pant 1985; Tiwari 1986). In many cases farmers have good cause for requesting and actively campaigning to attract outside assistance for structural improvements. In addition to more reliable and extensive irrigation, farmers are interested in reducing the effort--labor and in some cases, cash--that they need to invest in maintenance of their systems.

With increasing interest among agencies to target poorly performing systems for intervention, several practical questions emerge. It is clear that FMIS have been successful in increasing agriculture production. Some systems perform well and are close to achieving their potential. Others perform far below their potential. How does one distinguish between systems? What procedure can be used to quickly collect and analyze information for ranking systems in priority for assistance? How does one analyze the symptoms in order to diagnose the causes of low performance'? How does one intervene to improve the performance?

WECS has engaged in an action-research project to attempt to answer some of these questions.

THE WECS ACTION-RESEARCH PROJECT

The underlying rationale for the WECS action-research project is the hypothesis that farmers in the hills of Nepal have already, to some extent, developed most of the sites with potential land and water resources for irrigated agriculture. Few new systems will be built where there is not at least some existing irrigation activity. Where irrigated agriculture already exists, farmers have some irrigation management experience. They also have knowledge about the stream discharge, diversion and canal maintenance problems, soils, irrigated agriculture practices, and benefits of irrigated agriculture. It is expected that food production gains can best be made by examining the existing (running) systems to identify, and to the extent possible, release the constraints that farmers face in increasing agricultural production through intensification or expansion of their irrigation system.

The aim of the WECS project is to examine the physical, hydrologic, agronomic, economic, and social/organizational aspects of existing irrigation systems to first identify if there are water and land resources in a community that are not fully utilized, and then attempt to uncover the reason for less than full exploitation of the irrigation potential. Another aim is to develop and test processes to overcome the problems. Emphasis is placed on developing the necessary methods and tools for collecting useful information as quickly and cheaply as possible. After evaluating the alternatives, recommendations for upgrading and improving individual system operation will be made and carried out as a part of the project.

The intent is to carry out all activities in such a way as to enable the beneficiaries to continue to take full responsibility for the operation and maintenance of their irrigation system. This implies maximum participation by the farmers in the identification of the constraints, examination of alternatives, choice of the appropriate action, and implementation of the action. The action-research mode of carrying out the work allows specific problems to be addressed as they are identified. Recommended actions can be implemented immediately, offering an opportunity to further study the impact of these activities and to make additional recommendations and carry them out as necessary.

Objectives of the Project

The primary objective of this action-research project is to examine ways to assist farmer-managed systems that will allow them to overcome the constraints limiting intensification and expansion of irrigated agriculture. This includes testing lower-cost techniques and technologies and maximizing the participation and resource mobilization of the beneficiaries. It also includes developing and testing low-cost processes, procedures, methods, and technology for developing under-utilized human and physical resources. The maxim is to do this without shifting the responsibility for operation and maintenance to the government.

The WECS action-research project proposes to assist irrigation systems in the project area. However, success of the project will not be measured by the intensification or expansion of irrigated area, but by the degree to which the objectives of developing processes and procedures are accomplished.

The implementation of the project is being carried out in two phases. The first phase consists of information gathering, analysis, and recommendations of steps for initiating the second phase. The second phase will involve intervention in irrigation systems selected as a part of the first-phase activity. Monitoring and evaluating the intervention will be an integral part of the activity.

The chronological steps taken to carry out the first phase include:

1. Project site selection.

2. Development of the terms of reference for a reconnaissance/inventory and rapid appraisal study of the project area.

3. Selection of a local consulting firm to carry out the first phase field studies.

4. Development of a procedure for the reconnaissance/inventory study and carrying out the field work and report writing associated with it.

5. Selection of micro areas for further investigation by rapid appraisal techniques based on the reconnaissance/inventory study report.

6. Development of a procedure for the rapid appraisal study and carrying out the field work and report writing associated with it.

7. Development of a work plan for the second phase based on the reconnaissance/inventory and rapid appraisal reports by the consultants, and additional field reconnaissance by WECS staff.

With the exception of developing a work plan in the last step, the first phase is complete. The remainder of this paper will examine and analyze the procedure and results of the reconnaissance/inventory step of this activity.

Methodology and Field Procedures

The project site was envisioned to encompass a large river basin and include all of its numerous minor tributaries. The criteria for selecting the site were: accessibility from Kathmandu for supervision and representativeness of the hill areas of Nepal. The Indrawati River basin in Sindhupalchok fit these criteria. To further define the boundaries of the project, only the area above Sipa Ghat, extending four kilometers (km) on each side of the Indrawati River, was included. This excluded the Melaunche River, a major tributary, but included almost all of the remaining irrigated area in the basin.

The consultants were given background materials, including check-lists and write-up guides developed in different parts of the world, and available materials from Nepal. From this material they developed their own lists and guides for both the reconnaissance/inventory and rapid appraisal study.

To carry out the field work the consultants were to use an interdisciplinary team consisting of at least an engineer, a social scientist, and an agriculturalist. However, the nature of consulting firms does not lend itself to fielding such a team. Few persons can be employed full time by consulting firms, therefore individuals who can take leave from their regular jobs are recruited. Frequently the best-qualified persons on the roster are not available and others must be substituted. This allows little flexibility in selecting disciplines.

The reconnaissance/inventory field work was carried out by a civil engineer, an agriculture specialist, one junior hydrologist and two helpers. Some assistance was provided for part of the time in the field by an IIMI social scientist.

The reconnaissance/inventory team visited each irrigation system in the basin. The most important activity was to walk along the length of the canal from the intake to the command area. One or a group of farmers was invited to accompany the team. While walking along the canal the farmers were questioned about the operation and maintenance of the system and the organization that was in place to carry out the various irrigation activities. Problems with the diversion and along the canal were discussed while making this inspection.

Water in the source was estimated while inspecting the intake. Farmers were also asked to estimate the discharge in the stream and relate the observed discharge to that in each irrigation season. In addition to the consultant's estimate of discharge by visual inspection, he asked the farmers to make their own estimate by asking them how they measure water. Usually the response was in ghatta of water (discharge required to drive a locally-built water-powered flour mill assumed to average about 28 liters per second (lps)) or [illegible] (water pot used for carrying domestic water holding about 20 liters) or samaha (water basin 5-10 liters). Water for driving a ghatta was further differentiated by asking if the water was sufficient for grinding all types of grain. If at some periods of the year it could only grind millet, the discharge was clearly lower than at other times. Half or one-fourth ghatta of water were also typical responses for discharge estimates. For lower discharges, farmers were asked how long it would take to fill a gagri or samaha. Since time is not generally measured in minutes and seconds by the farmers, they were asked how many times the gagri would fill in the time that it took to smoke a cigarette, which was estimated to be about four minutes.

The error in this type of estimate is high. A mill can grind grain with 0.25 - 1 kilowatt (kw) of power and power is a function of both the discharge and head (height the water is dropped) as well as the efficiency of the particular ghatta. However, it does give an idea of the relative discharge and of the variation over the year, Coupled with information from the farmers about the adequacy of the water supply for irrigating different crops and whether there was sufficient water to expand the area irrigated, the discharge information provided insight into the extent that the water resource had potential for further utilization.

To the extent possible the command area was also inspected. This was a difficult task among the many ridges and valleys and not always possible in the time available. The farmers were asked to estimate the area in the hydraulic command of the canal, how much of that area was actually irrigated, how much was cultivated but not irrigated, and the extent of the waste area. While examining the command area, farmers were also asked about their agricultural practices.

Estimates of land area were more difficult for farmers to make than estimates of water discharge. The cadastral survey of this area is complete and individuals have knowledge about their own holdings but not of the aggregate in the system. The most common measure of land area used by the farmers in this area is the volume of seed required to plant the area. A rough estimate for conversion is 20 patti of seed/ha (91 liters of seed/ha). Unlike most systems studied in western Nepal, few of these systems had quantified the resource mobilization or water allocation of the system on the basis of land area. Therefore, farmers have not needed to compute the total land area or seed required for a system and found it difficult to do so. The accuracy of the land area information could be improved with good quality air photos.

Since maps of a suitable scale are not available, the consultants were asked to make a sketch map of the area showing the irrigation water source, rough alignment of the canal, and layout of the command area. The map included the names and relative locations of the intake, canal, and command area of each system from that particular water source.

RESULTS AND ANALYSIS OF THE RECONNAISSANCE/INVENTORY WORK

The project area covers about 200 square kilometers (km^2). The Indrawati River cannot be used extensively for irrigation because it is deeply incised, and is large, with violent floods. Almost all of the irrigated fields in the project area receive their water from the 25 tributary streams. Most of these streams are steep-sloped having highly destructive, short-duration floods during the rainy season and very little water in the dry season.

The reconnaissance/inventory study identified 119 irrigation systems in the project area with canals longer than 0.5 km. These systems irrigate about 2,100 ha of land and were found to benefit approximately 10,100 households. In addition there are many systems with shorter canals and small command areas in the valley bottoms which have easy access to the available water. These were not included in the inventory because they have little potential for intensification or expansion.

The longest canal was found to be 5.5 km from the source to the command area. On the average the canals are 1.9 km long and serve 100 households. Several systems irrigate over 100 ha. Up to 800 households own portions of land in the larger systems. The average land area served by the systems in the study area is 18 ha. However, the median area covered by a system is about 10 ha.

Of the approximately 3,800 ha within the boundaries that can be irrigated by gravity (hydraulic or gross command area) from the canals, 30 percent is too steep or rocky for cultivation. Of the gross area, 56 percent is irrigated and about 14 percent is cultivated but not irrigated because of insufficient water in the source or inability to deliver the water to the land.

The area irrigated represents about 11 percent of the total 200 km^2 project area. Although the project area is small and no claim can be made that it is average for the hills, this is possibly the best data presently available for estimating the area irrigated by FMIS in the hills and for estimating the total number of such systems. Extrapolation of the number of systems and percentage of area covered by FMIS in the project, to all of the hills and mountains of Nepal, yields an estimate of at least 17,000 systems covering 300,000 ha. The basis for land area in this calculation is taken from the Land

Resource Mapping Project (1986) and only Class I, II, and III land (land classified as supporting cultivation) from the siwaliks, mid-mountains, and high mountains was included.

Out of the 119 systems identified, 25 have received some form of outside assistance in the past 20 years. For some the assistance was a certain tonnage of grain for working on the improvement or rehabilitation of an existing canal. In such cases the beneficiaries did most or all of the work themselves. Eleven systems in the study area have been built (about half are still under construction) by the Department of Irrigation, Hydrology, and Meteorology.

A major accomplishment of the reconnaissance/inventory work is a detailed listing of the potential for either intensifying the cropping pattern or expanding the area irrigated by each system. Out of the 25 basins of the minor streams tapped for irrigation in the study area, only 11 basins with 21 different irrigation systems were identified by the consultant as having land and water resources with potential for expansion of the irrigated area. A more reliable water supply would allow more intensive cropping in many systems beyond these 21 and improvements in both the management and physical system would assist in making this possible. However, assisting the 21 systems identified by the reconnaissance/inventory study is likely to lead to the largest gain in food production.

In addition to the physical resources, the study examined operation and maintenance (O&M) activities of the irrigation systems and agricultural practices. Even by spending very little extra time in each system the team collected valuable information about the historical development of the system, the current organization for O&M, and the capability for resource mobilization. This information was considered along with information about the physical system in determining the potential for expanding water and land resource utilization.

A summary of the effort that went into carrying out the reconnaissance/inventory work is presented in Table 1. Here it is seen that the report writing was more time consuming than the field work. Attention should be given to making the report writing simpler without compromising content and also to making it more readable than the present two volumes totaling 500 pages.

Table 1. Resources expended in carrying out the reconnaissance/inventory work (person-days).

Activity	Office	Field
Preparatory Work[1]	12	2
Field Work	-	50[2]
Report Writing	73	-

[1]This included map collection and study, preparation of question-guide and write-up format, pretesting, etc.

[2]Twenty-one calendar days were spent in the field by the team.

By making a comparison of river basins it is estimated that the same level of intensive field work to cover the entire Sindhupalchok District would require one team to spend about 18 weeks in the field.

DISCUSSION AND CONCLUSIONS

Although the estimates of water discharge and land area are not accurate in absolute terms, the reconnaissance/inventory work is extremely valuable in determining the irrigation development potential in a relative sense. The study has successfully identified the existing irrigated land resource. It has also successfully captured farmer input in identifying under-utilized resources. Finally, it has allowed the identification of systems with obvious potential for intensification or expansion from among those with little or no potential. Through systematic examination, attention is focussed on 21 of the 119 systems. The study provides a combination of information on the agriculture system, management practices, and physical system, giving an insight into the constraints that must be overcome to make the systems more productive.

If this type of study were to be carried out on a district-wide basis it would allow planners and policy makers to set priorities that would maximize returns on investment in development. The cost for completing the reconnaissance/inventory study in Sindhupalchok would be approximately six times what has been invested in studying the Indrawati basin.

Two limitations of the present study should be addressed in future work. The land area estimates need to be improved and potential areas where farmers have not been able to develop irrigation should also be examined. Both of these could best be addressed by using good quality, large-scale air photos in the field. The possibility of using existing air photos by enlarging relevant areas should be examined. By tracing the boundaries of the irrigated area on the air photo, more accurate estimates of area could be calculated. Some effort would need to go into determining the scale of each photo segment by making measurements on the ground or using the cadastral map, if identifiable features can be found on both the photo and map.

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GUIDELINES FOR RAPID APPRAISAL OF IRRIGATION SYSTEMS EXPERIENCE FROM NEPAL

Prachanda Pradhan, Robert Yoder, and Ujjwal Pradhan[1]

THE UTILITY OF RAPID APPRAISAL

Given constraints of time, money, and manpower, rapid appraisal is a useful tool for assessing existing irrigation systems. It can be used to identify key issues and problem areas and to give direction for further investigation. The effort of rapid appraisal should lead to a wide variety of options and possible alternative arrangements for irrigation management.

The "quick and dirty image" often associated with rapid appraisals can be overcome with a well-developed framework and a team that is integrated in its effort. Intensive interaction of the team while in the field leads to cross-checking of information and an opportunity for follow-up questions.

One must recognize that rapid appraisal has limitations. Not all questions can be answered by it. Complex issues cannot be unraveled in a short time. Some results and conclusions will inevitably be wrong. Increased skill in cross-checking can reduce this problem but there is always danger that the investigator will be misled by one or a few informants. It is important to examine rapid appraisal results within the context of its limitations.

This guideline for rapid appraisal of irrigation systems was largely prepared on the basis of experience with farmer-managed irrigation systems in Nepal. With some modification it could be used to investigate agency-managed systems as well.

INTRODUCTION TO RAPID APPRAISAL

Agrarian change and agricultural development are quite intimately associated with the status of irrigation in Nepal. Irrigation systems are complex socio-technical units, and development activities have directly and indirectly affected the status of these systems. Due to resource constraints of a developing country, a detailed and in-depth study of each irrigation system under consideration is not possible. This is certainly not possible in Nepal where it is estimated that there are between 20,000-50,000 irrigation systems.

Effective rapid appraisal studies cannot be conducted by simply putting together a comprehensive question guide and taking it to the field for systematic investigation. Before a team goes to the field it is important that each member understand "what" the nature of a rapid appraisal study is, "why" rapid appraisal methods have been selected, "how" it will be applied, and what the nature of the "product" of the study will be.

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What Is Rapid Appraisal?

Rapid appraisal is a methodology for collecting information quickly. Appraisal is used in the general sense to mean investigation and analysis, and primary attention is given to practical investigation. Since the time-frame for field investigation is shortened, there is an attempt *to* compensate by intensive preparation and carefully planned procedures in the field. It is particularly well-suited for studies of irrigation systems since there is usually more than one system to examine, and time, funds, and skilled manpower are often a constraint to conventional studies. The output of rapid appraisal studies is generally a report for a specific purpose. The purpose for the study must be well defined in advance. The study is usually carried out by an interdisciplinary team.

Why Use Rapid Appraisal?

A rapid appraisal study can be used for various purposes. In some cases it can be used as a way to identify and describe systems for which there is no written documentation. It can be used to assess the physical system and problems associated with it such as identifying the need for rehabilitation. It can be used to assess the organizational strength and weaknesses of a system. A study can be used to lay out the socio-technical processes involved in the operation of a system and this information used to solicit participation in organizational activities or collaborative resource mobilization for improving the system. The utility of rapid appraisal methods will vary depending on the type and depth of information that is needed and how the results are to be used.

A series of rapid appraisal studies can be used to provide a comparative picture of irrigation operation across systems. By identifying pertinent variables such as maintenance labor mobilized per hectare, sanctions for water theft, leadership roles, etc., it is possible to make cross system comparisons and in some cases rank the strengths and weakness of each system.

A general picture of a single system or a comparative understanding of a series of systems helps decision makers focus on key issues. It might point toward the need for more in-depth research or identify the physical areas or social interactions that require further study. It may thus be a tool for identifying further research needs.

How to Undertake Rapid Appraisal?

Since irrigation is multidimensional with interacting physical, biological, and social environments, an interdisciplinary team has a definite advantage. This assumes, however, that the team will work together and interact: it is an ideal that cannot be taken for granted. A balance is needed among the team members to insure that the necessary multitude of perspectives are properly integrated and incorporated into the report.

There should be a conscious effort to cover the range of disciplines needed to understand the complex interaction of the biological, social, and physical environments. A valuable contribution that should not be overlooked is the opportunity for cross-fertilization of research methods among the different disciplines represented on the team.

Unstructured, small-group interviews and careful observation are powerful tools for collecting accurate information and should be used as much as possible. Interviews should be conducted with a checklist to ensure that the important points are not missed. Open-ended discussion should be encouraged by avoiding formal questionnaires. Since time is a factor in rapid appraisal, choose a guide who knows the people and is familiar with the part of the system to be visited. This will assist in moving about and meeting key informants, allowing for rapid investigation. Use maps or aerial photos to select locations and pick out key categories of information to determine which people to visit. Key infcrmants to interview should be selected for their specialized knowledge: irrigators (head, middle, and tail), women, agriculture workers, and project staff. When different versions of issues are given by different informants, they must be interpreted from the perspective of the different interests within the community. On sensitive issues one must be careful to remain neutral.

For many irrigation systems in Nepal, what one sees in the field visit will be dependent upon the time of the year. Some systems are not operating in the dry season. Most systems have been built for irrigating monsoon rice. It would be desirable to visit them during the monsoon even though that is the time when travel is most difficult. If a system is visited while it is not operating one must look for clues to how the system might function. For example, the cropping pattern and the extent and location of fallow land would lead to questions about water adequacy and the management of distribution. The logic for type and location of physical structures like aqueducts, siphons, and gates, or lack of structures, are easier to understand if the system is seen in operation but can also be visualized by imaginative questioning.

Preparatory steps before a rapid appraisal study. Gathering all available information such as maps, previous reports and air photos, is the logical way to begin any study. To become familiar with the study area, there is no substitute for desk work. If a large area or large number of systems are assigned for study, it may be necessary to do a reconnaissance. It is not necessary that all team members participate in this step. One or two persons can do the reconnaissance. The purpose of the reconnaissance is to help in selecting, or limiting, the type and number of systems for further study. It should give an overview of the situation and the reconnaissance report should provide valuable background material for briefing the team.

Formation of the team. For irrigation studies it is useful to have at least a mix of four disciplinary skills on the team--organizational, cultural/social, technical, and agronomic. However, even more important than the disciplinary mix is mutual respect and an attitude and desire to learn from each other's point of view. Three to six members on a team allow easy interaction and discussion. If a portable computer is available, an experienced typist with the team in the field would help reduce the drudgery of writing and speed up the report writing.

Rapid appraisal activities. There should be an organizational meeting where information is shared and roles for the study are established. A team leader should be selected to assign tasks: logistics, public relations, scheduling. All of the background material available should be shared among all of the team members. There should be discussion about the purpose of the study and the format of the report. The checklist or question guide should be discussed and amended by consensus. It is useful if this checklist can be arranged in the desired outline for the field notes. This facilitates merging each individual team member's notes into one complete set of comprehensive field notes containing all observations and data collected. Such a set of notes can be more easily checked for consistency than each member's separate complete set of notes. A sample checklist that doubles as an outline for merging the field notes is included in Appendix 1.

A useful exercise for the team in the first meeting would be to discuss the interaction of the various irrigation activities. This would help to underscore the need for different perspectives to establish a comprehensive Understanding of the irrigation system and how it operates. A matrix showing the interrelationship of organizational, physical and water use activities is given in Appendix 2. This matrix could be used to facilitate discussion.

If at all possible the team should be resident in the command area while in the field. There should be as much interaction as possible with farmers on an informal basis. The team must be disciplined in not displaying authoritative behavior. They should answer questions asked by farmers about the reason for the study as soon as they are raised with as much detail as necessary but without giving false assurances about assistance. Sensitivity about intruding upon the farmer's time is important. Food and services should be paid for.

The team should travel through the system together the first time (walking, if possible) to share observations and jointly conduct farmer interviews. Then the group should break into smaller units of two or three for subsequent visits. Useful suggestions from Chambers and Carruthers (1986) for offsetting frequent appraisal biases while carrying out field work are given in Table 1.

In addition to writing notes in the field (while observing the system and discussing with informants), the team members should spend time alone each day rewriting the notes according to the agreed-upon outline and making certain the notes are complete. If a typist is part of the field team the team members should have these rewritten field notes entered into the word processor. The emphasis should be on simple statements and phrases rather than polished sentences and paragraphs in order to record the raw data quickly and make it available for discussion with the rest of the team.

The most important group activity is to have frequent meetings to share and discuss what has been measured, observed, and heard. Different and contradictory points of view need to be aired and hypotheses formulated for testing in order to identify gaps in understanding and interpretation. This intensive discussion will help the team to comprehend the relationship among the physical, social, and agronomic environmenta. The group discussion sessions will generate new questions to be taken back to the field on the next visit.

Before leaving a system it is essential that each team member's notes be compiled into a master note file according to the agreed-upon outline. This can be done by each team member or one individual and is greatly facilitated by having a typist and computer in the field. Even though doing it by hand is time consuming and difficult when a computer and typist are not available, it improves accuracy and ease in report preparation later. The master note file assures that discussion of each point has taken place and discrepancies resolved before leaving the opportunity to ask a few final questions or make additional observations in the field. Analysis of the information while compiling the master note file allows weeding out of misleading information. It also assures that all of the information of one system has been processed before moving on to another system with the possibility of getting the two systems mixed and confused.

Table 1. Offsetting appraisal biases.

Source Bias	What to do
Visiting only head reaches and traveling canal roads by car.	Go to the tails and off the roads: walk around.
Examining the distribution system.	Look at the drains.
Visiting only during working hours and in daylight.	Go before and after working hours, and at night.
Making only one visit, or visiting at the same time each season. seasons.	Inquire about the situation at other times, and in other
Observing only physical works such as headworks, canals, cross regulators, and gates.	Find out about process--distribution, communication--and meet people.
Visiting only demonstration trials or special projects.	Visit fanners lower down the same channel who may get less water because of a trial or project.
Meeting only the elite: staff, better-off farmers, influential people, and men.	Make an effort to meet poorer fanners, laborers, and women.
Blaming farmers for misusing the system.	Find out why farmers do what they do.
Telling people what they should do.	Listen to people and learn from them.
Visiting people hurriedly.	Plan to spend more time and be patient with people.

Source: Chambers, Robert and Ian Carruthers. 1986. Rapid appraisal to improve canal irrigation performance: experience and options. IIMI Research Paper No. 3, IIMI, Digana Village, Sri Lanka.

THE PRODUCT OF RAPID APPRAISAL

The product of rapid appraisal is a report which reflects a well-integrated team effort. The integration begins with the organizational meeting when tasks and roles are assigned and continues in the field as notes of discussions are compiled. The effectiveness of rapid appraisal is due to the team effort and utilization of input from all team members on all issues.

The style of the report should reflect the purpose for which the information is intended to be used. If the primary purpose is identification and description of systems, the report will be mostly narration. However, if comparison of systems is planned, the variables to be compared should be identified before the report is written so that the material to be compared in different reports is presented in an identical format and is easily found in each report.

The structure of the final report should be decided by the group and does not need to follow the organization of the question guide. To ensure continuity in style and content it is best if one person writes the first draft of the report. The report should contain appropriate maps and sketches of important features. If possible, photos should be included to assist in communicating the information that has been collected.

Under constraints of time, finances, and manpower, rapid appraisal is a useful tool for compiling information that can only be acquired through field studies. Experience and skill in cross-checking are necessary to reduce the errors often associated with rapid appraisals. This requires a well developed framework and an integrated team effort.

APPENDIX 1

RAPID APPRAISAL CHECKLIST

I. INTRODUCTION

A. Arta overview

-Location: zone, district, village panchayat, ward.
-Access to the system.
-Access to support services and markets.
-Physical information of the surrounding area.
-Food sufficiency.
-Labor availability in each season: daily wage, contract.

B. Settlement pattern of surrounding area

-History of settlement.
-Population.
-Milestones in agricultural development (establishment of support services, introduction of new crops, etc.).
-In- and out-migration patterns.
-Ethnic composition.

C. History of the surrounding area's irrigation development

-Map or sketch including the following for each system: relative location, water source, diversion point, command area, name.
-For each system: type (hill, river valley,or tarai), management (agency, farmers, or joint).

II. HISTORY OF THE SYSTEM

A. Original construction

-When?
-Who initiated and directed?
-Amount and source of resources invested: cash, labor, materials.
-Basis for internal resource mobilization: household, landholding.
-External resources.

B. Improvements/rehabilitation

-Other than routine maintenance, when have major inputs and improvement8 been made?
-Who initiated? When? What was done?
-Internal or external resources.
-Basis for internal resource mobilization.
-Are there regular external resources given?

C. System expansion

-How have boundaries of system changed over time?

-Have new settlers (authorized or unauthorized) been allowed to join?
-Have segments of the system left?
-Has there been amalgamation, incorporation of systems?

III. DESCRIPTION OF THE SYSTEM

A. The physical system

1. Hydrology

-Source(s) of water.
-Catchment area.
-Rights to water in source: upstream and downstream systems.
-Seasonal variation of water supply at extraction point.
-Discharge in canal at extraction: maximum and minimum for each crop.
-Flood frequency.
-Drought frequency.
-Water quality: salt, lime, etc.
-Other uses of water: power, fire protection, animals, etc.
-Water constraints to expansion/intensification of irrigation.

2. Canals: main and branch

-Type of construction, materials, quality, and condition.
-Seasonal and long-term changes.
-Sketch or map of layout.
-Distance from source to first fields.
-Length of main canal in command area.
-Design capacity of main and branch canals.
-Density: including field canals (m/ha).
-Condition of rock and soil along alignment.
-Condition (specify in which season).

3. Structures

-Type of construction, materials, quality, and condition.
-Seasonal and long-term changes.
-Intake/diversion.
-Regulators: gates, fixed.
-Cross drains.
-Aqueducts, siphons, drop structures.
-Measuring devices.
-Main turnouts: type, number.

4. Boundaries of the irrigated area

-Irrigated area for each crop.
-Changes in system over time: amalgamation, expansion, or loss.
-Limitation of expansion for each crop: physical, water rights.

5. Drainage

-In command area.
-Escapes from canals.

6. Soils.

-Type: head, middle, tail.
-Fertility and suitability for irrigated agriculture.

IV. OPERATION AND MAINTENANCE

A. Activity/problems

-Related to water acquisition: water rights, paucity of supply, damage from floods, etc.
-Related to water delivery: canal cleaning, landslide repair, flood damage, crabs, animals, seepage.
-Related to water distribution and drainage.
-Priority tasks in O&M: maintenance of diversion and canal or water distribution.

B. Water distribution tasks (Frequency and magnitude of effort)

-Method of water distribution for each **crop** and variation during each crop: rotation (who and how initiated, frequency of turn); continuous flow; contract; turns (head to tail).
-Distribution during water-short period: rotation among outlets, among field neighbors within outlet.
-Match between water distribution and allocation: method of matching, proportioning weir, timed rotation.
-Relationship of water distribution to physical infrastructure.
-Who is responsible for water distribution activities?

C. Routine maintenance

-What work is done.
-Frequency.
-Purpose: improve performance, preventive.
-How long does it take?
-Who initiates and directs work?

D. Emergency maintenance

-Reasons.
-Frequency.
-How long does it take?
-Who determines it is an emergency?
-Who organizes and leads the work?

E. Extent of agency involvement in system

-What agency is involved?
-Management input of agency.
-Agency organization for water delivery and O&M.

V. INSTITUTIONS AND SOCIAL ENVIRONMENT

A. Social structure

-Landholding pattern.
-Nature of tenancy (criteria: owner, tenant, sharecropper).
-Ethnic composition in the command.
-Villages.
-Settlement pattern and irrigation labor availability.
-Power structure (related to land and panchayat affiliations).
-Religion.
-Kinship pattern.
-Leadership: formal, informal,
-Migrants: where from, previous irrigation experience.
-Non-agriculture employment.
-Seasonal migration for employment.

B. Organization **for** irrigation operation and maintenance

1. Membership

-Criteria: land, water share, crop, tenancy, official panchayat position, contractual, ethnic (exclusions), gender, age, labor, investment input.
-Membership in other systems.
-Absentee members.

2. Roles and positions

-For each position include: method of nomination, appointment, tenure, remuneration (cash, in kind, labor exemption).

-Appointed functionaries.
Chairman.
Vice-chairman.
Secretary.
Treasurer, etc.
Water supply and/or system damage monitor.
Crier.
External communications.
Moderator of meetings.
Tool keeper,

-Committees: regular and ex officio.
-Informal leaders.
-Relationship of panchayat and political leadership to system.

3. Tiers of organization

-Federation/unitary.
-Central.
-Regional/distributory.
-Village/farm channel (mauja).

4. Meetings

-Regular: time, place, who calls.
-Extra.
-Purpose: resource mobilization, accounts, maintenance, conflict.
-Attendance: landlords, tenants, women.
-Penalty **for** not attending.
-Leadership: moderator, minute keeper, how selected.

-How are resolutions passed'? vote, consensus.
-Records of meeting.

5. Conflict and conflict management

-Cause, nature, frequency of conflict.
-Specific to cropping season?
-Internal or external to the system.
-Among systems.
-Non-water issues.
-To whom is first appeal for conflict resolution and what is the step-by-step procedure for difficult cases?
-What is handled within the organization and what is taken outside?
-Police cases.
-Court cases,
-Panchayat involvement.
-Rules and sanctions.
-Records of conflict resolution.

6. Water rights at system level

-Sharing with other system.
-Permit, rent, prior appropriation, riparian.
-Customary rights.
-Evidence of conflict among systems.

7. Water allocation (water righta of members within system)

-Rases for allocation principle: land area, soil, investment, purchased, traded.
-How does water allocation change with crop, level of water supply.
-Outside influence due to assistance.
-Dominance of one social group.

8. Internal resource mobilization

-Purposes for resource mobilization.
-Basis: same as water allocation, household.
-Type of resource: cash, labor, in kind (remuneration, etc.), animal, bullock cart, local knowledge.
-Organization to manage.
-Accounts of resources due and contributed.
-Annual quantity of each type of resource.
-Sanctions for not contributing.
-Annual amount realized from fines, how collected and used?
-What is consequence of not paying fine?
-Where are funds and in-kind resources held? Is there intermediate (short-term loans) use?
-Discrimination against contribution: caste, sex, age.
-What if family does not have male member?
-Contractual arrangements for maintenance: method, reason.
-Resource generating activity: mill.

9. External resources

-Purpose.
-Source: connections, contacts.

- Who (person) initiated contact with outside agency, incumbent or previous experience in government position.
- Frequency.
- Type: cash, food-for-work, cement, gabion wire, technical advice.
- Equipment: bulldozer, jackhammer.

C. Organizational development.

- Changes over time in: rules, roles, resource mobilization, processes for electing functionaries, etc.
- Changes in decision-making process.
- Process of allowing new outlet from main canal.
- Terms and conditions of external agency for providing aid and resolving conflict.
- Change in involvement of panchayat or district offices.
- Changes in relationships with other systems: water sharing when temporary damage in canal, sharing resources *for* maintenance.

VI. DESCRIPTION OF THE AGRICULTURAL SYSTEM AND SERVICES

A. Agricultural system

1. General

- Main crops.
- General condition of crops.
- Cropping pattern (provide a rough sketch map indicating the crops growN in different locations).
- Crop calendar.
- Cropping intensity.
- Estimated yield.
- Change in agricultural practices in past 25 years: new crops, varieties, technology.
- Mechanization vs. labor-intensive system.

2. Production inputs

- Use of improved of seed.
- Use of fertilizer.
- Extension services (types, training, production campaign).
- Price of inputs.

3. Agricultural practices

- Land preparation methods.
- Use of manure, fertilizer.
- Broadcasting or transplantation.
- Yield per crop.
- Total yield per year.
- Prices and marketing.

VII. SYSTEM STRENGTH AND WEAKNESS

A. Strengths.
B. Weaknesses.

APPENDIX 2

IRRIGATION SYSTEM ACTIVITIES MATRIX

All irrigation systems require that certain essential tasks be accomplished if the system is to function productively. One set of management activities focuses directly on the water. Water must be acquired, allocated, distributed, and, if there is excess, drained. A second set of management activities deals with the physical structures for controlling the water. A final set of activities focusses on organization which manages the water and structures and includes decision making, resource mobilization, communication, and conflict management.

There is interaction among the activities of the three sets; for example, the organization must decide how to operate the structures to distribute the water. The matrix shown in the figure illustrates these interactions. Not all activities are equally important in each environment, and the farmers' irrigation management institutions will reflect the relative importance of activities in a particular location.

For a rapid appraisal study it is instructive to use the matrix to formulate questions about the management of the system. Each of the 64 boxes is a potentially important interaction. For example, one might ask what decisions need to be made about the operation of the system as it relates to water allocation. Often whole blocks of interactions "boxes" are not relevant for a particular system. This matrix is useful for examining the activities internal to the irrigation system.

IRRIGATION SYSTEM ACTIVITIES MATRIX

Adapted from: Uphoff, Norman, Ruth Meinzen-Dick, and Nancy St. Julien. 1985. Getting the process right: farmer organization and participation in irrigation water management. A State-of-the-Art Paper prepared at Cornell University for the Water Management Synthesis II Project, Consortium for International Development, Cornell University, Ithaca, NY.

SECTION II: CASE STUDIES

MULTI-FUNCTIONAL, NON-RESIDENTIAL
IRRIGATION ORGANIZATION: A CASE STUDY OF
KODKU IRRIGATION SYSTEM OF KATHMANDU VALLEY

S. P. Shresthd

INTRODUCTION

The Kodku irrigation system is one of the oldest and largest irrigation systems operating in Lalitpur District. The responsibility for operation and maintenance of the system is performed by the farmers who belong *to* organizations known as Si Guthis since a long time back. Si Guthi is an organization of the Newar ethnic group whose primary function is to perform funeral and cremation rites for its members. In the Kodku irrigation system the Si Guthis have taken on the additional function of mobilizing their members for the operation and maintenance of the system.

The diversion weir and canal are temporary in nature, and require regular repair. Sometimes even the course of the stream changes, and the farmers have had to put lots of effort into making the irrigation system work. Hence, the farmers had to organize themselves to get water delivered to their farms, which they accomplished through their Si Guthis.

In **1965** His Majesty's Government of Nepal (HMGN) undertook rehabilitation of the system with the assistance of the Government of India. After rehabilitation the responsibility for operation and maintenance of the system was assumed by the Department of Irrigation, Hydrology, and Meteorology (DIHM). DIHM employs dhalpas (canal gatekeepers), with a maintenance allocation from the Department.

The command area **is** 562 hectares (ha) which includes Thaiba, Harisidhi, and Imadol of Lalitpur District. DIHM has estimated the beneficiaries to be about 5,000 farmers. The source of water for this system is the Kodku Khola river (also called Karma Nasa) which originates at Guindaha of Badikhel village panchayat. This system is run-off-the-river type. The total length of the canal **is 5.67** kilometers (km). The water discharge, as estimated by DIHM, is 0.5 cubic meters per second (m^3/sec).

OBJECTIVES

The objectives of the study are:

1. **To** understand the organizational structure of the Si Guthi in relation to irrigation system management.

2. To observe the method of operation and maintenance **of** the system.

3. To determine the method of resource mobilization; and

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4. To understand the management of conflict during the time of water stealing and other events.

METHODOLOGY

The methodology used for this study is observation accomplished by a "walk-through" of the system, and unstructured interviews with farmers, Guthi members, and DIHM officials. Needing to collect informstion on the historical background of the system, a list of key informants was formulated in consultation with the farmers and other people who had been active in the irrigation system. In order to interview key members of the Guthis from both Patan and Thaiba, informants from these Guthis were identified. The informants introduced the researchers to key people involved with the irrigation system.

IRRIGATION ORGANIZATION

The irrigation organization is not the same throughout the system. The farmers at the head could only answer questions pertaining to their own group. Farmers in the middle and tailend of the system were likewise only concerned with the operation of their part of the system. There are distinctive features characterizing this system. Farmers at the head reside close to their fields, but those at the middle and tail sections live far from their fields. The farmers do not have one irrigators' association for the entire system, but carry out irrigation operation and maintenance functions through the direction of their respective Si Guthis. Si Guthi organizations have been active in performing irrigation functions in this system for many years.

The Kodku Irrigation System can be divided into three areas: head, middle and tailend. Most of the land in the head is tilled by the farmers of Harisidhi. In the middle, the land is tilled by the farmers of Lalitpur Town Panchayat and the people from Imadol till the land at the tailend of the system. Si Guthis manage the head and middle but not the tailend. The tailend people work individually or sometimes join with farmers from Lalitpur Town Panchayat during the desiltation of the canal. The farmers in the head and middle have little interaction in managing the system. The three groups manage their respective parts of the system by their separate organizations.

Organization of Farmers in Patan City

The farmers in Patan live in eight toles (sections of a street are known as toles): Dupat, Pilachen, Tyagal, Haku Tole, Saquo, Suwal, Dhalchess and Luchen. These eight toles together are known as Wachoo Khutwa. Most of the farmers are the tillers of Khonathu Faant (the middle section of the irrigation canal). The farmers in each tole manage the irrigation system through their Si Guthis.

About 75 percent of the farmers in Patan till land in the command area. However, even the Si Guthi members having no land in the command area are required to help desilt the canal when the Guthi so orders, A strict rule exists whereby everyone must obey orders issued by the Guthi.

In the Si Guthi the oldest member is a leader, called Nayo or Aaju. His orders should be obeyed by all members. Although decisions are made on the basis of majority, the voice of seniors carries much weight. Generally, the heads of households of the tole become members of a Si Guthi but membership is not compulsory. All the members in these Guthis belong to Maharjan castes.

The eight Si Guthis of the different toles have combined to mobilize labor for the operation and maintenance of the system. Dupat Tole has taken leadership among these Guthis. This authority, as reported, was delivered by the Malla king and it continues to be recognized. Functions which include determining meeting dates and keeping records are the responsibility of Dupat Tole.

When a meeting is needed, three messengers from Dupat known as Kaajis inform six senior members (Aajus) in the different Guthis. The decisions taken in the meeting are then conveyed to the appropriate Guthi member.

Organization of Farmers in Harisidhi

Similar to Patan, there are four Si Guthis: Raj Guthi, Etagu Guthi, Mydyagu Guthi, and Sallagu Guthi operating in this area which also perform management functions for the irrigation system at the head. All the people in these Guthis are from the Maharjan caste of the Newar ethnic group. Every household head of Harisidhi Panchayat is a member in one of the four Guthis. Even the migrant Maharjans in this area have been included in these Guthis. There are altogether 655 households including nonmembers.[2] There are only five families from non–Newar communities in the village who are not members of these Guthis and who need not contribute to operation and maintenance of the system.

Raj Guthi is recognized as the main Guthi in this area. It has the largest number of members and has been in existence for a long period of time. The directives issued by Raj Guthi are binding upon all the other Guthis in the area.

Various Guthi leaders perform specific functions for the organization:

1. Nayo: Nayo (leader) is the oldest member of the Guthi, and he is in charge of all Guthi activities. Other members act according to his direction.

2. Madaa: The madaa receives his position on a hereditary basis. His responsibility is to keep the account books. He is also responsible for mobilizing its members to collect firewood on the date fixed by HMGN. On that day they are allowed to cut the living trees in Pulchoki forest. The collected firewood is used only for cremating the Guthi members.

3. Paala: The paalas are Guthi members responsible for organizing different ceremonies. This responsibility is rotated annually to other members of the Guthi. There are four paalas in the Raj Guthi, three in Etagu, two each in Mudyagu and Sallagu Guthi at a time. During their term, they are responsible for informing members when work is to be done on the irrigation

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[2] A son maintaining a household separate from his father is considered a nonmember until the death of the parent, whereby the son becomes a Guthi member. Nevertheless, the son is expected to contribute 3.5 kg of rice to the Guthi each year so that his family can receive the Guthi's assistance when needed. There are 204 members and 300 nonmembers in Raj Guthi, 50 members and 57 nonmembers in Etagu, 30 and 14 in Mudyagu and Sallagu respectively.

canal. Paalas keep records of absentees and forward the information to the Guthi for punitive action.

Water Allocation and Distribution

In this irrigation system, within a section, there is no hard and fast rule for allocating water to a particular field. Wherever the farmers need water they open the canal outlet and irrigate their land. After getting enough water, they either channel it to another field or they close the outlet in the canal,

However, as reported by the farmers, there was an order issued by the then Rana Prime Minister, Judha Shamsher J.R.R. that farmers cultivating fields at the head should finish paddy transplantation before the end of June (15th of Ashadh on the Nepali calendar). This practice later became the rule. Therefore, farmers in this area usually transplant the paddy from the middle of May (beginning of Jestha) and finish before June. The turn then goes to the farmers cultivating in the middle part of the command area. In both places, farmers get enough water to their land for the transplantation of paddy.

There is another understanding: all land is to receive water for transplanting paddy before water can be re-distributed to the head where they have already used water for transplantation. There is no law regarding this. However, it is socially accepted that everybody should plant the paddy first, and unacceptable to get water repeatedly to the detriment of the transplantation of paddy of others. However, when there is no rain, the farmers at the head sometimes apply water repeatedly to their land. The farmers consider this water stealing. In order to check such malpractice the farmers in the middle area guard the canal. The canal gatekeepers/guards (dhalpas) continue their supervision until all the farmers finish the transplantation. The dhalpa system is usually only necessary during drought or if the monsoon is late.

For water allocation, land adjoining the canal receives first priority. Water is allocated according to land size. Water is usually allowed to reach a level of nine inches in the field before it is then channeled to adjoining land sequentially. This is easily achieved because the land is terraced.

For water distribution, no devices are used. There are outlets in the main canal as well as in the branch canals. When the farmers need water, they open the outlet in the canal. After using water, they close the outlet with mud known as chapari along with some bushes and stones. To channel the water from one terrace to another they make an opening in the bund and divert the water. This is the common field-to-field irrigation practice. During the season most farmers remain in the field awaiting their turns for water. In the middle section of the command area the dhalpas supervise the distribution.

Resource Mobilization

In order to manage the Kodku Irrigation System, Si Guthis mobilize labor for desiltation and canal repairs, and organize the dhalpas to guard against water stealing. They also assign the waa paas, who guard the ripe paddy crop from thieves.

Role of the farmers within Lalitpur Town Panchayat. In the past, when the intake washed away or needed major repair due to changes of the river course, a lot of labor and materials had to be mobilized. If the damage was beyond the capacity of the farmers, the farmers would request that the town brigade[3] provide assistance. The brigade would provide army personnel and materials (bamboo and wooden sticks) for the repair work.

There was a religious belief that iron implements should not be used in constructing the intake and everything should be done by hand. Thus, when they had to divert the stream they used bamboo and wooden sticks.

The annual task of desilting the canal is begun by the farmers of Wachoo Khutwa on the first of July (15th of Ashadh). Shortly before this date, a team of farmers including messengers from Dupat assesses the damage in the canal and reports to the Guthi members.

All Si Guthi members must be present at the time of desiltation. Persons absent from work are fined by their Guthi, which keeps records of attendance. The fines vary from one Si Guthi to another. Previously, the fine amounted to less than one cent U.S. but due to inflation the fine has been raised to approximately U.S.$1.00. The actual amount of the fine is not as important as is the social sanction which it enforces. Consequently, it is reported that relatively few people remain absent from the work.

When major repairs of the canal must be undertaken, a meeting is held in Dupat Tole where the area to be repaired is divided into parts and each part is assigned to a different Si Guthi.

During water shortages, the people from Wachoo Khutwa guard the canal. This practice continues until all the farmers complete paddy transplantation work.

Each of the five main Guthis send four persons (previously it was eight persons) and each of the three smaller Guthis send two persons each as guards (dhalpas). The 26 dhalpas are divided into three groups, each assigned to guard a particular area: the intake site, the water spout in Thaiba, and in Khonathu (the middle section).

The dhalpas at the intake are responsible for the canal section as far as Thaiba. The Thaiba dhalpa guards the canal up to the brick factory, and dhalpas staying in Khonathu are responsible for the rest of the canal. Each tole has a specific responsibility. Four people from Sunwal tole and four from Peenchen guard the intake. Four dhalpas from Dupat and four from Pilchen toles supervise the middle section, and ten persons from the four remaining toles are assigned to Thaiba.

The turn of the dhalpas is decided by the respective Si Guthi. Their responsibility is to operate the canal and prevent water stealing. The dhalpas staying in Khonathu also have to supervise the distribution of water in the field. The dhalpas do not get any remuneration for their work. It is their obligation as members of the Guthi.

In the past, there were often incidents of stealing the paddy from the field since the farmers of this area live far from their farms. To prevent this, the farmers from Wachoo Khutwa assigned people to guard the paddy fields at harvest time. The guards rotated duty. Usually only 20 guards were required.

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[3] Prior to the overthrowing of the Rana regime in Nepal in 1951 there was an Army brigade in Lalitpur located at Lagankhel whose responsibility was to maintain law and order in the area, similar to the Chief District Officer at present.

If somebody was caught stealing paddy, he or she was handed over to the brigade for punishment.

During the time of drought, farmers from Wachoo Khutwa and Hnrisirlhi visit Naudhara in Godavari to pray to the snake god for water. On that occasion, representatives from each house in Wachoo Khutwa and Harisidhi go to worship the snake god. The Rana government would provide a goat. and money for two Buddhiat Bajracharya priests to worship the snake god in Naudhara, and a goat is sacrificed to the goddess Fucha mai in Pulchoki. Then the farmers return and walk along the canal, asking for rain. On this occasion, all the members are not compelled to attend, but usually everyone would be present.

When the monsoon arrived too late for paddy transplantation, the brigade supplied pea seed to the farmers so that the land would not remain fallow.

Role of the farmers in head area. The farmers of this area mobilize labor for canal repair and operation. Generally, repairing and desilting this part of the canal is less problematic. The farmers at the head have only a small stretch of the canal to maintain. They usually transplant paddy during the middle of May (first week of Jestha) when the monsoon has not yet started. Therefore, there are less chances of changes in the course of the stream, and usually less repairs to the canal are needed.

If the canal is damaged, the Guthi members of the area organize for the maintenance of the canal. The leader of Raj Guthi and other members hold a meeting at which they estimate the amount of work needed to make the repairs, divide the duties among the various Guthis, and then make assignments to their own members. The paala relays the division of work assignments to the paalas of the other Guthis in the area, The paala is responsible for informing the members of his Guthi and he also keeps the record of absentees. Defaulters are fined and the funds raised from fines are kept in the Guthi's treasury. The names of those members who have already participated in the work are recorded and they need not contribute labor again until all the members have contributed.

Once all the members and nonmembers of a Guthi fulfill their duty the paalas inform another Guthi and it becomes the responsibility of that Guthi to work in the canal. This continues until all the members of the four Guthis complete their turns. All the members and nonmembers of the four Guthis may not finish their turn of duty in a year, in which case the turn rotates into the next year.

During a drought, the members of these Guthis also worship the rain god in Naudhara of Godavari. If it has not rained by the first of July (15th of Ashadh) the madaa collects money from each member of the four Guthis to pay for the offerings to the rain god, asking for rain for their lands. All members of the Guthi are not required to participate in the worship, but few farmers miss this event.

Conflict Management

Generally, there are few conflicts over water allocation and distribution among the members of a Guthi. Differences of opinions are usually resolved in Guthi meetings. However, when there are conflicts between the people of the head and middle sections of the system, the brigade is called in to resolve the dispute. Most of the conflicts occur during plantation time when farmers in the head area sometimes apply more water at the cost of plantation in the middle area.

The dispute is resolved in a public meeting held at the public court area of Lagankhel. The farmers and public gather to hear the case as put forth by the respective parties, and the colonel gives his decision. If punishment is necessary, the colonel determines what it should be. The culprit might be locked up in the army camp for several days, or he might be released after giving a written bond. In the case that the colonel of Lalitpur is unable to resolve the problem, he forwards the case to the Sundhara Brigade of Kathmandu, which is the headquarters of the three brigades of Kathmandu, Lalitpur, and Bhaktapur. Most cases referred to the brigade involved water stealing.

Aftermath of Rehabilitation

Under a program of rehabilitation, the DIHM took over the responsibility for the regular maintenance of the system. It hired government dhalpas and set aside funds for annual maintenance. Table 1 shows the operation and maintenance expenditure by DIHM for the Kodku system from 1983 to 1986.

However, the farmers say that the system has deteriorated since government has assumed responsibility for maintenance and operation. The government funds are insufficient to undertake necessary improvements and the dhalpas from DIHM do not take full responsibility for the operation and maintenance. When the system was run by the farmers a regular schedule for maintenance was followed and everyone knew the dates when the work was to be done. Now the Guthis are never sure whether DIHM will do the repairs and complete them in time. Due to lack of funds, maintenance is sometimes not performed. By the time the farmers realize the problem, it may be too late for agricultural activities.

Table 1. Actual operation and maintenance expenditure by DIHM for the' Kodku System from 1982/83 to 1985/86.

Fiscal year	Operation (Rs)	Maintenance (Rs)
1982/83	15,200	83,120
1983/84	24,595	234,363
1984/85	19,800	141,509
1985/86	11,200	97,969

CONCLUSION

This irrigation system is an old and traditionally community-managed system. The Si Guthis of the Newar ethnic group have been involved in the operation and maintenance of the system for a long time. With the intervention of DIHM in 1965 there has been structural improvement in the aystem thereby reducing the burden of labor mobilization to some extent. However, lack of communication between farmers and DIHM dhalpas in the O&M and the apathetic attitude of the DIHM dhalpas have affected the effective management of the irrigation system.

INSTITUTION BUILDING AND RURAL DEVELOPMENT IN NEPAL: GADKHAR WATER USERS COMMITTEE

Upendra Gautam[1]

INTRODUCTION

Building institutions in rural areas has become an important task for development projects undertaken by the government. The idea **is** that without decisive involvement, neither the benefactors nor the beneficiaries can fully identify with a project and donated resources will not be utilized effectively.

The government has now developed "users' committees" at the rural project level to increase the involvement of the beneficiaries. Formation of these committees is consistent with the Decentralization Act of 1982, which states that enlisting maximum participation from the local people in managing scarce resources and equitably distributing the fruits of development would promote the welfare of the whole population. The Act specifically provides for users' committees in Clause 19. Clauses 35 and 85 of the Decentralization Regulations laid down in 1984 stipulate that the committees would be responsible for the operation and maintenance of rural projects and for the collection of taxes levied on services delivered by the project. This would institutionalize a pattern of self-reliance in the rural development process.

FOCUS OF THE STUDY

Documentation is needed in the areas which have begun to build institutions to monitor ongoing projects, and it is the purpose of this paper to record part of this process.

The study focuses on the Gadkhar Irrigation Project Water **Users** Committee (WUC). It assesses the Committee's capacity for: 1) maintaining harmonious plural memberships; 2) distributive equality across command units; and **3)** sustaining the irrigation system.

The Users Committee is jointly managed by panchas (elected officials of local government agencies), public personnel, and users' representatives. There is a complex mix of political, bureaucratic, and socioeconomic influences in the organization which manages the physical structures. These diverse interests influence water allocation and distribution and the irrigation users' behavior.

OBJECTIVES OF THE STUDY

The major objectives of the study are to:

1. Examine relationships among the users' representatives, panchas, and public personnel involved in **the** Users' Committee, and the effect of these relationships on their ability to carry out the tasks required;

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2. Assess the capacity of the command units in terms of their accessibility and the extent of the Committee's ability to distribute irrigation resources equitably;

3. Identify the relationship betweer the status of the system and the Committee's ability to meet the system's maintenance requirements.

METHODOLOGY

Comparative analysis was used on information primarily gathered **from** organizational groups. Three groups were identified to meet the first objective of the study: the users' representatives, panchas, and public personnel involved in the Committee. The first group was categorized into classes in terms of land holding, ethnic group, and location status. Panchas were divided into incumbents and landholders. The public personnel were from agricultural and irrigation sectors.

To meet the second objective, the general users were taken as the reference group. They were organized into command units in terms of each unit's access to the irrigation facilities: head, middle, and tail.

For the third objective, attitudes of members of organizational groups towards resource mobilization to operate and maintain the system were identified. Information was sought on the formal (government) and informal (users) systems of operation and investment management. Members' attitudes towards public property, sanctions, and awareness of the status of the system vis-a-vis their values and expectations were ascertained.

The study was mainly empirical. All the members of the Water Users' Committee (WUC), 20 percent of households in the command area (20 households each in the head, middle, and tail units of the command, chosen at random from lists obtained from the Subdivisional Irrigation Office in Battar, Nuwakot), and relevant persons associated with the system were separately interviewed. Participant observation provided insight into the workings of the Committee. Gadkhar Irrigation Project was visited in June and August, 1986. Secondary data was collected from the WUC's Minute Books, the DIHM (Department of Irrigation, Hydrology and Meteorology), the Central Region Irrigation Directorate, and Battar Irrigation Subdivision Office (ISO).

BACKGROUND

Gadkhar Irrigation Project (GIP), which covers 105 hectares (ha) of land, lies in Choughada village panchayat of Nuwakot district, in the Central Development Region of Nepal. GIP is 12 kilometers (km) southeast of Trisuli, the district headquarters. Trisuli **is** linked **to** Kathmandu by a 70 km secondary highway, built to transport materials and labor for the construction of the Trisuli Hydel Plant in 1965. Gadkhar is difficult to reach by vehicle, especially in the monsoon, as there **is** no bridge over the Tadi River which separates the village from the mud road that **starts** off from Gungate, on the Kathmandu-Trisuli highway.

External Assistance

GIP was an offspring of the Rasuwa-Nuwakot Rural Development Project, financed by the International Development Association (IDA) and the International Bank for Reconstruction and Development (IBRD). These two donors provided 67 percent of the irrigation construction costs. The other third was borne by His Majesty's Government of Nepal (HMGN). The design, construction, and implementation of GIP were done under the umbrella of the DIHM. The project cost US$ 134,555 (NRs 2,946,743) to construct. Construction was started in 1979 and finally completed in 1982.

Between 1983-86, a total of US$ 44,642 (NRs 977,651) was invested in project maintenance and renewal works. Over this period, the per ha average maintenance and renewal costs were US$ 106 (NRs 2,328) each year. This increased substantially with the additional cost of an increasingly frequent labor contribution. The users also bore the cost of panipales (water guards). Each household would supply one pathi of paddy (about 3.6 kg) which would be equally divided among panipales as wages.

INTERRELATIONSHIPS AMONG MEMBERS OF THE WUC

The first WUC was constituted in 1980 to assume responsibility for operating and maintaining the irrigation system. Specifically, it was to set and enforce policies relating to water use (Peabody 1983). The engineer at the Battar ISO/DIHM, who was implementing GIP supervised its formation.

The farmers' assembly was presided over by the pradhan pancha (chairman of the village political unit). He was unanimously elected chairman, and 14 others, including a vice-chairman and secretary were also chosen. The irrigation engineer, overseer, and agricultural assistant were invited to attend.

Composition of the WUC

There were three Brahmins, eight Rais, one Chhetri, one Newar, and two others on the Committee. Four members were panchas; the rest considered themselves more users' representatives than panchas. There was no formal representation of public personnel in irrigation or agriculture.

Relationships among members of the committee were characterized by rank undiscipline. The vice-chairman was involved in more than one deliberate breaching of the branch II canal at the head, in order to divert water to his farm. The irrigation engineer ordered his personnel to repair the canal breach out of the maintenance budget. For various political and social reasons, the irrigation personnel became increasingly dependent on the vice-chairman, and the more the local farmers saw them hobnobbing with him, the more the farmers distrusted them, which in turn pushed the irrigation personnel further towards the panchas. The history of the area may throw light on how such a situation developed among a majority of the local farmers.

Historical Perspective

The head unit of the command used to be a large mango grove. It was a horticultural estate belonging to the Rana family. On the death of the Rana owner, the estate was divided into seven equal parts for his six sons and wife. The Rais, an ethic group who lived on the periphery of the estate, were considered inferior by the estate owners and were not allowed on the premises.

The death of the sole owner, the fragmentation of the estate, and the new laws stripping the Ranas of their power caused anarchy in the area. People tried to encroach upon the estate from all sides and take as much of the horticultural property as they could. A Newar businessman who was a pradhan pancha, and a Brahmin pancha took the opportunity to convince the heirs to the estate to dispose of their part of the estate. The Newar managed to pool enough resources from several buyers to purchase a major portion of the estate for himself. Then he cleared the horticultural resources for commercial gain, and resold the estate in plots to those buyers from whom he had already collected money. These buyers were predominantly Brahmins and Chhetris.

The Brahmin pancha purchased part of the estate directly from one of the deceased owner's sons. Thus, the estate was populated by Brahmins and Chhetris, who filled the socioeconomic vacuum left by the Ranas. The Rais did not gain at all from the changeover.

The Rais' point of view. The Rais felt that the irrigation project was for the benefit of the elite group living in the head unit of the command, In 1979 they opposed the project as they felt that what was a communal river and supply of water would become tied up in a system that excluded them.

The way the project developed in its initial years (1979-81) only strengthened the Rai's notion that it was to serve the local elite. A farmer was deprived of his water mill upstream because it was using water from the Likhu River. The farmer also lost part of his land to the canal. He has not yet received compensation.

The Rais noted that in the first two years of the project's phased water delivery, most of those who practiced irrigated agriculture were head unit, high caste people. Rais were pressured into selling good pieces of land that were favorably located in terms of the irrigation network. The buyers were quick to anticipate an increase in the value and agricultural productivity of the land. It has been estimated that the Rais lost over 10 percent of their land to high caste immigrants.

The committee chairman, who was an immigrant himself, seemed reluctant to open cases of illegitimate water diversion by his committee colleagues for public hearing, or to punish the guilty. The committee's failure to punish its own errant members affected its legitimacy. The head unit farmers enjoyed license to tamper with the canal anywhere and take the quantity of water they wished, whereas it was difficult for the middle and tail unit Rais to get the water they needed. The situation divided the farmers both at the command level and at the committee level. Many members began to feel that the chairman and vice-chairman were siding with the high castes and bullying the lower ones.

Irrigation officials did not contribute to harmony and equity. The engineer would informally allow high caste influential farmers to open new outlets unilaterally. The overseer was responsible to the engineer and to the committee. He did not have the power to correct or punish violations of the distribution system, and it was impractical for him to antagonize the committee's influential high caste pancha leaders.

The relationship between the committee and the water users often rendered committee decisions on water allocation and enforcement of sanctions against rule violators redundant. The committee was not able to bring its plural membership together to realize its purpose in a positive way. Although 8 out of 15 members were Rais they were too weak to correct the imbalance.

Another general assembly of users replaced the first committee with a new one in 1982. By this time, the village panchayat had a new pradhan pancha and the new committee was chaired by him.

Subsequent WUCs. The new chairman was a Rai who therefore represented the majority ethnic group in the command area, although this time they did not constitute the majority on the Committee (4 out of 11). He himself held less than ten ropanis (one ropani equals 0.13 acres) of land in the command. He was the first pradhan pancha to be elected by universal adult franchise, a system adopted in 1980 when the Third Amendment of the Constitution became effective. The controversial chairman and vice-chairman of the first committee both got membership positions on the second.

This reorganization probably reflected the users' concern to make the WUC ethnically broad-based and make it a more representative agency of cooperative relations among the communities that managed land in the head, middle and tail units. From a socio-organizational perspective this was an outstanding effort to sustain the users' divergent irrigation interests in terms of ethnic group, land ownership, and geography.

A perspective on 1981-86. Between 1981 and 1986 the water users of Gadkhar have elected five WUCs: a total of 58 members. A few were elected several times. Undisciplined water users were sometimes elected to the Committee. This was an attempt to make them accountable for a cause that called for collective cooperation and equitable irrigation management. A tradition of giving almost ex-officio membership to the Agricultural Technical Assistant and the irrigation overseer, was broken in later years since the users were interacting with these people less and less. In the last five years the total membership of the five WUCs decreased from 29 to 26 as public personnel were no longer included.

A majority of the Committee members were politically affiliated (54 percent), although 57 percent were non-incumbent and only 43 percent owned large pieces of land mostly at the head of the command. Rais constituted the largest single group (50 percent), followed by Brahmins (19 percent), Chhetris (11 percent), and Newars (8 percent). Most members were big landowners, with 31 percent and 27 percent in middle and small landownership strata respectively. Committee members equally represented the different locations in the command.

No important relationship between ethnic identity and land ownership status was noted. The Rais made up 23 percent of the big landholders, and the Brahmins were equally divided between the big and medium landholders. Each caste group had at least one politically affiliated member, except the Chhetris. Both Newars were panchas. Though one tenant and one big landowner were elected to all five Committees, it is clear that more farmers from the medium and small land ownership bracket were repeatedly re-elected than from the others.

CAPACITY AND IRRIGATION ACCESS OF THE COMMAND UNITS

Most land that was supplied with irrigated water was tar (flat highland) lying between two rivers, the Tadi and the Likhu. The former flows along the north boundary of the command area, and the latter, the water source of the project, flows along the south side. Ethnic groups were not evenly spread over different quality land in terms of access to irrigation, ability to use fertilizer, soil texture, and topography.

Ethnic Groups and Land Distribution

Although a majority of the households in the command area are Rais, only 27 percent of them lived in the head unit. All the Brahmin, Chhetri, and Newar households were located in the head unit.

Choughada Agricultural Subcenter Official Report of 1986 gave the following socioeconomic data on the Gadkhar command. There were 230 households of 1,610 people. Small landowners made up the largest group (45 percent), followed by marginal landowners (24 percent), medium landowners (20 percent), and big landowners (4 percent). Five percent were landless and the average landholding size in the command was 0.5 ha (10 ropanis), with the highest average at 0.83 ha and the lowest at 0.25 ha. These figures exclude land owned by Chhetrapal School and land under guthi (socio-religious trust).

What emerges from the findings is the fact that the Gadkhar command head unit was socially and economically dominated by Brahmins and Chhetris. They were strategically placed in terms of access to irrigated water. They used chemical fertilizers to compensate for the chemical deficiencies in the soil. The Rais were overwhelmingly the largest group in the middle and tail units, but their landholdings were smaller that those of the Brahmins. Some of their land was less productive than the soil in the head unit, but some had a clay-based soil and could match the latter's paddy and maize production. The tail unit farmers could not afford to use chemical fertilizers. If they could, they might substantially increase summer paddy yields.

WUC's EFFORTS TO DISTRIBUTE WATER EQUITABLY

Almost six months before the formation of the first WUC, GIP reached a stage in construction when water was released onto two ha owned by a Brahmin who used it to prepare paddy seedlings.

In the second year, water was released to 93 ha in the command. The Committee meeting held in 1980 set rules for rotational distribution of water, because it found that there was too little water for continuous irrigation throughout the command. Water would be released through one branch canal at a time. It would be distributed through the set tertiary pipe only. Distribution channels would be built after consulting with irrigation officials. The Committee also agreed that as there was not enough water, a ceiling would be fixed on each farmer's area of irrigated agriculture.

The rotational distribution schedule was for both wheat and an early paddy crop. It was decided that all farmers should grow summer paddy on 25 percent of their land, and traditional maize and millet crops on the other 75 percent (Committee Minute Book 1980). These decisions were rarely enforced. Farmers took water from wherever they could and cultivated summer paddy over large areas, despite the ceiling. This resulted in a shortage of water and unequal distribution of what was available.

Distribution Schedules

At a second major meeting held in 1981, the Committee decided to change the four-day rotational schedule to a five-day one, as the earlier one could not meet the users' requirements. It also elaborated on the method for water allocation in each branch canal area. Ostensibly for equity purposes, priority was given to tail unit households.

The second water distribution schedule was an improvement over the first: it was more equitable in terms of branches I and II and branches III and IV, water distribution priority was given to the tail unit users, and the area to be served was delineated geographically.

Unfortunately, these improvements were only put down on paper; the four-day distribution schedule continued in practice. The four-day rotation schedule had a built-in bias in favor of branches I and 11. The two branches, which irrigated a total of 31 ha, were given water for 48 hours. There were widespread complaints from tail and middle unit farmers of branches III and IV of not getting enough water. Possibly more revealing was the fact that the tail unit farmers of branches I and II also complained about the erratic supply. The committee leaders--the chairman and vice-chairman--were head unit users of branches I and II. A new four-day rotational distribution was activated that was to be effective from the 1982 summer paddy, because of water scarcity (Committee Minute Book 1981). By this time, irrigation water could potentially reach the entire command area.

The distribution bias continued, though this time the tail unit was given equal chance to get irrigation services. They continued to complain about the illegitimate canal breaches and water theft in the head unit, and the erratic supply.

On the advice of the engineer, the Committee decided that summer paddy should be planted on 50 ha of land, and millet on another 50 ha. No user heeded this suggestion and they continued to grow paddy on larger than prescribed areas, stealing water, and illegitimately breaching canals to do so. Later, the Committee admitted that it could not implement its decision. It felt that the intake of the system was too low, so it was suggested that the Irrigation Subdivision increase the system's capacity. At that time, they decided on a new rotation schedule which was unique in that it demarcated command units into more specific sub-command entities. For example, of the 32-hour supply given to the tail unit, water specifically flowed into one area of the tailend for 16 hours, and the second 16-hour supply flowed into another area.

Despite measures to be equitable, the problems of water theft and canal breaches continued, so the WUC decided to form a sub-committee for supervision and control of each branch canal. In a later meeting, these branch level sub-committees were reshuffled and authorized to punish those found guilty of water stealing and canal breaches. The punishment for each crime was fixed in the form of fines ranging from US$ 4.57-22.84 (NRs 100 to NRs 500). Private, overlarge, channel level distribution pipes were removed. A nine-day rotational schedule was adopted with branches I and II receiving water for 96 hours, and the other two for 120 hours.

In 1984, the nine-day schedule was replaced with the five-day one which had been proposed in 1981. Within 30 days the decision was amended as the committee tried hard to adapt to changes in water availability. The WUC also decided to dissolve the branch level sub-committees on the grounds that each branch had a representative on the main committee.

The WUC did not have problems of illegitimate water diversion in the command area alone. Farmers who had developed cropland just below the five kilometer idle main canal were now using water straight from the main canal.

WUC Persistence

The WUC's persistence in finding a rotation pattern that would allow a scarce resource to be distributed equitably was impressive. It was at pains to admit that despite these efforts, conflict and tension during rotational water distribution was increasing over the years (Gadkhar households were divided on the question of whether discipline levels had improved or declined). A farmers' general assembly was convened in 1985 to discuss the issue and a resolution was made. The resolution provided a new position of two panipales (water guards) in each branch canal who were employed by the committee. Their main duty was to distribute water equitably. They were solely employed at summer paddy time when the conflict for water was at its highest.

The panipales were a remarkable innovation. Although the middle and tail unit farmers were happy, the head unit farmers felt that panipales were a useless investment. In anticipation of such an attitude from the higher castes, the assembly nominated a high caste, head unit farmer as adviser to the present Committee on water distribution. The new Committee found the panipales to be useful and satisfactory *so* the arrangement was continued through 1986. However, some problems arose. Head unit farmers gave incorrect quantities of grain as payment for the panipales. The panipales felt that some of those they had caught stealing were not punished and therefore that the job was not worthwhile. The head unit farmers thought that the committee was simply shifting its responsibility for equitable water distribution onto some petty wage earners.

Communication

The users were not uneasy about *so* many institutional changes and innovations. They were aware when they were entitled to water, of the water allocation entitled to each branch **of** the command area, and limitations or constraints on access. This shows that the WUC maintained close communication with the farmers and made sure that they understood every decision.

The committee introduced all the major changes at the farmers general assembly which functioned as a mass communication mechanism. The committee was elected and structured in a manner that allowed representation of all four branch canals. Whenever the Committee made an important decision regarding water distribution, a representative from each branch would brief his fellow farmers. In addition, the panipales could inform farmers of any decision that related to them. **All** meetings and general assemblies were recorded in a Minute Book maintained by the member-secretary of the WUC. All decisions were taken formally: an agenda would be fixed by the Committee, a date and place agreed upon, and the signatures recorded in the Minute Book of all those who attended.

WUC AS RELATED TO THE STATUS OF THE SYSTEM

WUC members were also aware of the state of the Gadkhar Irrigation Project. They were aware of organizational problems and that the physical state of the project was seriously interfering with the Committee's potential for organizational growth.

An overwhelming majority of WUC members mentioned the following detrimental physical characteristics of the Project: 1) bad links between the intake and the river; 2) narrow canals that cannot contain and convey monsoon water; 3) emergence of new cropland between the river and the intake; 4) emergence of 20–25 ha of agricultural land just below the five km idle main canal; 5) indiscriminate insertion of distribution pipes of different sizes by irrigation officials; and 6) unstable, slide–prone sections along the main canal.

The project's physical state had been largely responsible for the promotion of certain organizational issues. The Committee was able to handle many of these issues, but not all. It mobilized the necessary labor every year to maintain/build a link canal or feeder channel between the intake and the river, and to restore unstable sections of the main canal destroyed by landslides. It took the initiative in demanding first rights to the water from farmers who had started to cultivate the area between the intake and the river.

However, the Committee was not *so* successful in preventing the indiscriminate insertion of varying sizes and qualities of pipes. This reflected a certain degree of manipulation as the more influential, high caste farmers laid the biggest pipes and therefore received the most water. With the introduction of panipales, the Committee had tried to control the release of water through the pipes, whatever the size, so that every farmer had three inches of water covering their summer paddy, but they did not exercise enough control.

Structural problems hampered efficient water conveyance and equitable water distribution. WUC members felt that the initial structural design was at fault and stressed that even though the water in the Likhu River was sufficient for nine months of the year, they were not getting enough water to irrigate their fields.

Irrigated farming below the idle main canal was diverting water illegitimately to farmers outside the command, adding 25 percent to the irrigated area. The Committee repeatedly suggested ways to tackle the problem. They pressed the <u>dhalpales</u> (government–employed canal guards) to be more vigilant, but during the night they could do nothing. The Committee tried a conciliatory approach at the last 1986 meeting. They offered farmers an agreement which would insure access to the water every 96 hours. This has come into operation recently and seems to be working, but the Committee has found itself supplying a much larger area than originally anticipated.

EXPECTATIONS

WUC members have had high expectations of the project for a long time. However, they feel that the future of the irrigation system is insecure due to the lack of a clear–cut government program that defines the government's responsibilities and their own for the system. Furthermore, their experience with the erratic performance of the government regarding the fulfillment of its maintenance responsibilities has made the committee members skeptical as to its fulfillment of promises in the future.

All WUC members perceived labor mobilization for system maintenance as critically important. It was increasingly felt that the Committee substantially filled the serious lapses and gaps in the public bureaucracy. It was becoming more involved at all levels of system management.

One year after the system went into operation, it became apparent that a new feeder channel had to be ouilt every year, to feed water into the intake. The Likhu River channel had shifted almost one km to the south. The Committee had to mobilize villagers to excavate the channel. Simultaneously, they had to perform the task of cleaning landslide debris out of the main canal and regular field canal maintenance. The Committee became more involved in maintenance each year, as the problems and defects of the system were revealed. The original design had not included structural facilities to drain excess rain water, and mud slides caused by deforestation on higher reaches of the main canal had made the canal portion with buried hume pipe more unstable.

The increasing preoccupation of the WUC with main canal maintenance, which was considered the responsibility of the Battar Subdivision, had an adverse effect on branch field channel maintenance and supervision. On several occasions, branch canals were left uncleaned. The Committee was aware of the situation and *so* organized the system of sub-committees for each branch canal mentioned earlier. Then they proposed to the Subdivision that it place its dhalpales whose task it was supervise the main canal repairs under WUC direction, thereby ensuring a continuous flow of water.

A major expectation is related to the construction of a new intake canal about one km upstream from the existing intake point to solve the problem of the gap between the latter and the river. Another pertains to increasing the capacity of the system. Water scarcity during the dry season was understandable, but non-availability during the summer monsoon months was intolerable. Members wanted larger hume pipe to be inserted along the canals to increase the capacity of the system. A suggested alternative was to link Gadkhar with a proposed irrigation project upstream at Simara. If Gadkhar could receive all the drainage water from Simara, it would solve Gadkhar's perennial water shortage. In response to queries, the WUC members replied that they could not possibly take over the system because they would not be able to maintain it. They felt they would need the technical supervision and assistance of irrigation officials to maintain some of the structures.

The farmers were wary of relying on the DIHM for assistance, even if they were assured of it. As one farmer explained, "even under the present arrangement whereby the DIHM is responsible for the operation and maintenance of the project, it took three years for them to release a grant to repair main canal damage". Fulfillment of farmers' expectations is a pre-condition for more responsible participation of the users in joint management of the project.

DECENTRALIZATION

Under the provisions of the Decentralization Act's Work Arrangement Regulation, and present policy level thinking, the GIP should have been handed over to the users for management. Legally, the users must have the leadership of the pradhan pancha and should function alongside the village panchayat. The WUC has met all these requirements.

A team of DIHM personnel visited the project at the beginning of 1986 and suggested that Battar Subdivision hand the overall management of it to the users. This suggestion was also made earlier by the Rasuwa-Nuwakot Rural Development Project Coordinator and his expatriate advisers. However, due to the physical state of the irrigation network, both the users and their pancha representatives were unwilling to take it over completely. Irrigation officials related to the project also felt that it should not be handed over until it had been remodeled. Estimates of the cost of remodeling ranged from US$ 27 398-US$ 91,324. According to the Subdivisional Assistant Engineer, the project was in the "poorest shape".

At the remodeling stage, the entire process would have to go through a different institutional channel. Under the Decentralization Act rules, Nuwakot District Panchayat. had to approve the resolution. It would then be referred to Battar Irrigation Subdivision for implementation (all field level developmental work agencies come under the District Panchayat Secretariat, in accordance with the provisions of the Decentralization Act). The District Panchayat has so far not touched the GIP as it is considered a central level project. In 1985, about 50 users approached the Local Development Officer with their grievances--the main one being the need for a new intake further upstream--but the District Panchayat Office could not respond in any meaningful way as the Project is beyond their jurisdiction.

CONCLUSIONS

Throughout the years, Committee members have upheld certain values that will eventually have a far-reaching impact on the institution and its future prospects:

1. They have been continuous and untiring in experimenting with new rules and regulations for water allocation and distribution in an effort to adapt to the needs of the users and physical changes over time.

2. They have steadfastly tried to make water distribution equitable, giving tail unit members priority and carefully selecting WIJC members so that all farmers were represented.

3. They have tried not to antagonize the high caste Hindu farmers who migrated to the area and took over strategically placed, good farmland, giving rise to sentiments such as "strong versus weak". The Committee's endeavors have helped the "weak" by giving them influential membership positions. Tail unit productivity increased as a result.

4. The Committee actively participated in system maintenance at all levels through massive labor mobilization and its belief that, irrespective of what is written in the Decentralization Act, it can manage the system only when the users and the DIHM cooperate to evolve a meaningful framework on which to build a capable institution.

The GIP case study highlights the struggle of a WUC to perform certain roles with the ultimate goal of distributing a scarce resource equitably. In its struggle, the Committee has repeatedly had to negotiate with interference from local politicians and elite. As the government proceeds to decentralize the operation and maintenance of irrigation systems, it must be recognized that WUCs are susceptible to a number of constraints including the physical limitations of the system, the need for government support for some technical expertise and monetary resources, and local power politics. Also, to function effectively, most members who have been repeatedly elected to the Committee feel that it needs authority to enforce sanctions on those who tamper with the system. It does not have sufficient power to punish abusers effectively. The decentralization process needs to consider the users' perceptions of what the) can reasonably manage themselves and what external resources, including technical and legal support, need to be provided by government.

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SECTION III: COMPARATIVE CASE STUDIES

COMPARATIVE STUDY OF PITHUWA AND CHAINPUR IRRIGATION SYSTEMS[1]

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INTRODUCTION

Farmer-managed irrigation systems are found in diverse environments and employ a wide range of technologies to exploit different types of water resources for the production of a variety of crops. All these irrigation systems require certain tasks to be accomplished if the system is to function productively. One set of management activities directly focuses on water. The water needs to be acquired, allocated, distributed, and if it is in excess, drained. A second set of management activities are concerned with physical structures for controlling water i.e., design, construction, operation and maintenance. A third set of activities focuses on organization to manage the water and the structures, i.e. decision making, resource mobilization, communication, and conflict management (Martin and Yoder 1986).

There is a positive interaction among the activities of these three sets for the operation and management of the systems and they have a direct impact over productivity. All the activities may not have equal priority in every irrigation system, however the priority is based on the need encountered in each specific situation (Martin and Yoder 1986).

The farmers' investment in irrigation in Nepal has gone largely unrecognized until recently, though over 70 percent of irrigation in the Tarai and over 90 percent in the hills are managed by farmers (Water Resource and Energy Commission Planning Unit [WEC] 1981). The pressing need to expand the use of irrigation for increased food production has prompted a search for new models and alternatives. Upadhyay and Koirala (1981:100-110) suggested that the experience, expertise, technology and knowledge that the local communities already have in building and operating the irrigation systems can be tapped by engineers and agriculturists for improving the performance of government-managed irrigation systems.

One of the first steps in understanding the farmer-managed irrigation systems of a country or a region is to document their nature, size, and the range of technologies employed in the operation of the systems. In order to incorporate farmer systems into the larger public sector irrigation development without losing the benefit of the experience and knowledge they present,

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[1] This material is based upon the work supported in part by the International Irrigation Management Institute (IIMI) and Institute of Agriculture and Animal Science (IAAS) for a project entitled "Water Resource Inventory of the Chitwan Valley Irrigation Management".

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irrigation activities and the ways in which the farmers organize to carry them out need to be identified and understood.

Therefore, a comparative study of the Pithuwa (agency-constructed and farmer-managed) and Chainpur (farmer-constructed and farmer-managedl irrigation systems in the Chitwan valley was undertaken to obtain data on organizational pstterns and irrigation activities such as repair and maintenance, resource mobilization, water allocation, water distribution and conflict management.

METHODOLOGY

Various informants within the command areas of the two irrigation systems were interviewed using a questionnaire. The questionnaire covered historical development, characteristics and performance of agricultural services and production, characteristics and performance of the physical system, and the social and institutional systems. Some unstructured interviews were also conducted during field visits to gain a general understanding of the irrigation procedures and farming systems.

The five-member study team walked from the head to tailend of the systems to identify the nature of diversion structures, characteristics and performance of conveyance structures, water allocation practices, and cropping patterns.

DESCRIPTION OF THE TWO IRRIGATION SYSTEMS

The Pithuwa irrigation system is a government-constructed farmer-managed system, named after Pithuwa Village Panchayat which falls within the command area of this project. The Chainpur irrigation system is a farmer-constructed farmer-managed system named after Chainpur Village Panchayat. Water has been tapped from the Kair Khola for both systems.

Though a perennial source, the discharge from Kair Khola diminishes considerably during the dry months. At the point of abstraction in the Kair Khola, water is diverted to the Pithuwa and Chainpur irrigation systems through separate intake structures. The point of abstraction of both systems being the same, water is diverted to the Chainpur system during the day and to the Pithuwa system at night during the dry season. Water is utilized for drinking purposes in the Chainpur system in the dry season since no drinking water facility is available. Although there is no written agreement, this understanding is strictly followed.

The canal network of the Pithuwa system extends through ward numbers one to nine of Pithuwa Village Panchayat except ward number six, which includes three villages in the command: Khairate, Madavpur and Pithuwa. The Chainpur system irrigates ward numbers three, eight, and nine of Chainpur Village Panchayat, covering four villages: Gaindehal, Kunaghari, Hatiledh, and Ladriko Dil. The command boundary of these systems is depicted in Figure 1. The command area of the Pithuwa system is 900 bighas (600 ha), whereas the Chainpur system covers a recorded command area of 98 bighas (67 ha). However, the actual irrigated area comes to a total of 233 bighas (158 ha).

Figure 1. Command area of Pithuwa and Chainpur Irrigation **systems.**

The Pithuwa irrigation scheme was implemented in 1967 under the minor irrigation program supported by the Regional Directorate of the Irrigation Department at a cost of Rs 75,000.00. A possibility for expansion of the command area was realized since the water supply in the Kair Khola was not a limiting factor for summer paddy cultivation. In 1971 the main canal was enlarged up to the Pithuwa market. Construction of outlets at the branch canals and modification of the old canal network were also accomplished. After the construction, the command area increased to 200 bighas (137 ha). The additional cost of construction was Rs 125,000, funded by the Department of Irrigation, Hydrology, and Meteorology (DIHM). To develop a better conveyance and regulation facility, a rehabilitation program was launched in 1974 which resulted in construction of a permanent head regulator, construction of a service road, and a number of outlets. The rehabilitation cost incurred was Rs 110,000, supported by DIHM. With these improvements, the command area of this system increased to 900 bighas (600 ha).

The history of the construction of the Chainpur system dates back to 1961 when the diversion and canal construction was started utilizing only local expertise and resources. The construction cost was Rs 1,800 and the operation started after July 1961. However, even during the monsoon, water was insufficient for irrigation. In 1972 a new canal was constructed with the intake approximately 3.5 kilometers (km) upstream of the old intake. The new canal was incorporated into the old system. This change provided sufficient water for irrigation during monsoon paddy season and drinking water during the dry season. The district panchayat provided Rs 17,000 and the technical assistance of an engineer to plan the canal alignment. The farmers mobilized labor estimated to be worth Rs 34,000 for the construction of the new canal.

Physical characteristics and distribution system

No permanent diversion structure exists in the Kair Khola for either of the systems. Every year an earthen weir is constructed by piling stones, sand, and dirt across the river. In the Pithuwa system water is diverted into the main canal through an earthen approach canal 75 meters (m) long from river to head regulator. After every high flood the weir and the approach canal are damaged, requiring frequent repair taking two to three days. A bulldozer has been provided by the Chitwan Irrigation Project to repair the approach canal and the weir during the rainy season. The network includes 16 branches and a main canal of 7.5 km. Piped outlets from the main canal have been provided at the branches. There are 19 masonry falls constructed in the main canal to stabilize the canal bed. The main canal runs in a north–south direction with the branches running east or west.

The designed discharge capacity of the main canal was 1,400 liters per second (liters/s) at the time of construction of the Pithuwa system. A heavy reduction in the carrying capacity of the canal occurred due to silt deposition in the canal bed. The canal is operated throughout the year. Over 600 households are served by this system.

In the Chainpur system a temporary check dam is constructed by piling logs, brush, and stones across the river to divert the water into the main canal. Water flow of 410 liters/s has been recorded in the Chainpur main canal (WECS 1985). The length of the main canal is five km with a trapezoidal cross-section. The canal network includes 10 branches to convey water to the farmers' fields. No change in the alignment has been made since the canal was first constructed. However, a few permanent structures such as flumes and aqueducts have been constructed after a major expansion program in 1972.

Temporary checks are made in the main canal at each outlet to divert, water into the branches. The amount of water allocated to each branch is calculated on the basis of area to be irrigated. Water allocation to branch channels is decided on a time basis. In the lean period, farmers get water through branch channels in rotations. Those who shared more labor and money for the construction of the system in the beginning have the right to sell water *to* other farmers not receiving water for irrigation according to the cumulative sharing of the cost of construction of the system. Once the share is sold to someone, the buyer of the land is entitled to water. Due to this the recorded command area is far less than the actual irrigated area.

Agricultural services and production

Farmers in both systems have adopted more or less the same cropping patterns. However, the farm sizes are smaller in the Chainpur system as compared to the Pithuwa system. Therefore, there is grenter intensification of farming practices in Chainpur, which has resulted in higher yields per unit of area in the Chainpur system. The other reason for higher yields in the Chainpur system is the cultivation of farms by the owners themselves. In Pithuwa village a share-cropping system is commonly practiced, resulting in relatively lower yields. In the share-cropping system the landowner provides all the inputs and the labor is supplied by the share-cropper. Each contract is valid for one crop season, particularly for paddy, and the product is distributed equally between the landowner and the share-cropper.

Paddy and maize are the major summer crops in both localities. The majority of the farmers grow paddy as the main summer crop. Among the winter crops, mustard and wheat are common. The cropping patterns in both areas are maize-paddy-mustard, paddy-wheat-fallow in the irrigated area. In the unirrigated areas the popular crop rotations are ghaiyapaddy (upland rice)-mustard-maize, maize-mustard-fallow, and maize-wheat-fallow. The cropping intensity is slightly higher in Chainpur (275-280 percent); in Pithuwa the intensity is 250-260 percent.

Masuli is a commonly grown paddy in both areas. 4 few farmers also grow IR-20 and IR-84 cultivars of paddy. RR-21, Lerma-54, and Siddartha cultivars of wheat are in extensive cultivation. Rampur yellow in summer and Arun in spring are the dominant varieties of maize in the area. In mustard, the Chitwan local variety is grown extensively. Although the Sajha Depot (cooperative) supplies chemical fertilizers and improved seeds, the sources of information for improved seeds and the use of chemical fertilizers are the innovative local farmers. Other minor crops grown in the area are black gram on the bunds of paddy fields and potato and other vegetables at the, kitchen yards and paddy nursery fields during winter.

The use of chemical fertilizers is limited to wheat and mustard crops in both systems. Nearly 95 percent of the farmers use chemical fertilizers for mustard, and 60 percent of them use it for wheat. However, the quantity of fertilizers used falls far below the recommended doses. The cooperative, located in Pithuwa Panchayat, is the source of supplies of these inputs for both systems. Farmyard manure is used extensively in both localities.

Free flooding is the common method of irrigation in both systems. The water holding capacity of the soil is medium to high. Furrow irrigation is limited to vegetables. The farmers rely on their own experiences to help them plan irrigation schedules depending upon the critical stages of the crops. There is no alternative source of irrigation in both command areas.

Organization for irrigation management

Strong organizational structures to supervise the ope-ation of and maintenance of the systems have been formed by the farmers of both systems through selection/election. The members of the organization decide the schedule of the major repair and maintenance program as well as resolve the conflicts arising due to water share and resource mobilization. The organizations are known as Kulo Samitis (canal committees) and have the respective functionaries shown in figure 2.

Figure 2. Functionaries of the Pithuwa and Chainpur systems.

Pithuwa irrigation system	Chainpur irrigation system
-Chairman (village pradhan)	-Chairman (selected/elected)
-Mahasachib-selected/elected (general secretary)	- Vice chairman (selected)
-16 members (chairpersons from the branch committees)	-10 members (one from each branch) (selected/elected)
	-Member secretary (elected)
	-Treasurer (selected)

In Pithuwa no water distribution policy was formulated after completion of the canal network by DIHM which resulted in conflicts over water shares. More powerful farmers encroached upon the rights of others. A prominent farmer of branch number 14 organized all the farmers of this branch into a committee. The committee formulated rules and regulations for water allocation and distribution of this branch. With the farmers' participation in the committee, the conflicts arising due to water share decreased quickly. The example set by this branch was observed by the farmers of other branches and they started organizing themselves into committees. Eventually all the farmers formed branch committees for water allocation and distribution. Once the branch committees started working satisfactorily a federation of branch canal committees was created by the elected/selected members of the general assembly of farmers known as Main **Kulo** Samiti.

The Chainpur system started with an irrigation system construction committee. This committee emerged as the Main Kulo Samiti after the water was released for irrigation. Those who contributed more labor and money for the construction of the system in the beginning had the right to sell water shares to others on the basis of cumulative sharing of the cost of construction, repair, and maintenance of the system. The selling of water shares started with the change of the source upstream which allowed water to be made available to an expanded area. This has created a feeling of equal ownership among the new members and hence, the Kulo Samiti is a strong organization. Other binding factors contributing to the development of a strong committee are the varied uses **of** water. The farmers are totally dependent on the water in the canals for household and livestock use. This has necessitated continuous repair and maintenance of the system.

The Chainpur farmers were engaged in a legal court case for the past five years due to the new irrigation canal diverting water from the same intake to cover an area at the upper side of the present system. The farmers had to spend more than Rs 60,000 for legal expenses. This has further acted as a strong binding factor for the unification of the farmers although they had to spend more money in the legal case than the cost of repair and maintenance. The farmers are highly motivated with the court decision court in their favor.

In both systems all farmers owning a water share are members of the general assembly. The general assembly meets once s year in the month of June in both systems. The date for the meeting is decided by the chairman of the Kulo Samiti. In the case of the Pithuwa system, Pithuwa Village Panchayat is the meeting place. In the Chainpur system, the meeting place is usually "Tilangeko Chhautaro," which is situated in the middle of the canal network. In both systems, at the general assembly a budget for the following year is formulated. Plans are made for major annual maintenance which begins shortly thereafter; new officials are selected/elected; and operating rules for the year are reviewed, amended, and formulated as necessary.

In Pithuwa, the chairman of the Main Kulo Committee is responsible for organizing, supervising, and coordinating the works done in the system. The mahasachib keeps the accounts, records of members, and records of water allocation and attendance at the work assignments, in addition to recording the minutes of the meetings of the Main Kulo Committee.

A similar organizational structure is followed in the branch canal committees. There are chairman, sachiv (secretary) and representative members of the branch. The number of members may vary as needed. The chairman of the branch committee represents the branch committee at the meetings of the main committee. He communicates the decisions made by the Main Kulo Committee to the branch committee and the farmers of that branch. The secretary of the branch committee keeps the records and implements the decisions of the branch committee. He supervises the water rotation schedule.

In Chainpur, the kulo chairman calls the meeting of the Kulo Samiti whenever there is a need to discuss problems related to the management of the system. The members from each branch are responsible for looking after the allocation and distribution at the branch level and the conflicts related to water shares. They are also responsible for repair and maintenance of the branch canal in addition to mobilizing labor and budget at the time of major repair in the main canal.

Resource mobilization for repair and maintenance

There is a major difference in the repair and maintenance practices between the two systems. The Pithuwa system was constructed by public investment and the maintenance of the main canal was done by Chitwan Irrigation Project until 1983. Thereafter Rs 100,000 was allocated by DIHM for the annual maintenance of the system. For the year 1986, the money made available for repair and maintenance was Rs 31,000. This money was handed over to the Pithuwa Main Kulo Committee. At present the Main Kulo Committee looks after the total maintenance of the system which includes desilting of the main canal, repair of the diversion structure, maintenance of service roads, and repairs of outlets. Though repair and maintenance of the main canal and outlets is done once a year, the diversion weir in the Kair Khola needs frequent repair. The committee has to set aside at least Rs 15,000 to pay for fuel for the bulldozer. The desilting of the main canal and branch canals is done by the farmers themselves. Additional cash required and labor contributions are raised from the beneficiaries on the basis of size of holding. The labor contributed last year for such repair was equivalent to 1,200 man-days.

In the Chainpur system two persons per household are required to wcrk when desilting of the main and branch canals and repairing of the intake structure is undertaken, irrespective of size of landholding. However, the monetary contributions for such works are decided on the basis of cropped area. For rehabilitation works which may include repair of dikes or construction of permanent structures, a contract is given. For such works the payment is made from the budget of the Kulo Samiti. Unlike the Pithuwa system, the budget includes the money collected as water fees (fixed by the Kulo Samiti, not the government fee), fines imposed on defaulters, monetary contributions from the farmers, and sometimes assistance received from local or district panchayat offices.

In both systems, there are standing rules and regulations for resource mobilization. However, Chainpur imposes more severe penalties upon defaulters than Pithuwa does. This is because Chainpur cannot function without effective local resource mobilization. On the other hand, farmers at Pithuwa had the full cost of repair and maintenance supported through government agencies. However, the situation during the last two years has changed and the Pithuwa farmers have gradually taken over the responsibility of repair and maintenance. Since the labor for maintenance work is contributed by the farmers themselves, farmers are reluctant to pay water fees to the government.

Conflicts arising due to water share are resolved at two levels of organization in the Pithuwa system: in the branch kulo committee and the main committee. The general secretary determines the penalty for defaulters depending upon the severity of the violation. Defaulters must either pay a fee of Rs 25 (approximately equivalent to wages for one day) or their share of water is withheld.

In the Chainpur system punishment varies according to the violation. If the water fee is not paid, the water supply is stopped until the fee is collected. If labor is not shared at the time of repair and maintenance a fine equivalent to the maximum wage rate is imposed. In the instances of water stealing, a penalty of Rs 50 to Rs 500 may be imposed depending upon the severity of the violation.

CONCLUSIONS AND IMPLICATIONS

Although the primary purpose of our study was not the comparison of these two systems, in the course of study some recommendations and their implications emerged.

1. An earthen diversion structure in Kair Khola requires huge inputs of labor and money for repair and maintenance as these structures are washed out after every high flood. A permanent or semipermanent diversion structure and river training work at the point of abstraction are urgently needed.

2. There is a remarkable increase in the command area of the Chainpur irrigation system resulting from the selling of water shares to new members who have to share the construction and repair costs. Selling shares was possible only after the source was changed, which made more water available. The system is getting stronger year by year in terms of resource mobilization and hence, more water is available for irrigation. Water is also used more efficiently with increased area and more resources mobilized for repair and maintenance of the system.

In the agency-constructed systems such as Pithuwa, expansions of the system are possible but intensification is extremely difficult once the agency defines the command area. For example, branch number 16 has been recently expanded, but intensive use of water is not possible because it is located at the tailend and was later expanded. Perhaps, as government grants for repairs and maintenance decrease, farmers will realize the need to use water more efficiently and perhaps even expand the area to generate sufficient funds for repair and maintenance.

3. The multifarious uses of water in the Chainpur system have necessitated a continuous supply of water in the canal. The need for drinking water has been acute in an adjoining area and there are instances of conflict between the farmers of the command area and outsiders. There was also a legal dispute over irrigation water. If standard water regulations are enacted by government, unnecessary expenses on legal cases could be avoided and resources spent for such cases could help to build common permanent structures at the source instead.

4. The farmers' intervention in the operation and maintenance of the system has improved the reliability of the water supply in the Pithuwa system. This suggests that perhaps repair and maintenance could be better accomplished with the farmers' participation rather than through government intervention.

5. The Pithuwa irrigation system's Main Kulo Committee and branch committees have had a remarkable influence on the intensive use of water throughout the year. Perhaps this is due to the large size of holdings and tenant cultivation practices. These have resulted in lower cropping intensity although water allocation patterns are similar to the Chainpur system. Chainpur system farmers on the other hand have higher cropping intensity and even higher productivity, particularly for winter crops due to intensive cultivation practices and owner-operated farming.

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A COMPARATIVE STUDY OF FARMER-MANAGED AND AGENCY-MANAGED IRRIGATION SYSTEMS

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OBJECTIVES OF THE STUDY

The primary objective of this study is to make an enquiry into the operational style of two irrigation systems in order to derive a logical base for farmers'/users' participation in the management of the Bhairahawa-Lumbini Ground Water Project (BLGWP), an irrigation system managed by the Department of Irrigation, Hydrology, and Meteorology (DIHM) of Nepal. The study is designed to make an independent study of some aspects of the Chhattis Mauja farmer-managed irrigation system and the BLGWP in the command area where the two management systems are functioning and the farmers are taking advantage of either or both options. The study is further designed to observe the views and behavior of the water users, some of whom are using water from both systems and others who are acquiring water from the BLGWP.

NEED OF THE STUDY

The most spectacular and unique aspect of the BLGWP stage I area is that the farmers in certain areas, particularly around Semara, Karahiya, and Bhalwari, still maintain traditional ties with the Chhattis Mauja surface water irrigation system, despite having used the BLGWP's irrigation facilities for the past three years. The BLGWP's envisaged objective of organizing the water users' group and mobilizing them for the operation and maintenance of the system has been only partially successful. The relations between the farmers and the project could hardly be called a harmonious one.

Under the circumstances the study is not only timely but also appropriate. From the point of view of the planners and policy makers this study will, we believe, give not only an in-depth analysis of the current situation therein but also be very useful for the stage II command area. It could also provide suggestions for organizing the water users and gain both their confidence and involvement in future irrigation projects which are now in the planning and implementation stage.

METHODOLOGY

The methodology we adopted could be classified broadly into two methods: descriptive and analytical. The data for analysis and description were collected from primary and secondary sources using questionnaires, interviews, and formal and informal meetings.

To obtain background on the irrigation projects we researched the historical development of the systems.

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During the field test we also organized formal and informal meetings among the water users including pradhan panchas (elected village lenders), upa pradhan panchas (vice village leaders), ward chairmen, and members of the three panchayats (local political units) under our study. System managers and agricultural extension agents enabled us to broaden our descriptive perspectives as well as cross-verify the data generated by the survey.

SAMPLE AND SITE STUDY

The three panchayats covered by the study are Karahiya, Madhubaliya and Gangabaliya Village Panchayats which are served by three BLGWP ground water tube-well units, viz. Karahiya, Bhalwari and Semara. In those areas the facilities of the Chhattis Mauja Irrigation system and those of BLGWP overlap. Three sets of questionnaires were prepared following a pre-test: one for the local leaders who are considered to be influential in the area, one for the managers, and finally the last set for the farmers/users. Total households and total command area were codified and a random sample obtained. The sample was selected from the area where the two irrigation systems overlap.

CHHATTIS MAUJA IRRIGATION SYSTEM

About 150 years ago a farmer named Jeddha Tharu was given permission to dig a canal system from the Tinau river in Butwal and link it with Kumari village in the plains of the Tarai. Thus the Chhattis Mauja Irrigation System came into existence as a large-size farmer/user-managed irrigation system designed to serve 36 maujas, or villages. It is also called the Kumari irrigation system, for it served the Kumari village in the beginning. At present, the system irrigates approximately 3,000 hectares (ha) of land in 54 villages in eight panchayats. More than 25 kilometers (km) in length, the canal of Chhattis Mauja ranges in width from 4 meters (m) to 10 m with a depth varying from 1 to 4 m.

It is a large-size farmer-managed irrigation system. The system has effectively undertaken water management for 3,000 ha of land. The water users are participating in the decision-making process concerning water management. A three-tier organizational structure is formed by the water users/farmers within the command area to manage the system. The committee is most concerned with the management of water for the monsoon (paddy) cultivation. During the period of water scarcity, the committee becomes quite active. The committee is responsible for the repair and maintenance of the canal and also for water distribution to the farms in its command area. About sixty thousand beneficiaries are mobilized by the committee for maintenance of the main canal each year. In cases of non-participation or failure to comply with the regulations, penalties both in cash and kind are levied against the offenders. Frequent non-compliance may lead to dismissal from membership in the irrigation network resulting in cut-off of the water supply.

During the field survey we organized a meeting designed to help interaction with the governing board of this irrigation system. The meeting took place at their headquarters and was presided over by the newly-elected chairman of the governing board. Local farmers also participated.

During this meeting, the farmers explained some of the problems they are facing. The committee is facing difficulties in maintaining the canals and getting cooperation from the water users. The main problem in maintaining the canal network at present is the paucity of log, timbers, and other forest products used for repairs, the procurement of which has become very difficult. The lack of enthusiastic cooperation on the part of the farmers/users can be attributed to the fact that they are obtaining water from other sources--the tube-wells.

An increase in the population has created an increased demand for water for irrigation, home use, and new industries. However, the supply of water has been adversely affected due to deforestation, bringing additional land under cultivation, and construction of highways and feeder roads.

Over the years, there has also been significant change in social values. One of the reasons for such change is the availability of a relatively free water supply from the agency-managed system, BLGWP. In the farmer-managed system the users had to work to acquire and distribute water themselves. With water from the government-managed project, community participation has eroded to an extent which has adversely affected the concept of farmer management. Basic problems faced in the management of the traditional irrigation system were changes in the social values and the role played by vested interests. This study did not go into the details of such changes in social values, but it was able to discern that the farmers/users were effectively obtaining an adequate supply in the head area while the establishment of new allied occupations such as dairy farming and cottage industries have diluted a sense of communal belonging. Development of different occupational patterns and migration of rural population to urban areas are responsible for the main changes in the social values.

Farmers' Participation in Chhattis Mauja

Beneficiaries of the Chhattis Mauja irrigation system are expected to provide labor to operate and maintain the system. Members failing to contribute labor are charged a fine fixed by the committee. The committee chairman reported that the cash income of the organization is increasing each year. The chairman attributed this increase to the fine rate fixed by the committee. The man/day rate fixed by the committee tended to be lower than that of the prevailing man/day rate for unskilled labor in the vicinity. This has induced some users to pay in cash instead of contributing labor.

When other local leaders and farmers were asked about this issue, additional reasons for the increase in cash contributions were mentioned. The difficulty of obtaining forest products needed for the diversion of the water in the canal and for repair and maintenance was cited as a reason. Deforestation and new government rules restricting the cutting of trees make it much more difficult to obtain these resources. The problems associated with obtaining forest resources has discouraged some farmers from contributing labor for the maintenance of their system; some feel it is easier to pay the cash fine. The migration of the rural population to urban centers, reducing the size of the labor resource was another reason that users sometimes found it easier to pay in cash.

BHAIRAHAWA-LUMBINI GROUND WATER PROJECT

A feasibility study of the BLGWP was undertaken in 1975 by Tahal Engineers Ltd. of Israel. Following the completion of the feasibility study, His Majesty's Government of Nepal (HMGN) asked the International Development Association (IDA) of World Bank to finance the project. The World Bank sent a

Bhairahawa

Group Mission to undertake appraisal of the project. The IDA agreed to provide a loan in 1976 for US$ 9 million which covered 60 percent of the cost of the project. The project started delivering water in May 1980.

The project is located in Rupandehi district, Lumbini Zone. The approximate altitude of the area is 100 meters (m). Sandwiched between the Dano river in the west and Rohini in the east, the project site is known for its alluvial deposits.

The main objective of the BLGWP is to provide water for irrigated agriculture to allow two or three crops per year. To achieve this, the project included the construction of 64 deer, tube-wells ranging from 100 m to 200 m in depth. Irrigation control structures to serve an area of approximately 120 ha around each tube-well were planned. The project included provisions for installing electric lines to provide power to run the tube-weli pumps, construction of 96 km of village roads, and the construction of offices to house DIHM staff in Bhairahawa.

According to present estimates of available water resources, approximately 60 million cubic meters of water can be pumped annually from the confined aquifer of the Gangetic sediments. This quantity would suffice to irrigate an area totalling about 7,500 ha.

Farmers' Participation vis-a-vis BLGWP

Utilization of tube-well water is one of the indicators of the participation by the beneficiaries in the system. When the tube-well discharge rate was calculated, the figure was not encouraging. Even during the peak paddy season period the discharge is relatively low. The working capacity of the pump is 18 hours a day. However, BLGWP records show that the pump worked for less than 4 hours a day on the average.

The formation of separate water users' groups for different tube-wells is an indication that BLGWP is trying to incorporate the water users in the decision-making process of every tube-well system. To assess the water users' participation in the decision-making process we examined the minutes of the water users' committees' of all three tube-well systems included in the study.

The water users' committee of the Bhalwari tube-well command area has yet to meet formally, hence nothing has been recorded in the minutes. The committee serving the Karahiya tube-well area had met only once, in 1982, at which time the decision taken by the committee clearly indicated that the BLGWP management failed to make provision for additional turn-outs and timely repair of the channel breaches even when the responsible officials were aware of the situation. The committee serving the Semara tube-well area revealed that only two meetings have been held, both in 1986. At one of these meetings the committee proposed the imposition of a fine of Rs 15 (US$ 0.68) per man-day to be charged against users who fail to contribute labor when required. There is no record of the implementation of this decision.

Regarding the users' participation in the operation and maintenance (O&M) of the project as measured by payment of the fees for use of the water, BLGWP records show that only Rs 60 (US5 2.75) have been paid. Furthermore, the water users do not consider themselves responsible for the minor repair of breaches in the tertiary channels

Regarding participation in the construction of the channel system, the farmers were paid for the land utilized by the channel network, which was designed by the project engineers and built by contractors employed by the project. The farmers were not involved in either design or construction.

FINDINGS AND CONCLUSIONS

Membership in the Two Irrigation Systems

Nearly half of the farmers are entirely dependent on the farmer-managed canal. For the farmers having alternatives, the main alternative is the tube-well system. This helped us conclude that the tube-well system is a strong alternative source of irrigation water in the command area under study. The DLGWP could develop the tube-well system without competing with the farmer-managed system.

Design of BLGWP

The farmers reported that they were not involved with the design of the channel system for the project. Channels with brick lining and cement pointing were found in the head areas. All other channels were constructed of mud. During the meeting with the farmers, a number of them asked why the project provided better structures only in the vicinity of the pumphouses. Some farmers voiced the opinion that this discrimination discouraged them from participating more actively in the project. The analysis of the situation helped us to conclude that the users must be involved from the design phase of the project to assure more active cooperation.

Water Allocation

For the purpose of this study, we have distinguished demand from need on the basis of who decides the timing of the application of water. If the farmer/user decides the point of time he needs the water and is supplied with water accordingly, then the allocation is considered to be made on demand. Whereas, if the water users' group/committee or some one in management decides when any particular area need6 water and arranges for the supply, then it is the case of water being availed on the basis of need.

The leaders believed that water under the Chhattis Mauja system is allocated on the basis of need and they desired replacement of it by demand as a criterion. On the other hand, the farmers/users believed that at present labor contributions determine the water allocation at the farm level, and like the leaders, they also advocated demand to be the desirable criterion of water allocation.

The criteria for water allocation helped us reach the conclusion that in the BLGWP tube-well system at present the basis for water allocation is a combination of both the need and demand. This is due to the fact that the water requisition form filled by a particular farmer/user has to be endorsed by the chairman of the water users' committee before the water is supplied to the farmer. Water would not be released until three separate, properly endorsed requisition forms are completed for the particular turn-out point.

Users' Responsibilities and Contributions

The majority of the farmers believed their major responsibility to be performing assigned work whereas most of the local leaders and managers felt. that bringing together collective cooperation was their major responsibility. This helped us conclude that different groups within the system have different responsibilities. The hypothesis test also supported our finding to this effect.

The Chhattis Mauja system is operated and maintained primarily through labor contributions from the users. Some cash is collected in the form of fines imposed upon those who fail to contribute labor. In the BLGWP system the water users' contribution is a cash fee assessed for use of the water. This is one of the major differences between the two systems.

In the BLGWP system it was observed that from May 1984 when water charges were levied to May 1987, less than Rs 60 have been realized from the water users as water charges. The water rate fixed by BLGWP is Rs 200 (US$ 9.13) per bigaha (0.67 ha) per annum. Neither the users nor the managers considered the rate to be too high in comparison to the labor contribution practice of the farmer-managed irrigation system where the labor contribution is at least 12 man-days per annum and calculated at the local wage rate of Rs 25-30 per day. It sometimes goes up to 30 man-days. When trying to identify the reasons behind the farmers' aversion to pay the water charges at the rate fixed by the BLGWP even when they consider it reasonable, we could identify the following reasons:

1. Water from the tube-wells is less preferred by the farmers because it does not contain any fertilizing elements which are found in the Chhattis Mauja surface water.

2. The tube-well system is considered by most as a secondary source of irrigation water.

3. Farmers prefer contributing labor over having to make cash contributions. It is not the rate that is not acceptable to them but it is the nature of the contribution which is not of their preference.

4. The farmers/users are aware of the minimum fixed overhead For the operation and maintenance of the tube-well system. Annual minimum overhead for each tube-well, except for repair and maintenance in case the pump goes out of order, is estimated to be Rs 72,000 (US$ 3,287.67), which includes the electricity charges at an average rate of Rs 5,000 (US$ 228) per month and the salary for ditch-rider and pump operator at the rate of Rs 500 (US$ 22.83) each per month. The farmers believe that if they start paying the water charges, they might be later given the responsibility for the O&M of the unit, and they would not be able to meet the costs. BLGWP should be able to clarify this issue with the water users and make a commitment as to what extent and for how long BLGWP can subsidize the overhead which can be expected to go up along with the change of pump operation hours from the current average operation hours of less than four hours a day should the tube-well water usage rate increase to the maximum capacity of 18 hours a day.

Conflict Resolution

In the Chhattis Mauja irrigation system conflicts are settled democratically by involving all users. In cases of water-related conflicts concerning the groundwater irrigation system, it is the chairman of the water users' committee who is most involved with resolving the conflicts.

Relationship Between BLGWP Users and Managers

When we observed the relationship between the farmers/users and managers at the farm level (the farmers and the pump operator), we were impressed by its cordiality. We could find no records of complaints reported against the primp operators. We also did not hear any complaints against the water users from the pump operator. (It should be noted here that the pump operator has control over the discharge of water from the tube-well for irrigation on demand from the water users.) This enabled us to conclude that the relationship between the farmers/users and the managers at the farm level is not the key factor responsible for poor participation of farmers/users in the BLGWP tube-well system.

Users' Attitudes Toward a Farmer-managed System for Tube-wells

A model test was conducted with a view to test the farmers' attitude towards the community (user) management system, in order to explore whether each tube-well unit could be brought under user management as a separate, independent system. Fishbein's Attitude Test used to test the hypothesis helped us reach the conclusion that since farmers/users lack a strong positive attitude towards the former-managed tube-well system, it is not possible that each tube-well unit as a separate system be brought under user management at this point in time.

Incentives

We came to the conclusion that the incentive to increase participation in the BLGWP for the farmers would be the opportunity to make labor contributions. Not having to pay any dues is a major incentive for the managers. Thus the incentive in the minds of both the farmers and managers is virtually the same in the sense that both groups have an aversion towards making cash payments.

POLICY IMPLICATIONS

The agency-managed irrigation system is a relatively new experience for both the farmers/users and the managers, planners, and policy makers in the limited areas where it has been introduced in Nepal, whereas the history of farmer-managed irrigation systems is long. The outcome of this study could be a guide to the planners and the managers at both the national and community levels. The following recommendations are offered:

1. Policy makers should take into account not only the mode of irrigation but also the location of farms to which the irrigation water is to be channeled. The system should be designed in such a way that it is geared to serve the whole command area instead of the land in the vicinity of the pumphouse primarily, as in the case of the ground water irrigation system.

2. Policy makers should note that the farmers'/users' prefer user management of an irrigation system. The success or failure of the irrigation system depends upon the extent to which the farmers/users identify themselves as one of the components of the total system. Our study has clearly revealed that farmers/users will not consider an irrigation network their property unless they have been consulted since the installation of the system.

3. The farmer-managed irrigation system faces technical and financial constraints in infra-structural matters. The Chhattis Mauja system is an outstanding example. This clearly is an area where policymakers at the national level should formulate policies which can further strengthen community involvement in irrigation management such as providing funding for permanent structures. It has been found that due to the increase in the population density caused by uncontrolled migration, changes have occurred in the social values resulting from the urbanization process and farmer-managed irrigation systems are encountering hitherto unforseen and/or unexperienced problems. This demonstrates that the farmer-managed system is facing difficulty brought by changes which can be solved by timely interventions at the national level and at local panchayat levels. This is an area where future planners must give serious thoughts to issues such as national forestry management, watershed management, and migration.

4. The farmers' reason for participation in the irrigation system is the interest in growing more crops. They are willing to try new crops if irrigation water is available. BLGWP should capitalize on this aspect in order to bring more farmers' participation within its system. According to the farmers' opinion and our discussion with the different groups during the field study, it was observed that farmers/users give priority to Chhattis Mauja water because it is richer in fertilizing elements whereas the ground water is devoid of them. The team also observed that the Chhattis Mauja system is able to provide water for summer paddy cultivation only. In order to make farmers' participation more forthcoming BLGWP management should encourage farmers/users to diversify their crops by giving different incentives such as pro-rata reduction in water charges for the use of water for crops other than summer paddy, free distribution of improved seeds, and free small farming consultancy which would teach farmers improved agricultural practices.

5. The failure of government policy to understand the O&M practices of farmer-managed irrigation systems have made it difficult to obtain forest products for system maintenance, and consequently it has led to increase in the man-days required for the maintenance of the system. The government forestry policy should support the farmer-managed irrigation system by guaranteeing that the forest in the nearby area be opened to community management and the area protected and promoted, This will encourage the farmers/users to work in the farmer-managed system while it will help the user management system reduce the involvement of man-days in the O&M.

6. The increasing trend of payment of cash fines is not favorable to the user management system. The majority of the farmers are in favor of labor contributions and if the cash contribution practice is encouraged, the user management system may come to the same fate as that of BLGWP which is able neither to collect water charges nor to involve the farmers/users in the O&M.

7. The Bhairahawa-Lumbini Ground Water Project should be prepared to work in tandem with the water users' committees and more actively involve them in the decision-making process.

In this context we recommend that BLGWP synchronize both the systems' modes of operation by forming a committee from the managers of both the systems which will coordinate on the issues relating to water allocation and participation. The committee will act as an advisory committee to BLGWP. In order to pool diverse experiences the committee should be chaired by a representative from the Chhattia Mauja system.

8. In order to mobilize farmers'/users' participation in the RLGWP system the RLGWP management should consider invoking the water users in the repair and maintenance of the system by having them contribute labor instead of raising water charges. The farmers/users are also willing to contribute labor.

A COMPARATIVE CASE STUDY OF TWO COMMUNITY-MANAGED IRRIGATION SYSTEMS IN CHITWAN DISTRICT, NEPAL

Ratna Raj Nirola
Fhvindra Prasad Pandey

INTRODUCTION

Nepal's irrigation potential is estimated at 1,050,000 hectares (ha) in the Tarai and 200,000 ha in the Hills (Pant and Lohani 1983). The 1981 Water Resource and Energy Commission study estimated that about 500,000 ha receive some irrigation, which is 22 percent of the cultivated area and about 26 percent of the irrigation potential. Four-fifths of the existing irrigation has been developed by farmers and government schemes account for only one fifth (Pant and Lohani 1983). This brings out the significance of farmer-managed irrigation systems in Nepal. This paper is a comparative case study between a traditional single community-managed irrigation system and a new multicommunity-managed irrigation system.

STUDY OBJECTIVES

The objectives of the study were to:

1. Compare the roles of irrigation water users and irrigation water authorities in the traditional single community and new multicommunity-managed irrigation systems. A traditional single community was defined as a group of people of the same origin and caste living together in the same area. The multicommunity was defined as a group of people of different castes and religions who have fairly recently migrated from different parts of the kingdom and who now live together in the same area.

2. Examine differences in the level of conflict in the two systems.

3. Compare the effectiveness of the two systems for mobilizing labor resources for system maintenance.

4. Determine the viability for continued operation of the two systems.

DESCRIPTIONS OF THE IRRIGATION SYSTEMS STUDIED

The Surtana irrigation system was selected for the study to represent a traditional single community-managed irrigation system, and the Lothar irrigation system was selected to represent a new multicommunity-managed irrigation system.

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Surtaria Irrigation System

Tho Surtana system is a single community-managed irrigation system in Chitwan district about 17 kilometers (km) east of Bharatpur and 2.0 km south of Parsa on the Bharatpur-Hetauda highway. This system which irrigates ward number five of Khaireni Village Panchayat was constructed about 150 years ago by the Tharus (an ethnic group of Nepal), and is still completely dominated by them. The command area of this system is about 350 ha.

The organizational structure of this system consists of a farmers' committee, with a chairman and six members. .Annually, before the pre-monsoon activities, the farmers meet and elect the chairman and committee members. The assembly makes decisions concerning the maintenance of the main canal and canal network.

Lothar Irrigation System

Lothar is a multicommunity-managed irrigation system in Chitwan district about 30 km east of Bharatpur and 1.0 km south of Pratapur on the Bharatpur-Hetauda highway. The new Lothar irrigation system was built by farmers in 1971. The system irrigated ward numbers 1, 2, 3, and 8 of Piple Panchayat. The total command area of the system was about 800 ha.

A majority of the farmers under this system were Brahmins and Chhetris (of the higher castes) who had migrated to Chitwan from the hills in the past 20 to 30 years.

In this system the farmers meet during the post-harvest period in January-February. The general assembly elects a chairman and vice-chairman. The chairman appoints the members of the seven branch canals. The chairman practically holds a mandate from the general assembly to implement all the assembly decisions.

METHODOLOGY

Sample Design

There were 121 households in the Surtana system and 300 in the Lothar system. Every second household from Surtana and every third household from Lothar was chosen for the study, forming a sample of 62 households in Surtana and 100 in Lothar.

Data Collection Procedure

Three different methods were followed for the collection of the information regarding the systems' organization.

1. Interview. Data on the socio-economic condition of the people of the command area was collected by interviewing heads of households.

2. Survey/observation. The investigator used a checklist to systematically collect data on the physical aspects of the irrigation systems.

3. Participants' checklists. Data regarding the operation and maintenance of the system was collected using various formats. A four-point

rating scale was used to collect the opinion of water users about their roles and the role of the water authority. Key informants were interviewed using a list, of questions pertaining to the development. and operation of the systems. Another checklist relating to the views of the water users as related to water allocation, distribution, maintenance, and conflict resolution was administered to water users.

Comparative Inferential Analysis

This was the major part of the study, where each of the objectives was analyzed separately and an inference was drawn on each.

Role comparison. Since this study focused on the job performance of the water authority and water users, the authority's as **well** as users' work-roles had been chosen for analysis in terms of the various activities performed in the irrigation organization. In that context, the degree of responsibility borne by the authority and users as expected or perceived by the incumbents of the position, viz water users was worked out.

The roles were analyzed at two levels: 1) consensus among members of the same system, or intra-system consensus, and 2) 'consensus between the two systems, or inter-system consensus.

Role perception was defined as work actually performed by either water users or water authority. To measure the role perception, the respondents were asked what the water users and the water authority had done in a given situation.

Role expectation was defined as work that should have been performed by either the users or the authority. Respondents were asked what they thought the water users and water authority should do in a given situation.

Level of conflict. Three aspects were considered while examining the level of conflict. Conflict in the role of water users and the water authority was examined by analyzing the variation between the role expertation and perception with the help of F-statistics. The level of conflict over water allocation and distribution was analyzed by studying the respondents' replies to questions related to these issues. The level of conflict regarding system maintenance was identified in the same manner.

Labor resource mobilization. A comparative-descriptive analysis was carried out to study the labor resource mobilization techniques employed.

Continuity status. A critical analysis of both irrigation systems regarding the physical and organizational structure was performed to determine the continuity status of both systems. The continuity status was further identified by studying the level of conflict between the two organizations.

RESULTS OF THE ANALYSIS OF THE DATA

1. The intra-system variation regarding work roles between the two systems was not similar. Among the items on which respondents agreed within one system, 50 percent were the same in the other system regarding role perception. Sixty-two percent of the items on which respondents agreed regarding role expectation were the same in both systems.

2. The responsibility score of the water users of Lothar was higher than in Surtana, hence it can be concluded that the water users of the Lothar irrigation system participate more fully in the operation and maintenance of their system.

3. The responsibility score of the water authority of Surtana was higher than that, of Lothar, indicating that the water authority in the Surtana system performed more of the operation and maintenance duties than is the case of Lothar.

4. Among those items that showed high responsibility in the work role of the water users as they performed their jobs in both irrigation systems were:

a) Distribution and allocation of water among water users.

b) Checking whether the distribution is proper at the sub-system level.

c) Fixing type and degree of punishment to those who violate the rules.

d) Distribution of water to the farm.

e) Preparation of the schedule and norms for regular maintenanre work.

f) Resolving emergency situations at the main and sub-system levels.

g) Resolving conflicts between users.

5. Both systems agreed on more than 70 percent of the items as to the roles and performance of the users in operation and maintenancr of their system. Rut the two systems disagreed on more than half of the items regarding the roles and performance of the water authority. The following are the items on which the respondents in the two systems disagreed:

a) Lothar farmers felt it was the water authority's responsibility to take action on a violation of rules. Surtana gave the responsibility to the water users.

b) Lothar gave the task of estimation of resources and materials for regular maintenance to the water authority.

c) Lothar water users had the responsibility of checking attendance of the laborers in maintenance work. In Surtana this was tho water authority's job.

d) Surtana considered it the job of the authority to detect any problems in the system; in Lothar this was performed by the users.

e) The fixation of taxes or other donations for irrigation activities was set by the water users in Lothar, hut by the authority in Surtana.

f) Lothar water users resolved water-related conflicts that arose among the users. In Surtana this was performed by the water authority.

6. The respondents in both systems shared similar attitudes about perception and expectation.

7. The level of conflict in the work role was a bit higher in Lothar as compared to Surtana. The farmers in Lothar were more interactive with the water authority and conscious of their responsibilities. In Surtana the traditional leaders and customs of the Tharu community dictated how the system was operated.

8. There was no conflict regarding water distribution and allocation in either system as there is an abundant water supply available. However, in Surtana the level of ethnic conflict was higher because of a high level of discrimination of the Tharus against the minority group of newly-arrived hill people. In the future this level of conflict may lead to an increase in conflirts between the large Tharu farmer and smaller farmer regarding water allocation.

9. Regarding labor mobilization, there was more conflict. in Surtana. The smaller farmers in Surtana were not satisfied with the present system of mobilizing labor. In this system all the members of the household (except household head, women, school children, and shepherds) who use irrigation water are required to contribute labor throughout the period of maintenance. Sixty percent of the farmers preferred that labor contributions be assessed according to size of landholdings.

In Lothar a household using irrigation water has to contribute only one laborer throughout the period of maintenance. Fifty-eight percent of the farmers in Lothar were satisfied with this system.

10. The Lothar irrigation system had a more effective way of mobilizing labor. During the early paddy season the farmers are not allowed to cultivate more than one hectare of land. They share their land with other landless farmers, providing them with 50 percent of the seeds and fertilizer needed. In return the early paddy cultivator provides the landlord with half cf the produce. As this cultivator uses irrigation water, he is required to contribute one laborer per maintenance activity, thereby enlarging the labor resource.

11. The physical system was stronger in Surtana as compared to Lothar. The Surtana water source is a non-perennial one and its intake structure is permanent. Lothar takes water from the Lothar Khola as well as the Rapti river. Its intake is built on the flood plains of the Rapti river, and is washed away every year by the Rapti floods.

However, the organizational structure was stronger in Lothar because the level of conflict in Lothar was much lower, and also because the labor mobilization pattern is seen as more effective. Lothar holds more promise in terms of the ability of its organization to continue to function effectively.

SUMMARY

The findings of this study may help policy makers get a general view of the managerial situations found in different community-owned irrigation systems. On the basis of the findings, the following recommendations are made for consideration in similar situations.

1. The agencies dealing with the development of irrigation in Nepal should focus on the ethnological composition of the water users in a given irrigation area. This is important because the homogeneous/heterogeneous ethnological composition affects the management of an irrigation system, particularly as related to conflict resolution, resource mobilization, leadership,

and the extent of equity in irrigation resource distribution and user participation.

Contrary to the generally-held belief that in ethnically homogeneous irrigation systems better management is more easily achievable, this study showed that in the ethnically heterogeneous Lothar irrigation system, management in terms of those factors mentioned above was better in comparison to Surtana, the ethnically homogeneous system.

2. Policy makers and implementing agencies should give priority to intervention in heterogeneous migrant irrigation communities (especially **in** the Tarai) in order to bolster its modern organizational and management capacity.

3. Single community-managed irrigation systems require a more subtle approach when designing intervention. The homogeneous community felt that outsiders were threats to established traditions. Therefore, it **is** very important. that the leaders of these communities first. he taken into confidence before any irrigation development program is launched.

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SECTION IV: CONCEPT PAPERS

ORGANIZATIONAL STRUCTURE FOR RESOURCE MOBILIZATION IN HILL IRRIGATION SYSTEMS

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INTRODUCTION: HYPOTHESES

Farmer-managed irrigation systems exhibit a diversity of organizational structures and varying degrees of formality of structure. This paper analyzes factors that potentially influence the degree of formal structure of the organizations of farmer-managed irrigation systems in the hills of Nepal. The paper is based on one-and-a-half years of field research conducted by the authors in 1982-83 on eight farmer-managed systems. These systems are located in four villages in the mid-hills of the districts of Palpa, Gulmi, and Nawalparasi. Information from these eight intensively-studied systems was supplemented by rapid appraisals of an additional ten farmer-managed irrigation systems. Table 1 presents some basic information of the eight systems.

Tahle 1. Basic information on the eight irrigation systems studied.

System	Command Area (ha)	Irrigated Area (ha)	Percent Irrigated	Number of Members	Canal Length (km)
Thulo Kulo, Chherlung	41.7	34.8	83	105.	7.0
Raj Kulo, Argali	102.9	46.5	45	158	3.0
Tallo Kulo, Chherlung	23.9	17.9	75	61	6.5
Saili Kulo, Argali	14.9	14.9	100	51	2.5
Kanchi Kulo, Argali	14.2	10.7	75	28	2.0
Maili Kulo, Argali	15.8	15.8	100	72	2.7
Damgha Kulo, Majuwa	27.5	27.5	100	111	2.5
Tallo Kulo, Thambesi	50.0	22.6	45	55	0.2

It was expected that organizational structure would vary among $:>-stems, and one aim of the research was to understand, in broad terms, the factors causing the organizations to be structured differently. The hypothesis that guided the development of the study and selection of research sites was that the level of formal structure of the farmer irrigation organizations would be inversely correlated with the water supply relative to the area that could be irrigated. The effort and discipline needed to distribute efficiently and equitably a scarce water supply would require the organization to be structured with a higher degree of formality than if the water supply was abundant.

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There are other factors that may contribute to the level of formal organizational structure, and several additional hypotheses will also be investigated. It may be that the relationship of organizational structure to water supply is not an inverse relationship but rather an inverted U-shaped one, i.e., little formal structure at the extremes of water supply and more in the middle of the spectrum.

If a system is not irrigating the entire hydraulic command area, it may be that a stronger and more formal organization is needed to limit access to the water and prevent those on the periphery of the irrigated area from stealing water or pressing to require the organization to allow them access to water. Certainly the need for formal organizational structure is likely related to the size of the organization, at least when it reaches a certain threshold.

The ability of each of these factors individually to explain the observed difference in degree of formal organizational structure will be analyzed. Finally, the need to mobilize resources every year for the ongoing maintenance of the system will be argued to be the most significant factor influencing the level of formal organizational structure observed in farmer-managed irrigation systems in the hills of Nepal.

MEASURE OF THE DEGREE OF FORMAL ORGANIZATIONAL STRUCTURE

Before analyzing the possible determinants of organizational structure, it is necessary to rate the different irrigation management organizations according to the degree of formal structure. The formal structure of an organization can be described with reference to the following indicators: designated roles within the organization, its meetings, and the type of written records that it maintains.

Description of Organizations

The Thulo Kulo system of Chherlung exhibits the highest level of management intensity and organizational structure among the sample systems. There is significant differentiation of functions among the 105 members with an elected leader (mukhiya), secretary (sachiv), and management committee. The organization holds regularly scheduled meetings for conducting business and making decisions at which attendance is mandatory. Minutes are recorded of the meetings, and written records of members' water allocations and attendance at work, as well as accounts of the organization, are maintained. Fines are imposed for missing work.

The degree of formal organizational structure and management of the Raj Kulo of Argali is among the highest observed. The Raj Kulo organization has a written constitution and a number of elected functionaries. It maintains written records of the 158 members' attendance at work and their water allocations, the organization's accounts, and minutes of meetings which are signed by all members present. Sanctions for missing work or stealing water are set and enforced. Regular and extraordinary meetings of the organization are held to discuss plans, elect officers, present financial reports, and make policy decisions. Each year an audit committee is appointed to examine the accounts. Sometimes special committees are appointed to develop proposals for consideration or to carry out specific tasks.

The Tallo Kulo of Chherlung also exhibits a high degree of formal organizational structure with ten officers, a management committee, regular meetings, attendance records, minutes, accounts, and a sophisticated record of members' water allocation. Fines for absence from work, dirtying the main canal, and water atealing are imposed.

The Maili, Saili, and Kanchi Kulo organizations of Argali have similar management organizations. 'They all have elected officers; hold regular meetings; and maintain written minutes, records of merbers' attendance at, wcrk, and accounts. They establish and enforce sanctions for missing work. Maili and Saili Kulo systems are land-constrained, i.e., there is no additional area that could he irrigated and the area irrigated equals the hydraulic command area.

The Damgha Kulo system in Majuwa is land constrained, and the water supply relative to the hydraulic command area is abundant. The observed level of organizational structure was low, although there is more structure than in the Thambesi system. There are no elected officers in the organization. Functioning as a de facto leader is one of the members who has been awarded a contract for carrying out all of the maintenance on the main canal. Since members pay him according to their water allocations, he keeps a record of the allocation of each of the 111 members and of their payments. Other than this there are no written records. There are two regular meetings of the organization during the year.

In the Tallo Kulo system of Thambesi, the water supply is very scarce. necessitating intensive rotational distribution throughout the season. The organization, consisting of 55 farmers, has no designated officers or functionaries, holds no regularly scheduled meetings, does not have established sanctions for infractions, and maintains no written records except a list of members.

Methodology

The degree of organizational structure has been quantified by giving one point for the existence of each of the following: management committee, membership list, record of members' water allocations, written attendance record, written accounts, minutes of meetings, written constitution, regular meetings, and established sanctions (fines). Table 2 records the observation of the indicators for each system. To these was added the number of designated functionaries or officers of the organization. One could question whether this number should be added to the others, but the higher this number, the more role specialization there is, which is an indicator of organizational structure.

The sum of the organizational structure indicators is used to rank the level of organization in each system. The ranking shown in Table 2 fits quite well with the subjective "feel"that we developed for the relative degree of structure during the one-and-a-half years spent in the different communities. A different rank ordering of the systems is generated by each hypothesis that is tested. The ranking of the systems, according to relative degree of formal organizational structure, predicted by each hypothesis will be compared with that given in Table 2. The Spearman rank correlation coefficient will be used to test whether the two rank orderings are significantly different or not.

Organization as a Function of Relative Water Supply

It was expected that the management organization of systems with a scarce water supply would be more structured than that of systems in which the water supply was relatively abundant. A stronger organization with clearly defined rules and sanctions would be required to efficiently capture, convey, arid equitably distribute a scarce supply of water among the member farmers' fields lhan would be needed if the supply were abundant. Increased management intensity to manage scarce water more efficiently requires not only more control over water (physical control). but also increased control over human behavior (social control), resulting in the need for a more formal or structured organization. An organization distributing water by rotation requires a specified distribution plan and the ability to discipline its members to follow the rotatiun. If water is scarce, there will be more likelihood of water stealing and conflict; hence a method of managing conflicts, including a process for adjudicating complaints and applying and enforcing sanctions against offenders, is needed.

Table 2. Summary and rating of observed levels of organizational structure.

System	A	B	C	D	E	F	G	H	I	J	K	L	Rating
Thulo Kulo, Chherlung	11	1	1	1	1	1	1	1	0	1	19	1	V. High
Raj Kulo, Argali	10	0	1	1	1	1	1	1	1	1	18	2	V. High
Tallo Kulo, Chherlung	10	1	1	1	1	1	1	1	0	1	18	2	V. High
Saili Kulo, Argali	3	1	1	1	1	1	1	1	0	1	11	4	Medium
Kanchi Kulo, Argali	2	0	1	1	1	1	1	1	0	1	9	5	Medium
Maili Kulo, Argali	2	0	1	1	1	1	1	1	0	1	9	5	Medium
Damgha Kulo, Majuwa	1	0	1	1	1	0	1	0	0	0	5	7	Low
Tallo Kulo, Thambesi	0	0	0	1	0	0	0	0	0	0	1	8	V. Low

A - Number of officers
B - Management committee
C - Regular meetings
D - List of meetings
E - List of members' water allocation
F - Work attendance record
G - Accounts
H - Minutes
I - Constitution
J - Fines
K - Indicator (Sum A through J)
L - Observed rank order (1 equals highest)

Downing (1974) refers to this as the "excess scarcity hypothesis." The hypothesis is of the form "scarce water = more conflicts = more social control" (1974:119). He argues that it is not scarcity per se, hut scarcity relative to the crop's demand for water, i.e., a low relative water supply, that leads to more conflict necessitating more social control. He hypothesizes that "water scarcity during the (crop's) moisture-sensitive period forces some kind of rigid social organization to allocate water" (1974:121)

Observation of the technology and management practices used for distribution of water revealed that more intensive efforts were employed when the supply was relatively scarce than when it was abundant. The Damgha Kulo system of Majuwa, with the most abundant water supply, used several saachos (proportioning weirs) to distribute a measured allotment of water from the main canal into secondary canals. From below the secondary level, continuous-flow distribution without measuring devices was practiced.

The four systems in Argali used saachos to apportion the water from main canal to secondary canals and from secondary canals to field canals. In some parts of the Raj Kulo, saachos were used to distribute water from field canals into individual farmers' fields. Systems with a scarcer supply were not able to distribute water continuously to the entire irrigated area. Both systems in Chherlung practiced rotational distribution below the secondary canals, beginning part way into the season. The Tallo Kulo system of Thambesi with the scarcest supply had to distribute water by rotation throughout the season.

The eight irrigation organizations will now be analyzed to test the hypothesis that the level of formal organizational structure is inversely correlated with the water supply. This comparison among systems analyzes how the Organizations are structured for irrigation management during the monsoon rice season. The primary purpose of all the systems is irrigation of the monsoon rice crop, and the organizations are structured for carrying out the activities necessary to successfully irrigate this crop. Some inter-seasonal comparison of management practices within a single system will also be included.

Relative water supply in this analysis is defined as the supply of irrigation water divided by the demand, where demand is evapotranspiration plus seepage and percolation, used to grow rice on the irrigated area. A further distinction of land area is made to define "gross relative water supply" (GRWS) and "net relative water supply" (NRWS). The GRWS is defined as the ratio of the available water supply to the water needed (water demand) to grow a crop on the potentially irrigable land area, i.e., the hydraulic command area.[2] The NRWS is defined as the ratio of the water supply to the water needed to grow a crop on the actually irrigated land area. The crop in the analysis is rice, and the demand is an average figure for the season, assuming that the soil is kept in a permanently saturated state without standing water on the surface.

Seepage and percolation rates measured in sample fields yielded an average demand over the season of approximately 4 liters/sec (approximate!:; 35 ha-mm/ha/day) in all sites. Compared to data from the Philippines (Valera and Wickham 1974) and Indonesia (Oad 19821, this demand is estremely high. However, farmers applied water at this rate and even higher, but no overland drainage was observed. The porous alluvial soils on the river terraces where the water table is far below the surface require very high rates of water application to maintain continuously ponded water in the fields.

The supply term of the GRWS and NRWS ratios is the total amount of irrigation supplied to the command area over a 98-day period from immediately after the seedlings were transplanted until the farmers dried their fields for the harvest.[3]

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[2]The available water supply used in this analysis is the discharge measured in the canal as it arrived at the command area. A more appropriate supply would actually be the flow in the stream at the diversion structure. It was not, however, possible to measure this on a daily basis because of the nature of the topography and stream discharge.

[3]Beginning the calculation after transplanting ignores the water needed for land preparation. This does not seriously affect the analysis because land preparation in these systems is accomplished in one day, using little water compared to the Philippines where the water utilized for land preparation may account for more than 30 percent of the seasonal requirement (Valera and Wickham 1974).

The expected ranking of systems was generated by 'the hypothesis that the degree of formal organizational structure would be inversely proportional to the GRWS. For example, a low GRWS would predict a high level of organizational structure, and a high GRWS, a low level of organizational structure. The hypothesis, thus, predicts that lhe Tallo Kulo of Thnmbesi, with the lowest GRWS would rank highest in degree of organizational formality and structure and Damgha Kulo of Majuwa with the highest GRWS, the lowest.

While the water supply may be scarce relative to the hydraulic command area, yielding a low gross relative water supply and a high expected level of formal organizational structure, the NRWS may not be low. This is because the area actually irrigated is often significantly less than the hydraulic command area. This can be seen in Table 1 where the hydraulic command area is compared with the area actually irrigated by the systems.

The Saili Kulo and Maili Kulo systems of Argali and Damgha Kulo system of Majuwa are land-constrained systems, i.e., the irrigated areas are bordered by other irrigation systems, major rivers, and drains which render irrigation of additional land unfeasible. The other systems are water-constrained, i.e., there is land in the hydraulic command area that is not being irrigated hut *to* which it would be feasible to deliver water. Table **3** presents both the GRWS and NRWS and compares the rank of the level of organizational structure predicted by each to the observed rank.

Since the GRWS in the Raj Kulo of Argali is low, the expected level of organizational structure is high. The GRWS and expected level of organizational structure of Argali's Kanchi Kulo are medium. However, the NRWS in these two irrigation systems is high and the expected level of organizational structure is low. In both of these systems there is additional area that could be irrigated, and the conclusion one would draw is that since the organization is using a large amount of water on a limited area it is weak and ineffective, and the organization of users is not using the scarce water resource efficiently.

Table 3. Predicted organizational structure determined by the GRWS and the NRWS compared to the observed rank.

			Predicted Rank[a]		
Organization	GRWS	NRWS	GRWS	NRWS	Observed Rank
Thulo Kulo, Chherlung	0.82	0.99	4	3	1
Raj Kulo, Argali	0.60	1.34	2	6	2
Tallo Kulo, Chherlung	0.67	0.90	3	2	2
Saili Kulo, Argali	1.26	1.26	7	5	4
Kanchi Kulo, Argali	1.02	1.35	5	7	5
Maili Kulo, Argali	1.18	1.18	6	4	5
Damgha Kulo, Majuwa	1.70	1.75	8	8	7
Tallo Kulo, Thambesi	0.28	0.61	1	1	8

[a]Predicted rank of level of organizational structure (1 = highest).

It is true that the organization does not appear to hr using the water efficiently.[4] But this is not because the organizations are loosely structured or ineffective. On the contrary, both are highly structured and effective.

It is not ineffectiveness of the organizations which accounts for the high water supply relative to the area actually irrigated Rather the organizations are able, through the established tradition of water rights, to effectively restrict access to water from the system. Thus, only a portion of the hydraulic command area receives irrigation for monsoon rice, even though there is sufficient water to irrigate a larger area if a more intensive form of management of distribution were adopted.

ALTERNATIVE HYPOTHESES

The above discussion has examined the hypothesis that the level of formal organizational structure is inversely correlated with the relative water supply and found that it does not hold for **a** number of the systems that were studied. These results forced us to look for other explanations for the organizational structure.

Weak at the Extremes, Strong in the Middle

Since the level of formal organization in Damgha Kulo in Majuwa with a very high GRWS and **NRWS** and that of Tallo Kulo **in** Thambesi with a very low GRWS and NRWS were similar, we hypothesized that the relationship of management intensity and formal organizational structure to the relative water supply is described by an inverted U-shaped function as in Figure 1.

Figure 1. Organizational structure vs. water supply: an alternative hypothesis.

[4]It is important to introduce a caveat here. The use of water was only measured during one year in these systems. It may be that in some years with less rainfall the organization must work very hard to irrigate the area that we observed and that water-use efficiency would be much higher. From comparison of annual rainfall data from a meteorological station nearby, the rainfall in the year we observed was about average.

At the extremes where water is either very scarce or extremely abundant, increased management efforts through a stronger organization are either unproductive or unnecessary. The maximum returns to, and thus, incentives for organized group activity may be in cases of intermediate water supplies. This type of community response function was suggested by Uphoff, Wickramasinghe, and Wijayaratna (1981) in analyzing incentives for farmers' participation in irrigation system management.

By this hypothesis it would be expected that the Tallo Kulo system in Thambesi and the Damgha Kulo system in Majuwa would both have very low levels of organizational structure, as they do. The rank order predicted by this hypothesis is presented in Table 4 together with the observed rank from Table 2.

Table 4. Rank order of levels of organizational structure predicted by inverted-U hypothesis and compared to the observed rank.

System	Distance from Mean NRWS[a]	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	-.19	5	1
Raj Kulo, Argali	.16	3	2
Tallo Kulo, Chherlung	-.28	6	2
Saili Kulo, Argali	.08	2	4
Kanchi Kulo, Argali	.17	4	5
Maili Kulo, Argali	.00	1	5
Damgha Kulo, Majuwa	.57	7	7
Tallo Kulo, Thambesi	-.57	7	8

[a]Observed NRWS of the system minus mean NRWS of all eight systems.

The organizations which the hypothesis significantly misranked are the Maili Kulo of Argali and the two organizations in Chherlung. It could be that the midpoint between the two extremes of Majuwa and Thambesi does not really define the point at which the maximum incentives for strong organization are to be found. The maximum of the inverted U may be closer to the NRWS of the Thulo Kulo organization in Chherlung than to that of the Maili Kulo of Argali, which happened to be the midpoint between the observed extremes.

Organization to Restrict Access to the Water Resource

The high degree of formal organizational structure of both the Raj Kulo and Kanchi Kulo systems might be due to the fact that they are irrigating less than the entire command area, yet operating at a relatively high NRWS. An argument could be made that systems with a relatively high NRWS and a low GRWS will need to have a strong organization to be able to restrict access to the water since there is additional land that could be irrigated. According to this hypothesis, systems which irrigate a low proportion of the hydraulic command area would exhibit a high degree of formal organizational structure and vice versa. Table 5 presents the ranking of the systems given by this hypothesis.

Table 5. Rank order of organizational structure predicted by the hypothesis that organizations are strong to restrict access to water.

System	Percent Irrigated	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	83	5	1
Raj Kulo, Argali	45	1	2
Tallo Kulo, Chherlung	75	3	2
Saili Kulo, Argali	100	6	4
Kanchi Kulo, Argali	75	3	5
Maili Kulo, Argali	100	6	5
Damgha Kulo, Majuwa	100	6	I
Tallo Kulo, Thambesi	45	1	8

One would think that since water is such a valuable resource, farmers whose fields are located so that they could be irrigated would be clamoring to force organizations like the Raj Kulo and Kanchi Kulo to allow them access to the water for irrigating monsoon rice. Surprisingly, very little of this type of sentiment was encountered. Several factors could explain this. First, the systems are very old, and the principle of water rights is so well established that people do not think of questioning it. Second, the information obtained concerning the development of these systems suggests that the relatively abundant supply may be a recent phenomenon. At least in the case of the Raj Kulo, improvements in the system over the past two to three decades are said to have greatly increased the volume and reliability of the supply.

Pressure to allow greater access to the water may yet develop as farmers without a water allocation realize over a period of time that there is excess water in the system. Finally, the fact that all farmers with fields in the command area are permitted to use the system to irrigate wheat and maize in the winter and spring may remove some of the pressure to allow wider access to the water in the monsoon season.

Organizational Structure as a Function of Size

Size, especially the number of members, would seem to be an important variable explaining the level of organizational structure. Organizational theory says that, in general, an organization with a large number of members will be more formally structured than one with fewer members. While this may contribute to the level of formal organizational structure, it does not explain much of the variation observed among the systems. The Damgha Kulo organization with 111 members is the second largest organization, yet has a low level of organizational structure. The Kanchi Kulo organization of Argali with only 28 members is considerably smaller than all the other organizations. However, it has a considerably higher degree of formal structure than the Tallo Kulo of Thambesi, with 55 members, and the Damgha Kulo organization. The number of members in each organization and the ranking of the relative levels of organizational structure predicted by this hypothesis arc. given in Table *6.*

Table 6. Number of organization members and rank order of organizational structure predicted by organization size.

System	Members	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	105	3	1
Raj Kulo, Argali	158	1	2
Tallo Kulo, Chherlung	61	5	2
Saili Kulo, Argali	51	7	4
Kanchi Kulo, Argali	28	a	5
Maili Kulo, Argali	72	4	5
Damgha Kulo, Majuwa	111	2	7
Tallo Kulo, Thambesi	55	6	8

ORGANIZATION TO MOBILIZE RESOURCES FOR SYSTEM MAINTENANCE - A TENTATIVE HYPOTHESIS

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

Rut there are other activities required for the operation of an irrigation system, and in different environments different ones may be more determinative of the organizational structure. After doing a rapid appraisal of irrigation systems in Iihairini in Gulmi District, we developed .an alternative hypothesis that better explains the organizational structure of farmer-managed irrigation systems in the hills of Nepal.

There are several irrigation organizations in Khairini, and all have an extremely abundant water supply. The organizations have almost no formal structure, much like the Tallo Kulo system in Thambesi which, however, has a scarce water supply. One of the Khairini organizations, however, did have a list of the members. Several years prior to our visit, this canal had been badly damaged by a flood. A list of the members had been compiled and attendance taken during the repair work. In thinking about this and reflecting on our observations *of* the other systems' organizations, we concluded that the mobilization of labor for maintenance of the system was a key activity in this environment and the factor which was most influential in determining the nature of the organizational structure. The greater the amount of labor that must be mobilized to maintain the headworks and main canal *to* capture and convey water to the command area, the more highly structured and formal is the organization. This was found to be true irrespective of the amount of supply available. In this environment of monsoon flood streams and unstable hill slopes, organization to maintain the system for water acquisition is more important than for water distribution.

Both the relative water supply and the need to mobilize resources for maintenance are, at least conceptually, important factors determining the structure of the management organizations of faimer-managed irrigation systems. The effect of scarcity of supply on the structure of the farmer-managed irrigation organizations has already been analyzed, and we have seen that, for the systems studied in the hills of Nepal, the relative water supply does not have the expected impact on the structure of the irrigation management organizations. The influence of the need to mobilize resources for water acquisition, particularly labor, on the level of formal organizational structure, will now be analyzed.

Analysis of Resource Mobilization and Organizational Structure

The critical organizational activity in many of the systems in the hill region of Nepal is resource mobilization for maintenance of the intake and main canal for water acquisition, and the structure of the organization reflects this. Many organizations do major annual maintenance in June prior to transplanting the monsoon rice crop. During the monsoon season, one or two men patrol the main canal every day to repair small leaks in the intake and canal and to alert other members if major damage, such as a landslide, has occurred, requiring emergency maintenance work by all members of the system.

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

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

All of the organizations in Chherlung and Argali have, in recent years, assessed cash contributions from their members to make improvements to their intakes and main canals. Keeping account of these contributions and the expenditures also requires a more formal organizational structure. The Damgha

Kulo system in Majuwa has the same need to record accounts since the maintenance is given out on contract. Contracts have also been given out several times for tunnel construction on the main canal of the Damgha Kulo system. The Tallo Kulo organization in Thambesi has not raised any cash from its members.

The records maintained by the organizations in Argali and Chherlung proved to be a good source of data concerning resource mobilization, particularly labor, over the years. No written records of labor mobilization were maintained by the Tallo Kulo system of Thambesi and Damgha Kulo system of Majuwa. An estimate of the total labor mobilized in Thambesi was made by taking the average number of days that the sample farmers reported they had worked on the system and extrapolating for the total membership. Maintenance of the Damgha Kulo is done on contract by several members. The value of the contract was divided by the daily wage rate to estimate the amount of labor mobilized.

Table 7 relates the amount of resources (man-days of labor) mobilized to the predicted and actual degree of formal organizational structure. According to Table 7, the level of formal organizational structure is highly correlated with the <u>total</u> amount of labor that must be mobilized annually in a system to acquire water, i.e., to maintain the intake and conveyance canal so that water can be delivered to the command area.

Table 7. Annual labor mobilization and rank of organizational structure predicted by resource mobilization compared to the observed rank.

Organization	Years of Labor Records	Total Annual Days of Labor Mobilized	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	3	2440	1	I
Raj Kulo, Argali	18	1909	3	2
Tallo Kulo, Chherlung	7	1979	2	2
Saili Kulo, Argali	4	1208	4	4
Kanchi Kulo, Argali	5	608	6	3
Maili Kulo, Argali	11	827	5	5
Damgha Kulo, Majuwa	a	440	7	7
Tallo Kulo, Thambesi	b	370	8	8

[a]Estimated by dividing the value of the maintenance contract. by the daily wage rate.
[b]Estimated by extrapolating from sample farmers' responses to a question about how many days they worked on the system.

It would seem that one could control for the scale of activity relative to command area. The amount of <u>labor per hectare</u> and <u>labor per member</u> are thus, other variables that should be examined, Table 8 presents an analysis of the predicted ranking of Organizational structure based on the labor required per hectare and per member.

Table 8. Labor per hectare and labor per member used to predict the level of organizational structure.

Organization	Man-days/ Ha	Predicted Rank	Man-days/ Member	Predicted Rank	Observed Rank
Thulo Kulo, Chherlung	70	3	23	3	1
Raj Kulo, Argali	41	6	12	5	2
Tallo Kulo, Chherlung	111	1	32	1	2
Saili Kulo, Argali	81	2	24	2	4
Kanchi Kulo, Argali	54	4	22	4	5
Maili Kulo, Argali	52	5	11	6	5
Damgha Kulo, Majuwa	16	8	4	8	7
Tallo Kulo, Thambesi	16	7	7	7	8

Neither man-days of labor per hectare nor man-days of labor per member proved to be as good as total labor for predicting the level of formal organizational structure in these systems, although both are better than the other variables which were tested.

STATISTICAL TEST OF THE RANKING OF ORGANIZATIONAL STRUCTURE BY DIFFERENT HYPOTHESES

A statistical procedure which can be used to compare the rankings of the organizations according to the predicted levels of formal organizational structure with the levels actually observed is the Spearman rank-correlation coefficient. It is a well-known non-parametric statistical method used to compare two rankings of a variable to determine whether they are statistically different (Snedecor and Cochran 1967:194). This statistic was calculated for the rankings predicted by each hypothesis, comparing the actually observed ranking of the levels of organizational structure from Table 2 with the predicted rankings. Table 9 reviews the rankings and presents the Spearman rank-correlation statistic for the ranking given by each hypothesis.

The ranking according to the total amount of labor mobilized for maintenance of the system is the one most similar to the actually observed ranking. The null hypothesis that they are uncorrelated is rejected at the 1% level. Annual maintenance labor per member is significant at the 5% level, and labor per hectare is the next best predictor. The two relative water supply variables are the poorest predictors for this sample of systems.

Inter-seasonal Comparison

All of the discussion and analysis above has been based on the organizations' activities and structure for the monsoon rice season. A comparison of organizations in this season with their activities and structure in the winter season supports the above conclusions. The Raj Kulo of Argali is a particularly striking case. In the winter, the water supply in the stream is much less than during the monsoon, yet the area that is irrigated is over 100 hectares compared to 47 hectares in the monsoon season. Farmers who do not have access to water for irrigating rice are permitted to irrigate wheat in the winter. This can be done because irrigation of wheat requires much less water than irrigation of rice.

Table 9. Ranking of systems according to **predicted** level of organizational structure.

System	A	B	C	D	E	F	C	H	I
	Ranking Variable or Hypothesis								
Thulo Kulo, Chherlung	1	4	3	5	5	3	1	3	3
Raj Kulo, Argali	2.5	2	6	3	1	1	3	6	5
Tallo Kulo, Chherlung	2.5	3	2	6	3	5	2	1	1
Saili Kulo, Argali	4	7	5	2	7	7	4	2	2
Kanchi Kulo, Argali	5.5	5	7	4	4	8	6	4	4
Maili Kulo, Argali	5.5	6	4	1	7	4	5	5	6
Damgha Kulo, Majuwa	7	8	8	7.5	7	2	7	8	8
Tallo Kulo, Thambesi	8	1	1	7.5	2	6	8	7	7
Rank correlation coefficient	-	.18	.14	.34	.19	.30	.98[b]	.68	.75[c]

A - Observed level of organizational structure
B - GRWS
C - NRWS
D - Inverted U-shape (weak at extremes, strong in middle)
E - Percent of command area irrigated
F - Number of members in organization
G - Total maintenance labor per year
H - Maintenance labor per hectare
I - Maintenance labor per member per

[b] significant at 1% level
[c] significant at 5% level

The intensity of management and the level of formal orqanizational structure is much lower in the Raj Kulo system during the winter than in the monsoon season. There is no systematic procedure for coordinating water distribution among all the farmers. Farmers meet at a designated place on the main canal on the day they want to irrigate, and those who are there that day decide among themselves the order of distribution. In the winter almost no maintenance is required to keep the water flowing. There is very little rainfall during this season; hence, the intake is seldom destroyed by floods, and landslides which damage the canal rarely occur. Thus, the organizational mechanisms for resource mobilization are not observed in the winter.

System Performance

There is a relationship between the need to mobilize resources to acquire water and the effectiveness of distribution of the water. Lewis (1971) compared two systems in the hills of Illocos Norte in the Philippines. The one required much maintenance (40 to 60 work days per member annually). It enforced fines for absence from work, and repeat. offenders were denied water. However, in the year that he observed, there were few absences, and all fines were paid. The members were satisfied that they were receiving the water to which they were entitled. In the other system, much less maintenance labor was required, but "some members regularly failed to appear for labor, and fines against them are often impossible to collect" (Lewis 1971:165). Members in the tail area of this system complained of inequitable distribution, and several who were most commonly not. served dropped out of the organiaation.

Similar results were seen in the systems studied in Nepal. In systems requiring the mobilization of large amounts of resources for maintenance, the distrihution of water more nearly coincided with the allocation of entitlements to the water than in systems that require little effort in water acquisition. In the Tallo Kulo of Thamhesi, which requires little labor for maintenance, the fields at the tail of the system suffered much more moisture stress than those at the head, even though their allocation of water was said to be the same. This was not true of systems in which much labor had to he invested to keep the supply flowing. In these the actual distribution of water matched the allocation of water remarkably well. Yoder's (1986) analysis of water distribution and stress in the Kanchi Kulo of Argali and the Thulo Kulo of Chherlung demonstrates this.

The organizations in Argali and Chherlung required the resources of all the members to acquire the water. The farmers at the head of the system could not take all the water they wanted, denying the tailend farmers their share, because they were dependent for their supply on the assistance of those at the tail in maintaining the system. This interdependence among the farmers in systems requiring a high level of resource mobilization is a key factor affecting their equitable and efficient operation. Where few resources are needed to keep the supply flowing, the farmers at the head do not have to be concerned with keeping the tailend farmers satisfied that they are receiving their fair share of the water so that they will continue assisting in the acquisition of water.

It appears that it is more difficult to maintain an effective organization in a system where water distribution is the primary activity than in one where water acquisition is the key activity. Farmers in a system all face the same incentives for water acquisition but not for distribution. When water is scarce, the farmers at the head have an incentive to break the rules and take more than their allotted share of the water. Without the interdependence resulting from the need to mobilize much labor for maintenance, it is more difficult to enforce an equitable distribution of water.

CONCLUSION

An irrigation organization has a number of different tasks which it must accomplish to make effective use of the water resource in agricultural production. Different environments render different activities more or less important, and the nature of the activity and its relative importance will determine, to some degree, the organizational requirements of a system. These in turn, will have an impact on the structure of the organization.

The physical activities directly related to water in an irrigation system are: acquisition, distribution, and drainage. In the extremely well-drained soils of the river terraces in Nepal where the systems studied are located, drainage is not a significant concern of the organizations. Both acquisition and distribution are important. A more intensive technology and management to achieve a greater degree of control over the distribution of water were observed where the water supply was scarce relative to tho area irrigated. Organizations installed technology (saachos) or adopted management practices (rotational distribution or distribution by contract) which enabled them to distribute scarce water more efficiently and equitably. However, this activity did not have nearly as great an impact on the structure of the organizations as did the activity of water acquisition.

Organizations which must mobilize large amounts of resources, particularly labor, to maintain the system for acquisition of water, irrespective of the amount of water delivered, exhibited a higher degree of formal structure than those which require relatively few resources to keep the water flowing. The water supply relative to area irrigated (NRWS) and the amount of resources that must be mobilized for water acquisition certainly affect the nature of the organization, but the organizational requirements for mobilizing resources to acquire water dominate the structure of the organizations in this environment,.

The labor requirement for rotational distribution can be considerable although, with the exception of the Tallo Kulo in Thambesi, it does not exceed the labor needed for water acquisition. Even though a significant amount of labor may be required for water distribution, it does not have the same effect on the organization as the labor for acquiring the water. This is, at least in part, because labor for distribution is essentially an individual affair.[5] The organization as a whole does not suffer if an individual is absent when it is his turn to receive water--only he does. However, if failure to participate in maintaining the system results in less water delivery, everyone will suffer to some extent from a shortage of water.

Systems that required the mobilization of large amounts of resources for maintenance had better performance as measured by the comparison of actual water distribution to the water allocation. Where the organizations were strong, requiring resources from all members to acquire the water, farmers at the head of the system could not take all the water they wanted, denying the tailend farmers their share. Farmers at the head were dependent for their supply on the assistance of all users in maintaining the system. This interdependence among the farmers in systems requiring a high level of resource mobilization was found to be an important factor affecting the equitable and efficient operation of systems.

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[5]There are examples, though not observed in the systems studied, of a group of farmers working together for distribution. When it is time for the group's part of the system to receive water, some of them police the canal while others in the group irrigate.

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RESOURCE MOBILIZATION AND ORGANIZATIONAL SUPPORT IN IRRIGATION SYSTEM MANAGEMENT: EXPERIENCES FROM KULARIYA, JAMARA, AND RANI KULOS OF KAILALI DISTRICT

Prachanda Prsdhan, Khadka Giri, and Dirghs Nidhi Tiwari

INTRODUCTION

Irrigation organizations are formed to perform different sorio-technical functions for irrigation systems. These functions range from water acquisition, water allocation, water distribution, and drainage to the design, construction, maintenance of the system, resource mobilization and management,. However, the importance of the particular function differs from system to system on the basis of the nature and terrain of the system.

Kulariya, Jamara, and Rani Kulos of the eastern part of Kailali District joined together in 1986 in order to acquire water collectively from the Karnali river, one of the biggest river systems in Nepal. Hence, the East Kailali Irrigation System, formed by the consolidation of Kulariya, Jamara, and Rani Kulos, **is** one of the largest farmer-managed irrigation systems, commanding about 15,000 hectares (ha). Previously, these systems were separate and took water from the Karnali independently.

Gross area as measured from the 1:10,000 scale aerial photograph is about 20,000 ha. This large expanse of tarai plain gently slopes ***to*** the south. The western boundary of the command area is the Patharaiya River and the southern boundary is the Mohana river, which is also the border with India. The command area of the canals has expanded over a period of time due to the clearing **of** forests and settlement programs. The cadastral survey of 1964 indicated a command area **of** only 8,000 ha. According to a recent water resources inventory and estimates on the basis of aerial photography taken in 1987, the command area is about 15,000 ha. Table 1 gives the area irrigated in each panchayat in the command area as reported in 1985.

The discharge of the Karnali varies from season to season. According to the Karnali project report, the average water discharge is 1,340 cubic meters per second (m^3/s). The lowest discharge is between 250-300 m^3/s. The highest discharge is about 24,500 m^3/s, occurring during a high flood in 1984.

About one kilometer below Chisapani, the Karnali River divides into two channels. The left channel **is** called Gerwa and the right Karnali. In 1984 there was a large flood that caused major changes in the systems. The river course shifted so that in the dry season the Karnali channel dries up and more effort is required **of** the people of these irrigation systems to divert water from the Garwa to the Karnali channel (see map).

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Map of the Kulariya, Jamara and Rani Kulo Irrigation systems.

Because of the huge variations in discharge, annual repair of the intake and the canals near the Karnali river is a major operation. In order to meet this challenge the irrigators have to mobilize people and resources. Both money and natural resources such as branches, brush, and stones are needed. There are different tiers of organization in existence to mobilize these resources for the repair and maintenance of the system.

Table 1. List of panchayats and area irrigated in each panchayat in the command area.

Panchayats	Area Irrigated (ha)
1. Baliya	400
2. Pathaiya	1750
3. Janaki Nager	945
4. Duragauli	1130
5. Manuwa	1650
6. Tikapur	3710
7. Narayanpur	1760
8. Dhangsingpur	1755
9. Pratapur	300
TOTAL	14000

Source:Hydro-Engineering Service. Water resource inventory study of Kailali Districts of Seti zone. WECS, Kathmandu.

OBJECTIVES OF THE PAPER

The objectives of this paper are to identify:

1. The features of organizational support for internal and external resource mobilization for the operation and maintenance of the system.

2. The organizational structure and its implications on resource mobilization.

3. The adjustment and adaptation of the organizations to changes in the environment such as expansion of the command area and demographic changes within the command area.

4. The adaptation of different levels of organization in order to mobilize external resources.

METHODOLOGY

The study is divided into preparatory work and field work. In Kathmandu, preparatory work sought to identify a large farmer-managed irrigation system. Water resource inventory reports of Dang Deukhuri, Bardiya, and Kailali Districts were studied and vital information from these reports (Hydro-Engineering Service 1985) was collected. A reconnaissance report by Tahal Consulting Engineers was also reviewed (Tahal Consulting Engineers 1978).

Dr. Hari Man Shrestha and Mr. B.K. Pradhan of the Water and Energy Commission were also consulted before going to the field.

Reconnaissance was done by a team consisting of a social scientist, an agricultural economist, and an agronomist in November 1986 (see Shivakoti, et al.). Interviews were conducted with the farmers, officials of the irrigation system, and elites of the area. The physical features of the system were also observed.

After the reconnaissance, a six-member team consisting of three engineers, one agricultural economist, and two social scientists went to the Kailali systems to identify the area for study. it was decided that, the stud? would be phased into two years due to its size. During the reconnaissance and subsequent trips, information was collected through interviews with the leaders of these systems. Their record books were also examined.

In the meantime, the study on resource mobilization and organizational interaction was initiated. Major resource mobilization activity takes place during February and March. An Asian Institute of Technology graduate student, as a part of his master's thesis research, was fielded in Chisapani to observe the operation of the organization and resource mobilization.

CONCEPTUAL FRAMEWORK ON RESOURCE MOBILIZATION

Resource mobilization is one of the major functions of farmer-managed irrigation organizations. The major share of manpower, materials, and money for the operation and maintenance of the system comes from within the system. There is a close relationship between the strength of the irrigation organization and the amount of resources the organization must mobilize. The greater the difficulty for the acquisition of water, the more resources require:?, the stronger the organization has to be.

One of the objectives of this paper is to show that the type of irrigators' organization that exists in a particular system is related to the nature of the resources the organization must mobilize. A change in the environment may force the organization to adapt its structure in order to respond to the changed environmental requirements. Examples from the East Kailali Irrigation System demonstrate the dynamic nature of these organizations.

Internal Resource Mobilization

Resource mobilization can be broadly categorized into internal and external mobilization.

Within the irrigation system itself there are a number of different resources which the community may have to organize, obtain, and utilize. Internal resource mobilization includes:

1. Labor mobilization.

2. Cash mobilization.

3. Acquisition of forest products such as tree trunks, brush, and branches (jhalapata).

4. Mobilization of bullock carts to bring jhalapata and stone for temporary diversion dam construction or to make the proportioning weirs,

5. Establishment of enterprises such as water mills by the irrigation organization.

6. Sale of water share, as in the Chherlung systems of Palpa district.

7. Utilization of any technical expertise which may exist among members of the community.

The common feature of resource mobilization for operation and maintenance (O&M) in farmer-managed systems is the labor and cash from within the command area and from among the water users. Other resources such as bullock carts and forest products are also used. In the Kulariya system, each water user pays approximately US$ 0.50 (Rs 10) to get permission from the Forest Range Office to collect jhalapata to divert water and for construction of the bunds and temporary check dams. The assigned forest for the collection of these materials is far from the work site, so the bullock carts are needed to transport the jhalapata (Yoder, et al. 1987).

In some systems, in order to lessen the burden on labor mobilization, the irrigation organization has entered into the operation of water mills. The money collected from this enterprise is used for system maintenance.

In other systems, water is considered a salable product. Water is sold to expand the membership and finance improvement of the system. Water selling is also seen in some systems as the basis upon which resource mobilization for irrigation improvement is calculated (Martin 1986).

Utilization of the local people's knowledge is also important. The knowledge of local leaders about what can be done and how it can be done are significant resources existing within many systems. For example, the expertise of local tunnel makers was used in hill irrigation systems of Nepal.

Each irrigation organization must develop a structure and set of rules in which to operate so that resources can be effectively mobilized. During the time of labor mobilization, the norms, basis, customs, and amount of work t.o be done are considered and determined by the organization. The rules for the enforcement of labor mobilization are established by the irrigation organization. In the same way, the rules of punishment for members who do not fulfill their obligations to the organization are strictly supervised by the .irrigation organization.

Changes in the Kailali internal resource mobilization structure. The characteristics of resource mobilization change along with changes in the resource base such as water course changes, or expansion of the command area, or population growth resulting from migration into the system. In the irrigation system under study, all these factors of change have taken place. In the initial stage of irrigation development, the Kailali system had abundant land but there was a shortage of manpower. Every able body from each household had to contribute to the repair and maintenance of the system irrespective of the size of landholding in the command. With the migration of hill people to the area, lack of manpower is no longer a constraint. At present, labor contributions for O&M are determined by the size of individual landholdings. Hence, population changes within the command area resulted in an increase in the labor resource and prompted a change in the basis upon which labor contributions are determined. The character of the organization cannot remain static but must adapt to these changing situations.

External Resource Mobilization

In some irrigation systems the O&M requirements are greater than the capacity of the farmers to perform. In this case they must organize and seek outside help, usually from government or international donor agencies. In order to obtain external resources the irrigation organization may have to strengthen its leadership and adapt its structure. External resource mobilization encompasses a number of different activities:

1. Cash mobilization at the national, district, or village panchayat levels, or from voluntary or international organizations.

2. Material mobilization including gabion wire, cement, pipes, or food for **work.**

3. Dissemination of technological knowledge from outside sources.

4. Supervision by the technical people of work done by the local people. This could be from within the country, or from international agencies or from international voluntary organizations.

5. Machinery mobilization. Bulldozers or excavators are brought in during the time of desilting or repair of the canals.

6. Credit mobilization.

External resource mobilization in the Kailali systems. In 1984 a large flood caused a shift in the river course where the Karnali River divides into the Karnali and Gerwa channels. During the dry season, water no longer flows into the Karnali channel and farmers of Kulariya, Jamara, and Rani Kulos must make much larger investments of time, labor, and equipment to obtain water than before. They have therefore sought outside assistance.

Rani Kulo and Kulariya Kulo have mobilized some resources from Kailali district panchayat. However, the money was channeled through the village panchayat. These irrigation systems extend over nine village panchayats so giving money to only one village panchayat does not help the improvement of the system. However, the irrigation organization does not have a legal base so it has to align with local political units for external resource mobilization. As a result, nonbeneficiaries become involved in the leadership of the organization and the irrigation organization is pushed into the political arena where factors extraneous to the operation of the system may take control.

Previous to 1987, Kulariya, Jamara, and Rani Kulos each had its own irrigators' organization which functioned independently of each other. On 18 February 1987 a joint committee of the three irrigation systems was formed with the purpose of obtaining external support for the O&M of irrigation in the command area. The farmers felt that they needed the support of an influential person and obtained the cooperation of Mr. Khadga Bahadur Singh, a very prominent national politician, who was named chairman of the joint committee. Mr. Singh does not have land in these irrigation systems, so he is neither user nor beneficiary. However, the users felt that he would be useful in drawing government's attention to these irrigation systems.

In 1987, approximately US$ 3,196 (Rs 70,000) was granted by the Ministry of Agriculture and a bulldozer was assigned to help with the repair and maintenance of these systems. All the water users of the three canals worked together to divert water from the Karnali. According to the records, the Kulariya Kulo was responsible to send 963, Rani Kulo 353 and Jamara Kulo 740 laborers each day of work for a total of 2,056 persons. Table 2 gives the actual details of the labor-days contributed in the main canal diversion work. It shows that an average of 2124 person were working each day.

Money and bulldozers made available to the irrigation system this year were obtained through the Tikapur Development Board of Kailali established in 1971. Because the irrigators' organization has no legal standing, it cannot directly receive government funds. However, Mr. Khadga Bahadur Singh is the chairman of the Tikapur Development Board. Through his influence, money and equipment were made available to the Tikapur Development Board, which channeled the resources to the East Kailali system. Mr. Singh was also able to obtain the attention of His Majesty King Birendra, who, during his Far Western Nepal tour in 1987, issued a directive to make technical manpower and gabion wire available for the improvement of these systems.

Table 2. Details of labor days involved in the main canal diversion work.

Day	Number days	Canal Subsystem	Number of persons per day: Working	Supporting	Total	Person days: Working	Total
6-14	8	Rani Kulo	357	163	520		
		Jamara Kulo	449	220	669		
		Kulariya Kulo	632	270	902		
		Sub total	1438	635	2091	11,504	16,728
13-24	11	Rani Kulo	667	121	788		
		Jamara Kulo	648	154	802		
		Kulariya Kulo	519	152	671		
		Sub total	1834	427	2261	20,174	24,871
24-26	3	Rani Kulo	341	170	517		
		Jamara Kulo	448	204	652		
		Kulariya Kulo	329	214	543		
		Sub total	1124	588	1712	3,372	5,136
		Total	4396	1650	6064	35,050	46,735

Source: Khadka Giri field observation record. February 1987

HISTORY OF THE AREA'S IRRIGATED AGRICULTURAL DEVELOPMENT

Some time ago, Kailali belonged to Kalwapur Raja, who was also known as Chisapani Chautariya. About 60 years ago Colonel Dhundi Raj Sahi, Bada Hakim of Bardiya, got the zamindari of Tikapur. He initiated the canal construction, Rani Kulo being the first built.. The chaudhary of Kulariya confirms this historical event. The old people of Tikapur could identify only a few villages in existence 40 years *ago*. They are Derawali, Belwa, Laxhmipur, Satti, and Bhagwanpur. The rest of the area was covered by thick forest,.

According to the statute of Nepal at that, time, under the section of new cultivation, certain districts including Bardiya, Banke, Kailali, and Kanchanpur were encouraged to cultivate new lands. Landlords who cultivated the land were given a 10-year land revenue holiday. New villages were settled and people brought in from other areas. These people were given shelter and food and were expected to work for the landlord. The agricultural laborers kept moving from place to place and productivity was very unstable.

At present, agricultural laborers are hired on the basis of a one-year contract known as kamaiya. They receive food plus remuneration, and credit when they need it. By and large, the Tharus, who compose the majority of the agricultural labor force in this area, prefer this kamaiya arrangement. However, the laborers under this contract have little incentive to increase agricultural production.

STRUCTURE OF THE IRRIGATION ORGANIZATION

The main functionaries of the irrigation organization of the three canals are the following:

Chaudhary. The chaudhary is the chief of the irrigation system. Previously, the local landlord himself would be the chaudhary. Now, ercept in Jamara, Tharus have become the chsudhary. The chaudhary calls the meeting of badghars or assistant chaudharys to resolve issues regarding irrigation and assumes the leading role in the resolution of conflicts. He determines the date when desawar (the farmers' assembly) is mobilized for repair and desilting of the main canal. The chaudhary must be present during all labor mobilization and maintenance work. The pan chirage reports to him on the condition of the canal and dams.

Pan Chirage or Desawar Chirage. He is the messenger of the irrigation system. The chaudhary communicates to the badghar through the pan chirage. His other major responsibility is to go to the intake every other day and supervise the system. If there is a major breach or break, he reports to the chaudhary and the chaudhary, with the help of the badghars, mobilizes people to repair the system.

Badghar. The badghar is the leader in the village. His cooperation is necessary to obtain the participation of the villagers. The badghar is responsible for the village irrigation canal, the village road, and other public works in the village. The badghar settles village conflicts. He also maintains the village water distribution schedule.

He is the chaudhary's contact to mobilize villagers for irrigation maintenance. He has to bring his quota of people during the annual repair of the canal. Each year, the badghar reports how many people are coming from his village to participate in the annual repair work. If he fails to bring that number of people, he is fined.

During maintenance and repair, he has to bring an ax to clear the trees on the canal route. Therefore, he is expected to walk in front of the group.

Nandnrwa. The nandarwa allocates the area to be desilted by each village. During desawar, he specifies what is he done, how it is to he done, and certifies that the work is completed. He carries a 10-foot stick called a ~~nan~~. One person per 18 inches per day in easy areas, and two persons per 18 inches in difficult, rocky portions of the canal is the basis for work allocation. His allocation of work is final,and it is strictly supported by the kulo chaudhary and other leaders.

Pachuwa. The pachuwa assists the nandarwa and works in his absence.

Lekhandaran. The lekhandaran keeps all the records. He records the attendance of the farmers in the farmers' assembly. Those who are absent from the work are fined. He is accountable to the farmers' assembly.

Budhiya. Previously, fines collected in the system as well as any unspent funds were deposited in the care of the budhiya. Now however, this function is performed by local hanks. Funds collected in the system are deposited in the banks under the joint names of the chaudhary and lekhsndaran.

Desawar (Assembly of all the farmers). The desawar takes care of maintenance and repair of the system. Desawar also refers to the time when all the farmers of the system work collectively to do major maintenance of the canals.

The farmers elect the organization's leaders and during times of crises in decision-making, the desawar helps make the decisions.

When the fines imposed could not be collected, all the members (desawar) of the system go to the village of the defaulters, and force them to pay the fine. Different methods including physical assault or damage to property are used to collect the fines. The funds collected are used by the desawar for feasting.

DESAWAR IN ACTION

The pan chirage announces the date for mohilization for canal repair work at Chisapani according to the decision of the desawar. The irrigators have to he present at the work site and stay for five days.

When they come to Chisapani they make temporary sheds and set up a common kitchen for each village. Each village brings the following items to the work site: 1) 5 kg of rice; 2) cooking oil, salt, red pepper; 3) plates and drinking glasses; 4) quilts or blankets; 5) picks (pharwas), axes, and sickles; 6) round umbrellas of bamboo (local); 7) bankas (a kind of grass to make rope) or net weaving thread; and 8) cooking pots and water cans. The cooking pots are community property which are used only for desawar.

The nanderwa carries a 10-foot long stick and the people follow him. The name of the village and amount of the work to be done is called out by the lekhandaran out of the record hook, and measurement of the work to be done is designated. As soon as the work is assigned, the people start to dig the canal. The work must be completed within a fixed amount of time. The nandarwa assigns the width and depth of the excavation to be done. When the work assignments are being made another person walks ahead of the nandarwa carrying a 10-foot ,stick with a white cloth hanging from the top. This man's job is to establish a target that the nandarwa can see above the press of the crowd of workers in order to be able to lay out. the canal in a straight line.

If the assigned number of people from the village do not show up, the work is riot completed. The badghar or assistant chaudhary of that village is summoned by the chaudhary of the system. If the people from that village do not appear for work, the whole village is fined. Should the village be recalcitrant in payment of the fine, the desawar visits the village and obtains the fine by any means.

After the main canal desilting and intake repair work is completed, the desawar works on its distributory and field channels. Because of the flat terrain, check dams are needed at the offtake of distributories anti field channels.

Observations on Resource Mobilization for River Diversion in 1987

River diversion took 22 days of Desawar and 26 days of bulldozer work. The total number of people mobilized in 22 days was 46,000. The quantity of earthwork excavated during this period was about 30,000 cubic meters (m^3). Table 3 gives the details of the volume of excavation done by the farmers. The total volume of work done by bulldozer for river diversion was 13,936 m3 plus the work in last year's diversion of 1,617 m^3 (Table 4).

Table 3. Volume of excavation (boulders, stones, gravel) done by farmers including support staff in the main canal diversion.

Date	Details of Work Done				Days Worked
	Length (m)	Width (m)	Height (m)	Quantity (m^3)	
6-14	785.9	20.0	1.0	15,718	8
13-24	620.4	13.5	1.30	10,888	11
24-26	208.0	20.6	0.84	3,599	3
Total	1614.3			30,205	

Source: Khadka Giri field observation. February 1987.

The total volume of boulders, gravel, and sand removed by people and machine to divert water from the Karnali into the canals is 45,500 m^3. (This is the description of only one part of the work they have completed in diverting the river. The quantity of work done by the desawar in individual canals and intakes has not been included here.)

The farmers, with support staff, were able to excavate 0.86 m^3/day (See Appendix 2). Analysis of' rates by His Majesty's Government, Nepal (HMGN) prescribes the quantity of work to be done per laborer *to* be 0.67 m^3/day. A comparison of the figures shows that the farmers were able to excavate more earth per day than government laborers.

Table 4. Volume of excavation (boulders, stones, gravel) done by bulldozer.

Measurement period	Length (m)	Average width (m)	Height (m)	Quantity (m^3)	Time (hr)	Output (m^3/hr)
1	34	19.0	0.54	348	5.5	63
2	300	24.8	0.43	3199	28.0	113
3	220	20.0	0.57	2508	40.0	63
Total	554			6055	73.5	82

Total hours work done by bulldozer = 156 hr
Total volume of work done on new canal: 156 hr x 82 m^3/hr = 12,800 m^3
Desilting work on old canal (4 days) = 1,617 m^3

Total volume of work done by bulldozer 14,417 m3

Source: Khadka Giri field observation. February 1987.

The total cost incurred in mobilizing desawar at US$ 0.68/day/person (Rs 15/day) comes to US$ 32,010 (Rs 701,000). The unit cost of work done when the support labor is included comes to US$ 1.06/m^3 (Rs 23.221. This is almost exactly the government rate.

The cost per unit of work done by bulldozer comes to US$ 0.22/m^3. This does not include the costs of fuel and lubrication for the machine. depreciation, and food for the driver and helpers.

SUMMARY

Changes in the environment in which an irrigation system operates may compel the farmers in the system to use their internal resources differently. Such changes may also promote a need for the mobilization of resources external to the community. In order to adapt to the changing needs of the system, the irrigators' organization, its rules, leaders, and structure also adapt to accommodate new situations.

The example of the development of the three irrigation systems within the East Kailali command area demonstrates this dynamic principle. When the available labor force grew and the command area increased, the organization revised its basis for O&M labor contributions. The changed river course and the wide fluctuations of discharge in the Karnali required O&M resources beyond the capacity of the farmers. As a result, the farmers of Kulariya, Jamara, and Rani Kulos decided to join together to obtain external assistance. For this purpose a joint committee with representatives from each of the three systems was formed and an influential outsider was named chairman. Once again, the structure and leadership of the irrigators' organization adapted to the requirements for more extensive resource mobilization.

The structure of the irrigators' organization is closely related to the extent and type of resources it commands. Changes in resources produce an adaptive response in the organization which may go beyond the individual system level. In order to perform effectively, irrigators' organizations do not remain static. As the environment in which they operate changes, the organizations develop various mechanisms for response.

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APPENDIX 1

CLASSIFICATION OF FARMERS FOR THE PURPOSE OF LABOR MOBILIZATION EXAMPLES FROM RANI KULO SYSTEM

Farmers of the area have defined specific rules to assure that labor assignments are shared equitably. The irrigatiot. organization classifies the farmers according to the amount of land each owns, and work assignments are apportioned according to this classification. The following examples are taken from the minutes of the Rani Kulo organization's 1985 meeting.

Sadriya. Those farmers who own .03 ha or less are called Sadriya. They are exempted from work and pay only US$ 0.68 (Rs 15) for the whole season.

Kodriya. Small farmers with less than **3** ha and only one pair of oxen need to contribute five days labor per turn.

Kisan**.** Farmers holding more than 3.0 ha and owning two pairs of oxen are expected to provide labor throughout the time work is in progress. Each member of his household needs to work for five days in turn.

From all categories, women are exempted from irrigation work.

In March, 1985, the Rani Kulo committee consisting of leaders of three panchayats and irrigation organization leaders made the following decisions.

1. A fee of US$ 0.68/0.03 ha (Rs 15/.0.03 ha = Rs 500/ha) is charged to farmers owning 0.15–0.30 ha

2. Farmers who own a plow are assessed an additional fee of US$ 19.22 (Rs 420).

3. Farmers who own two plows must contribute labor every day that work is in progress, **plus** pay a fee of US5 38.45 (Rs 840)

4. Farmers who do not fulfill their obligations to provide labor will be summoned for repair and maintenance work and fined for the days **of** absence at the rate of US$ 0.68 (Rs 15) per day through the badghar. If the badghar does not obtain cooperation, the case is reported to the panchayat. Finally, if results are not achieved through the panchayat, desawar makes the final decision, and the entire assembly of farmers will force the defaulter to comply.

5. Funds held by the organization are used for the following: a) to pay annual allowances to the chaudhary (US$ 27.40 [Rs 60011, nandarwa (US$ 21.92 [Rs 480]), lekhandaran (US$ 16.44 [Rs 360]), and pachuwa (US$ 5.48 [Rs 120]); b) to organize the feast for desawar; and finally, c) the surplus is deposited in the bank.

6. The committee meets and decides the main **issues** before desawar.

7. Accounts of the organization are settled at a meeting at which the pradhan panch (panchayat leader), chaudhary, badghar, and kisans are present.

APPENDIX 2

EXAMPLES OF THE RESOURCE MOBILIZATION IN 1987

Field measurements were taken during resource mobilization in 1986/87 for main canal diversion wrrks. The comparative figures of work performance in man-days and volume of the earthwork done is indicated in Table 5.

Table 5. Analysis of work output per person.

Excavation (including support persons):

30,205 m^3/46,735 person days = 0.65 m^3/person/day

Excavation (without support persons):

30,205 m^3/35,050 person days = 0.86 m^3/person/day

Table 2 indicates that the total person days employed in the main canal diversion was 46,735 with actual work done (not including the supporting persons) amounting to 35,050 person days. Performance of the laborers in excavation work per day as seen from Table 5 is 0.86 m^3/day. The quantity of such works assigned per person in the analysis of rates (9) suggested by HMGN for the purpose of labor requirement estimations is about 0.67 m^3. The farmers were able to excavate more earth per day than government laborers. Being more motivated to complete the job, the farmers may have worked more hours per day.

At the same time a bulldozer was mobilized for 26 days to remove the mixed deposit of sand, gravel, and boulders. The total quantity of deposits removed by the bulldozer was estimated to be 13,936 m3 with additional desilting work of 1,617.0 m3.

The total cost incurred in mobilizing desawar at the rate of US$ 0.68 (Rs 15.0) per man-day is US$ 32,010 (Rs 701,000) and the per unit cost of work done comes to US$ 1.06/m^3 (Rs 23.22). This rate is almost exactly the same as the government rate which is US$ 1.05/m^3 (Rs 23). However, if the supporting work for food, etc., is not included as it would not be in the government rate, then the per unit cost of work is US$ 0.79/m^3 (Rs 17.30).

Resides depreciation on capital cost, the total amount of money assigned for bulldozer by the government was US$ 3,425 (Rs 75,000). The cost per unit of work done by bulldozer at this amount is US$ 0.22/m^3 (Rs 4.82). In addition, the beneficiaries also paid fuel and lubricants for the machine and food for the driver and helpers.

PROPERTY PERSPECTIVE IN THE EVOLUTION OF A HILL IRRIGATION SYSTEM: A CASE FROM WESTERN NEPAL[1]

Ujjwal Pradhan[2]

THE FOCUS OF INQUIRY

National governments and agencies involved in irrigation development in Asia, as elsewhere, frequently have experienced unexpected problems and outcomes from their intervention in farmer-managed irrigation systems. Several causes of these problems and unintended results have been identified, e.g., poor technical design, agency inefficiencies, non-existent local organization. Consequently, governments and agencies have been perplexed as to how best to work with community- or farmer-managed irrigation systems.

(Inward (1985; 1985a) suggests that another cause of problems is the alterations in property rights that often occur during project implementation. To examine this proposition, field research was carried out on several hill irrigation systems in Nepal which investigated the dynamics of property rights and obligations.

The discussion in this paper is limited to the preliminary findings on the negotiation processes for arriving at agreements which affect water allocation and sharing arrangements. The arrangements have resulted in alterations in property rights and relations. A section on the research methodology is included.

CONCEPTUALIZATION

In irrigation systems, different kinds of property rights and relations exist over different objects (i.e., land, labor, water, and hydraulic structures). These relations change over time and space.

Irrigated agriculture creates and is created by social :*elations based on the use and control over not only land, but also hydraulic structures and water. An understanding of such property relations would facilitate a more comprehensive understanding of irrigated agriculture.

Property is a complex system of recognized rights and duties with reference to the control of valuable objects. The processes of social interaction for control of such objects are validated by traditional beliefs, attitudes, and values and are sanctioned in custom and law. Hallowell (1955:246) notes that property rights are institutionalized means of defining who may control various classes of valuable objects for a variety of present and future purposes. Property rights also outline the conditions under which this power of control may be exercised.

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Property could also be considered as a conglomerate of rights especially when different people exercise different rights over a particular object of property. Though a person may have ownership rights, the usufructuary rights may be with somebody else. And at times, thr owner of a certain object cannot alienate this object to whomsoever he or she pleases. Certain sanctions and constraints might be laid down. The nuances and deviations from one such conglomerate to another would depend very much on the nature of the broad macro social formation as well as the micro individual, communal, or customary adjustments made. Often, this macro to micro interaction determines the nature of a certain set of rights.

Since property rights direct benefits to certain individuals or groups, they are not only mechanisms of acquisition or access, but also mechanisms of distribution. Where a change in property rights alters this distribrition of wealth, income, or benefits, the result will create new gainers and new losers. Naturally, people do not always prefer the existing framework of property rights, or the proposed changes in their structure. Such changes define certain adjustments in the social relationships among people.

Coward notes that the development of irrigated agriculture is a property creating process in which both the local communities as well as the state at large have played interactive and dynamic roles (Coward 1983:4). In community irrigation systems, Coward observes that the group must have the capacity to mobilize labor for its initial property creation and the capacity to regularly repeat this labor investment to sustain and elaborate what had been created. Often the basic relationships among the members and leaders of a system are property based, i.e., their relationships reflect the rights and privileges that the respective parties have to the common property of the irrigation works (Coward 1983). The need for high investment to sustain the system perpetuates the property rights in irrigated agriculture. Such investment needs call for concomitant obligations with respect to the rights held.

The role of the state in establishing and enforcing property riahts and relations has been very significant. State intervention in existing irrigation systems has produced responses within the organizational processes of these systems sometimes resulting in modifications in property rights and relations (Pradhan 1987). Likewise, the state's enactment of formal laws reqarding irrigation water, as well as its adjudication of disputes have contributed to reinforcing existing or changing different property relations.

THE CONTEXT FOR NEPAL

The Basic Principles of the Seventh Plan (1985-1990) in Nepal accords overall priority to the agricultural sector. Irrigation is a key component of its agricultural development strategy and irrigation programs of all sizes are to be launched on a wide scale in both the hills and the plains. It is envisioned that legal provisions will be made for the use of both surface and ground water resources. Currently, legislation of this kind is either non-existent or clearly inadequate (National Planning Commission 1984).

Existing irrigation is noted **for** its scale and management diversity, a consequence **of** numerous and distinct geographic regions, many ethnic groups, traditions, and the variety of possible agricultural crops. Many systems are farmer-managed in a variety of environmental settings. Traditionally, property rights have been well defined by custom, or by the community at **large,** rather than by statute.

The Irrigatinn and Related Water Resources Act, of 1967 recognizes the right of individuals and groups to construct irrigation systems to divert water from rivers and streams and to estract underground water so long as such activities do not adversely obstruct or affect a government irrigation project or hydro-electric plant. No amount of compensation for taking the resource is mentioned.

The Law on the Reclamation of Wasteland' in the Muluki Ain (Legal Code of Nepal) outlines principles of property rights in water for irrigation. Investment in the form of construction gives entitlement to water which is usually according to the doctrine of prior appropriation. Rules for sharing water, provisions for rights-of-way, loss of water rights, and obligations associated to justify the possessions of the rights are also outlined. Previous field studies of Nepali irrigation systems have, to some extent, revealed the dynamics of property rights and their implications for irrigation (Martin 1986; Pradhan 1982, 1984; Yoder 1986).

An understanding of the dynamics of property rights and relations will provide insights to irrigation development processes and appropriate rehabilitation activities. It will also help in the formulation and modification of Nepal's water laws, taking into account the implications for existing, customary rights. Since irrigation development is a property creating or altering process involving benefits, losses, access, rights, obligations, and changes in relations, **a** significant sociological contribution to the improvement of irrigation development strategies will emerge from the study of the property factor in irrigation.

RESEARCH OBJECTIVE AND METHODOLOGY

The specific objective of the research reported here is to ascertain the impact of significant changes in resource mobilization processes on property rights and relations, and in turn, the subsequent effects of the property changes on continuing resource mobilization processes. Resource mobilization in an irrigation system is a process of accumulation of resources--labor, cash, capital. and other materials--for the construction, operation, and the maintenance of the system. The mobilization of resources can be undertaken by the state, or the community of irrigators, or by **a** combination of both.

A fundamental research assumption is that a relationship exists between resource mobilization and the property structure. For example, often resources are mobilized on the basis of water rights--those with greater rights are expected to provide more labor, larger amounts of cash and so on, than those with lesser rights. Sometimes, resources are mobilized just on the basis of membership and not on the amount of rights. This research also assumes that any change in either the resource mobilization process or the property structure will result in a change in the other. One source of change in resource mobilization is state intervention in the form of finance, new technology, **or** technical assistance. This state intervention may result in changes in the property structure, and these changes in turn may affect subsequent resource mobilization by either the state or the local group. Following state

[3]The English translation **is** included in the appendix of Regmi (1963).

intervention, new water rights holders may be created, or the existing ones reduced or displaced. Farmers now may view the system as the state's, and expect the state to continue maintaining it. Thus, state mobilization of resources may serve to demnbilize local resources and unbalance the existing property structure.

In farmer-managed irrigation systems, members of the system have pooled their resources to carry out irrigation activities and to perpetuate the system. They have also mobilized resources from outside the system with increasing frequency in recent years. The sources for such outside resource mobilization have primarily been the state, private voluntary organizations, non-government organizations, and donor agencies. The nature and form of resource mobilization from each of these categories is varied. Sometimes, as changes in resource mobilization occur, conflicts over property rights and relations ensue (Pradhan 1982). A process of adjustments, negotiations, rules, and compromises among the various actors involved may result in the formation of a different configuration of property rights and relations that have an impact on resource mobilization. The interplay between changes in resource mobilization and changes in property rights and relations has been an ongoing process. It is this process of mutual alterations that this research addresses.

Tnformation was gathered through field studies. Processes of resource mobilization and property relationships were studied in the settings where rhey occurred--farmer-managed irrigation systems that have received state assistance. Besides documenting contemporary processes, the field studies include historical reconstruction of prior social arrangements and negotiation processes, and any prior involvements with state assistance.

The units for analysis are community- or farmer-managed irrigation systems that have or are esperiencing changes in resource mobilization through some form of state intervention. Two systems that have experienced external resource mobilization and concomitant conflict over property rights were selected for detailed field study. One case is referred to in this paper to illustrate the process of negotiations undertaken during the conflict. Conflict has thus been used as a prism to understand the dynamics of property.

Data collection was done through participant observation, interviews, and survey questionnaires. The questionnaires were administered to key informants for information on the organization of the system and to a sample of farmers selected--on the basis of water rights, the criterion for membership in the system--for detailed study on agricultural, irrigation, and property practices. Rapid appraisals of nearby systems were conducted to compare differences in property rights with those systems selected for detailed study.

THE CASE OF CHHERLUNG

The irrigation system studied is known as the Brangdhi Tallo Kulo (lower canal). Currently, it encompasses four distinct command areas at various places along its alignment. The four areas are Taplek, Pokhariya, Chherlung, and Artunga. They have come under one irrigation water source through processes of extensions and amalgamation of two irrigation systems.

In addition to the Tallo Kulo there is currently one other major canal known as the Thulo Kulo (large canal) which is parallel and slightly above the Tallo Kulo (See Figure 1 for the relative position of the canals). The canals are situated in Bougha Gumha panchayat on the south bank of the Kali

Figure 1. Chherlung land **use and irrigation systems** (Source: Yoder 1986).

Gandaki river in Palpa district of Lumbini Zone. Access is by walking on a trail that takes three hours from Tansen via Ranighat.

From an historical perspective, the first canal tapping water from Rrangdhi stream served only the Taplek area. Taplek presently has a command area of nearly two hectares. It is said that this canal was built during the Sen period, but the exact date is unknown.

Building of the Thulo Kulo irrigation system to Chherlung was financed by some 27 villagers under the initiative of two village leaders in 1928. The cost of the construction was Rs 5,000 and water was divided into fifty sharps, each share representing one hundred rupees. Each person who contributed to the construction of the canal received shares in proportion to the investment he had made. Those who had more shares, i.e., the water delivered by their shares was more than they needed--were able to sell part of their shares to others and thus divide the shares into smaller parts. Consequently the number of members in the system has increased.

The original investors had their land and settlement in the lower part of the village. As partial compensation for right-of-way along the upper part of the village, those investing in the construction of the system agreed to sell some water to the upper part. However, they would not sell nearly as much as the upper village wanted. It was not possible for this single canal to irrigate both the upper and the lower villages. Therefore, under the leadership of two Magar (an ethnic group in Nepal) leaders, one of them the father of the present mukhiya (head of the irrigation system), a second canal was financed and constructed during 1932. Through mobilization of their personal funds and loans from businessmen in Tansen, they raised Rs 5,500 for construction of the canal.

The Tallo Kulo builders had to divert water from a point lower on the stream than the Thulo and Taplek Kulos because they built their canal last. Under customary rights, backed by the civil code of Nepal at that time, if intakes were constructed upstream they had to be more than a 100 meters (m) away, The distance between intakes placed downstream did not matter. The distance between the Thulo Kulo (placed upstream) and Taplek Kulo intakes is 280 m, while that between Taplek and Tallo Kulos (placed downstream) was only 42 m. Customarily, in this area, an upstream intake has the right and the privilege to dam the whole stream and divert all the water. Additional springs downstream have lessened the potential conflicts over acquisition of water from the stream.[4]

Construction began for this Tallo Kulo in 1932 and water was finally delivered in 1938. Traditional tunnel diggers known as agris from Damukh Khani near Seti Beni were employed. The contract was undertaken by the construction team leaders (naikes), Bal Bir Sunar, and Man Bir Sunar, both blacksmiths.

It is documented that the construction work was stopped for nearly three years by the regional administration when Tansen municipality complained that the road to Ranighat, their cremation bank, would be spoiled by the canal work and seepage. The work was resumed only after Pratap Singh, one of the

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[4]However in a nearby stream where such multiple water sources do not exist, processes of negotiations regarding water sharing at the stream has taken place several times during the past several decades.

two Magar leaders, got permission from the Public Works Department for the Hills from the Rana commander-in-chief. This gave them clearance for a three-meter-wide right-of-way. The construction party was to regulate traffic while the construction was going on.[5]

The Rana administration considered having the Thulo Kulo broadened when the conflict with the municipality occurred but the water supply from this canal could not possibly irrigate both the villages. Furthermore, the villagers had already spent Rs 3,600 in constructing the canal, now two-thirds completr. Taplek farmers had thrown away the tools of the agris and stopped the work because right-of-way through their land had not been negotiated. Added reclamation of land meant more revenue for the national treasury. So the administration decided that the farmers using the canal would be responsible for maintaining and repairing the road if damaged by the canal, and would also have to compensate reclaimed land that falls along the alignment. Permission to continue work was granted along with provisions for rights of way. The Tansen municipality declined the option of having to reimburse Rs 3,600 if they really wanted the work stopped. The state played an active role even then, in deciding the canal's fate.

Initially, the two Magar leaders had requested that Taplek extend their canal to the upper part of Chherlung village but Pokhariya, an area just. beyond the Taplek command area, had objected and demanded that since their land was nearer to Taplek, they should have prior rights to using the extended canal if ever it was to be extended. *So* in the same year as construction for the Tallo Kulo began, an extension was made from Taplek to Pokhariya. By then the people from the upper part of Chherlung begun constructing the Tallo Kulo.

The mutual agreement between Taplek and Pokhariya regarding the sharing and acquiring of new water rights were that Pokhariya would not damage or waste the water that Taplek had been using and that Pokhariya would broaden the canal and take the increased discharge the improvements allowed to be delivered. Pokhariya was not to use force to acquire water and both parties were to clean and maintain the canal. If Pokhariya did not abide by the conditions then Taplek had the right to render this agreement null and void. Pokhariya farmers spent nearly Rs 1,400 in the extension and divided the water among themselves in accordance to their investments. In due time they also bought rights to additional water from Taplek.

In 1970 a flood caused havoc along the Brangdhi Khola, washing away all the intakes. In the same year, a landslide occurred near the intake of the Tallo Kulo. It was not possible for the farmers to overcome the damage caused by the landslide and for nearly two years winter irrigation was almost impossible in the area served by the Tallo Kulo. Due to the flood, a spring just below the Taplek intake which was their main winter water source had shifted downstream. For some time water was brought by means of an aqueduct hut that too was carried away in a landslide. At times the Tallo Kulo shared water from the Thulo Kulo but mainly they stole water from the Taplek-Pokhariya and Thulo Kulos to carry on irrigation.

Initial attempts to negotiate with the people using the Taplek-Pokhariya Kulo did not bring results. At one point, the village panchayat intervened but the water users felt that it was an internal matter for them to settle by

[5]The present mukhiya has this document.

themselves. External intervention or pressure was not tolerated. Seeing no other way out, the Chherlung Tallo Kulo people went humbly and gave a feast to the Taplek-Pokhariya people and an understanding about sharing water was reached.

Taplek-Pokhariya people feared that in the future the government administration night take sides with Chherlung people and help thrm construct a canal above theirs. They realized that this would either lead to more conflicts or reduce Taplek's and Pokhariya's water supply. An agreement was signed in 1977 whereby the Tallo Kulo members were to repair and broaden the Taplek and Pokhariya canal and were to place a proportioning weir of 40 inches at Taplek with arrangements for 8 inches of water for Taplek nnd 12 inches of water for Pokhariya and the remaining 20 inches for Chherlung, i.e., half the water was to go to Chherlung.

As compensation for giving water to Chherlung, the Taplek and Pokhariya irrigators were to he exempt from all canal maintenance work, except during emergencies when all the members of the canal would be summoned for work. Those not turning up were to be fined according to the canal rules. If water was in excess at Taplek and Pokhariya, it was not to be wasted. Rather, the excess water was to flow along the canal to Chherlung. If it was found that water was being wasted, then Taplek and Pokhariya would bear the punishment as laid down by the canal rules. In years of water shortage, the total amount. of water was to be used by Taplek and Pokhariya during the day, and Chherlung was to use all the water during the night.

It was also agreed that if there was a water shortage during wheat sowing, maize planting, or during seed-bed preparation for rice the different sub-command areas would rotate the total amount of irrigation water by turns. However, the first priority is to go to Taplek, then to Pokhariya, and finally to Chherlung. After this agreement, approximately Rs 18,000 was invested in making improvements in the canal. Rupees 7,250 were raised as cash an.' the rest as labor contributions. Water is tightly controlled by the Chherlung organization so that no one, even in Taplek and Pokhariya, is allowed to use the canal water for early (premonsoon) rice due to water shortage.

An extension project for the Tallo Kulo was sanctioned by the district panchayat secretariat in 1978. The Tallo Kulo was to be improved and extended so that Artunga (Ward 7 of Argali Village Panchayat) could he irrigated too. This was a project within the realm of Panchayat and Local Development.

A meeting of the canal members of Chherlung, future beneficiaries in Artunga, the two panchayats' officials, district panchayat officials, and the engineer who had carried out the survey, was held. The decisions of this meeting were the only agreement made between Chherlung and Artunga. It was decided that a "Chherlung-Artunga Irrigation Reconstruction Canal Committee" be constituted for the work. Surprisingly, there were members in this committee who were not irrigating or even expected to be future beneficiaries of the irrigation system. The chairman of the committee himself was not a water user of the canal. It was decided that after the reconstruction, land areas in Taplek, Pokhariya, Chherlung, and Artunga could be irrigated "better," so the district panchayat was asked to determine a just allocation of water taking into consideration the land areas of the respective places. Both Artunga and Chherlung were to contribute equal labor and inputs from the panchayat boundary to the intake.

Work began and a total expenditure of nearly Rs 150,000 was made. Rupees 95,000 was actual cash given by the district panchayat and the rest was mobilized as labor contributions from Chherlung and Artunga. The work was completed in 1981. With the work complete, it was time to decide on the water allocation to Artunga. Several meetings were held over tho nest two years for this purpose but because of serious disagreements all was in a stalemate. Chherlung resisted the district panchayat's adjudication because it felt. that it was their system's fate that was being decided and they preferred to settle the debate internally. There was no consensus on haw the water was to be allocated. External presence and interference was not wanted. Since no actual water measurements were taken before and after the project, it was impossible to tell how much more water was delivered by the project.

Chherlung stated that Artunga could take water only after the water demand for Chherlung was fulfilled. Chherlung's interpretation of just water allocation according to land was meeting the total water demand of Chherlung for its irrigated land. However, Artunga claimed that the development activity was undertaken for the benefit of all, and that their input also went into the project. Since they had as much irrigable land as Chherlung they felt they were entitled to at least one-fourth if not one-third of the water supply. Taplek and Pokhariya did not want to be included in the dispute. They said that the agreement was between Chherlung and Artunga and that they were to be left alone. According to the earlier agreement with Chherlung, Taplek and Pokhariya insisted that they were to get the half of the water for their land and Chherlung should take the remaining half and reach a settlement with Artunga.

In the case of this canal the feeling of ownership of the system entails many consequences for effective resource mobilization and management. Chherlung felt, that because, for nearly half a century they had taken risks and invested labor and money into the system, it was a private canal, not a state-owned or state-constructed one. It was thus quite irreconcilable for Chherlung to give half of their water to Artunga simply because of a development program of Rs 95,000. Chherlung felt that it was their duty to be responsible for their system and would thus take all measures to safeguard what they owned.

The role of the district panchayat must be seen in light of this dispute. The ambiguity of the previous agreement for water allocation and its inability *to* arbitrate aver this case clearly shows its lack of farsightedness and knowledge of the social dynamics of development activities. The district panchayat tried to make both sides happy and seek solutions elsewhere. Panchayat leaders made Artunga happy by letting the farmers know that until other projects materialize, they were entitled to water; and Chherlung was told that although they could not give much water, they should give some. Chherlung, Artunga, and the district panchayat fell into this deadlock. If a formal agreement that was unambiguous had been made before starting construction, these problems could have been avoided.

Finally, in 1983 an agreement was reached. Until then, Artunga received water only **for** winter irrigation and was not allowed to contribute labor during maintenance work days because that would have entitled them to the canal and water rights. The agreement stipulated that it would have no effect or make any changes on the previous agreement made between Taplek, Pokhariya, and Chherlunp during their amalgamation process. Due to the grant by the district panchayat and mutual labor contribution from both Chherlung and Artunga,

Artunga irrigators were entitled from that day onwards to he shareholders in thr canal.

According to the agreement with Taplek and Pokhariya, half of the water in the canal is to flow to Chherlung. From the time that Chherlung farmers built the Tallo Kulo they have divided the water arriving at their command area into 55 shares represented by 55 inches of opening in the first. proportioning weir. In the agreement with Artunga this was increased to 59 inches and the four increased shares (four inches of water from the first, proportioning weir) are to be given to Artunga.

For the four inches of water, Artunga is to provide 16 laborers during maintenance work while Chherlung provides only one laborer per inch of water. Artunga farmers are responsible for allocating the four inches of water among themselves and submitting their agreement to that. effect to the canal committee. They also had to obtain registration forms for individual water rights. The proportioning weir that was to deliver the four inches of water for Artunga would be installed at Chaptol in Chherlung. If Artunga irrigators want to increase their share of water, they can purchase water from Chherlung farmers at the current price. If these conditions are not adhered to, then the agreement will he null and void. If Artunga manages to arrange for a separate canal, then they will forgo the four inches of water without condition. It is also stated in the aqreement that besides the conditions laid down in the contrart., both parties will abide by the rules and regulations of the canal.

An effective organization, mainly controlled and operated by the Chherlung command area members, exists to take care of the various tasks and institutional elements of the system.[6]

CONCLUSIONS

This paper started out with a brief theoretical exposition of property, then related it to the author's research focus and objective. The latter part of the paper outlined the historical perspective of the processes of the amalgamation, espansion, and extension that brought about negotiations regarding acquisition and sharing of property rights as well as thr concomitant changes in property rights and relations. Some were internally induced, while others were necessitated from the outside. Internally, farmrrs' resource mobilization itself brought about changes in property rights and relations through a series of negotiations.

The negotiating process and resulting agreements have laid down rules and norms for the stated or de-jure property rights and relations. In the analysis of documents on negotiations, one notes a hierarchy of property rights, reflecting previous input or investment in the system for acquiring membership status. Senior and junior water rights exist. By analyzing water rights from an historical perspective, one sees the reasons for them being so. The nature of both the property rights and resource mobilization obligations have been altered after the interventions by the farmers or the government. The control of the system, in this case, lies in the hands of the Chherlung members. Artunga is definitely in a position of having most junior water rights.

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[6]A general description of the functioning of this organization is made in Pradhan 1982.

When property rights in water can be negotiated and separated from property rights in land, not only at the individual level, but also at. the command area level, one notes enhanced area reclamation and irrigation expansion. Water allocation through purchased shares fosters this. If the water allocation principle has implications for irrigation expansion or area reclamation, then more thought rhould be given to determining the type of water allocation principles so that further development and expansion is ensured.

This case study has shown the dynamic and ever-growing nature of an irrigation system. Thus designs for new systems and modification to existing systems should have built-in flexibility so that the system can be dynamic. The nature of the physical structures must interact with the water allocation principle.

Each right, entails a certain obligation towards the upkeep of the system and to the organization. When one is guaranteed a certain type of right, forfeited only when one does not fulfill the obligation, then he can fully participate in the decision-making process that governs the fate of the system. Fulfillment of certain tasks bring about leadership qualities in the members.

Farmers are willing to invest in the hydraulic system only when rights in determining use of the property are guaranteed. In some of the irrigation systems, effective organizations exist for the preservation of these rights. Implementing agencies would do well to recognize this and come out with a planning and implementing approach such that the rights are not jeopardized or negated. Prior communication and dialogue is necessary for a negotiating process that sustains the existing members' co-operation and incorporation, if needs be.

Since existing irrigation systems have some form of organization capable of innovations in institutional arrangements over time, an analysis of the existing institutional arrangements that take into account the property aspects should be completed. A checklist might include topics like water rights within the system and among systems at the source; seasonal rights and who the members are; the nature of existing property rights and the transaction of rights: how potential beneficiaries can gain water rights; right-of-way for construction; and duties, obligations, and sanctions for the preservation of rights. This type of analysis geared towards the specific locale should be undertaken before any intervention.

When external resource input and adjudication means external control, shifting management and maintenance activities away from the beneficiaries, then the system will perpetually need external resources. Such depletion of a system's self-reliance takes away leadership roles and the resiliency of the organization to adapt to changing circumstances. The system will no longer be dynamic.

Nepal is faced by a fiscal crisis and has accumulated loans from investment in irrigation infrastructure that need to be paid back. To improve irrigation performance there have been attempts to establish water users associations and to implement decentralization norms. This must be accompanied by finding ways to enlist active participation of the beneficiaries in maintaining their systems. But unless and until beneficiaries feel that their rights are secure, guaranteed, and reliable, they cannot be expected to invest in maintaining their system.

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SECTION V:

FARMERS' PANEL DISCUSSION

A highlight of the seminar was the participation of twelve beneficiaries from eight farmer-managed irrigation systems. They represented systems from both the hills and tarai that researchers have visited frequently over the past few years. The topic that they were asked to address was the type and purpose of records that the beneficiaries in each of their systems keep. In their presentations they first described the characteristics of their system and then the role and method of record keeping. Participants from several systems brought record books along to display.

A point of similarity reported by all farmer participants was different levels of labor mobilization for system maintenance and the need to keep good records of each beneficiary's work attendance. Routine work is carried out in a well-defined season with fine rates for absence generally set at the prevailing local wage rate. However, provisions are also made for emergency labor mobilization, and in many cases the fine for not attending is double the local wage rate to ensure sufficient labor to complete the work quickly.

Accounts and minutes of meetings that record the changes in rules from year to year were the next most important records reported. In most systems the water allocation is clearly defined for each beneficiary. A few organizations keep written records of the water allocation while in many systems this is only by oral tradition.

CHHATTIS MAUJA IRRIGATION SYSTEM OF BUTWAL, RUPANDHA DISTRICT

Mr. Prem Bahadur Bhandary, chairman of the Chhattis Mauja irrigation system first gave a brief description of their system. He said that the system has a command area of about 4,000 hectares (ha). Water is diverted from the Tinau Khola at Butwal. About 54 villages are presently served water by the canal. The canal is nearly 25 kilometers (km) from the head to the tail.

A central committee consisting of 15 members responsible for looking after the operation and maintenance has been in existence for a number of years. The chairman and vice-chairman of the committee are elected at the general assembly where all beneficiaries are invited to attend. In the pas: this was an annual election but recently the term of these elected officials has been changed to two years to make it easier to clear the accounts. Three members are appointed by the chairman and the rest are chosen by beneficiaries from different regions of the command area. The committee has also appointed four persons on a daily wage basis to observe and supervise the canal.

The chairman stressed that this system is successful because of its ability to mobilize internal resources for the annual maintenance and gradual improvement of the system. Direct labor contributions according to the size of land cultivated is the primary basis for resource mobilization both for village and system-level operation and maintenance activities. If a serious crisis occurs, a special type of labor mobilization called jhara is used to call persons from every household to work collectively. On such a day up to 10,000 persons are working. The muktier (secretary) from each village assigns work and keeps record of the persons present. Those who fail to contribute labor are required to pay a penalty of Rs 20 per day of absence. Committee-appointed inspectors supervise the work.

The chairman highlighted the reasons that their system functions well:

1. All beneficiaries of the irrigation system understand their obligations for maintenance of the system and obey the rules and regulations.

2. Persons who steal water are punished with a Rs 1,500-2,000 fine.

3. Water is allocated and distributed to all farmers according to the individual landholding size.

He also mentioned that the system has several serious problems. Water is scarce during the dry season and about 80 percent of the command area is planted to maize. During the rainy season there is sufficient water in the river to divert all that they need into the system. However, the canal diversion is difficult to maintain. Each year before the monsoon it must be repaired, requiring the mobilization of a huge labor force. The diversion is frequently damaged by floods again requiring labor to rebuild the diversion and desilt the canal. Repair of the diversion is dependent upon branches and brush that used to be abundant. As the forest has diminished, repair has become increasingly difficult.

The Chhattis Mauja committee has petitioned to His Majesty the king requesting a permanent weir for the Chhattis Mauja diversion. Two grants, the first of Rs 116,000 and the second of RE 121,000 were made available. These were not sufficient for a permanent diversion so the money was used to repair the gate and regulator at Kanya Dhunga and Itabhod.

'The system inherited a problem after the Marchwar Irrigation Project of the Tinau River failed. The canal of Sora Mauja was closed by the protecting wall of the weir and they were forced to develop an alternative intake. Later an agreement was made to share water for Chhattis Mauja and Sora Mauja from the same canal. The Sora Mauja beneficiaries continually tried to take more water and the dispute became a continual problem. To resolve this, the Department of Irrigation, Hydrology, and Meteorology (DIHM) was approached, and the construction of a permanent proportioning weir at the canal bifurcation point called Tara Prasad Bhod was requested. This strurture was constructed at a cost of Rs 553,000 with Rs 270,000 contributed as cash by DIHM and the remainder raised by the beneficiaries on the basis of landholding. All of the work was done by the committee and the beneficiaries. The work was supervised by a joint committee of the Sora and Chhattis Mauja systems.

Referring to a question raised during a previous discussion about the unsatisfactory performance of the agency-managed systems, the chairman stated that this is due to the beneficiaries not being involved in the management of agency-built systems. Once beneficiaries are involved in the management they feel responsible for the system. In the case of agency management, if the canal is damaged by a flood, the agency bureaucracy must first be informed, then someone will be assigned to estimate the extent of the damage, prepare an estimate, and get it approved. This process is so long that the current crop will often be lost, In the case of the Chhattis Mauja system, a message will be passed on to the concerned person who will estimate the extent of damage and work to be done. The beneficiaries will be notified and begin repair work immediately. If the government should take over the Chhattis

Mauja, the beneficiaries would not be able to produce sufficient fond as is being done under their own management. However, a shared responsibility with the agency would hc desirable to reduce the heavy burden of labor required *to* keep the system operating.

CHHERLUNG TALLO KULO, PALPA

Mr. Bir Rahadur Saru, chairman of the Chherlung Tallo Kulo made the presentation about their system. He said that the Tallo Kulo is not as large as the Chhattis Mauja. However, it has its own interesting history. In Chherlung there are two irrigation systems which run parallel along the seven kilometer mountain slope bringing water from the Brangdhi Khola to the command area. The two canals are known as Upalo Kulo and Tallo Kulo.

The construction of the Tallo Kulo started in 1932. Many problems were encountered during the time of the construction. Some of the people from Tansen Bazaar opposed the construction of the canal and protested to the government,. 'The government served notice that construction was to stop. A delegation headed by the chairman's father made the ten-day trek to Kathmandu t.o appeal the case and **seek** permission to continue construction. It took almost three years to get approval for construction.

The Tallo Kulo is managed by a committee headed by the mukhiya (chairman). Seven tharis (leaders),one for each day of the week, are selected to help the chairman and to undertake day-to-day inspectioc and maintenance. A secretary is also appointed.

The chairman keeps all the records. He is assisted in the record keeping by the secretary. He said it is recognized by all the beneficiaries that good record keeping is essential to run the system properly and to maintain it in good condition. Proper record keeping will also help future generations understand their rights and obligations. They have maintained records right from the beginning of the system.

There are 69 households that receive water from the canal in Chherlung to irrigate approximately 18 ha. To maintain the canal a family with an average water allocation must spend about 30 days working on repairs and improvements each year. The chairman said that one of the most important functions of record keeping is to correctly record the labor contribution of the beneficiaries. Two types of labor contribution take place. One is called Barkhe Jhara (monsoon labor mobilization1 and the other Hiude Jhara (winter labor mobilization). Before land preparation for monsoon rice, the farmers assemble to plan the work and set the date to begin maintenance. They also fix the wage rate for labor mobilization (this is set to the prevailing local wage rate). Beneficiaries who do not contribute their share of labor in a year are fined and those who contribute more are paid at the fixed rate.

Labor mobilization requirements of each beneficiary are according to his water allocation. The water allocation is fixed according to the investment that each beneficiary has made in the system, either when the system was constructed or by purchasing a share of water from a system member who had excess water. The committee has introduced a system of issuing share certificates to certify the entitlement of each beneficiary. This certificate contains the name of the beneficiary, the size of the share, and the location to which the water is to be delivered. The share certificate provides proof and guarantee of water rights and reduces conflicts. All transactions of water shares from one farmer to another must be recorded and signed by the chairman and the respective owner of the share certificate. The chairman keeps a duplicate record in his register book.

KULARIYA KULO OF KAILALI DISTRICT

Mr. Rabi Lal Chaudhary, the secretary of the Kulariya irrigation committee, described the three irrigation canals diverting water from the Karnali River. Each canal had a separate organization and management until a pear ago when they combined their efforts to redivert. water from the Gerwa to the Karnali channels at Chisapani. To do this they formed a central committee under the chairmanship of Mr. Khadga Bahadur Singh. This crmmittee consists of the chaudharies (system leaders), secretaries, and 104 badghars (village leaders) of the three systems.

The farmers must contribute labor during desawar (assembly of all the farmers). In addition, each farmer must contribute Rs 5 in cash to pay royalty to the forest office for collecting forest products (branches and logs) necessary to maintain the diversions and check dams.

The secretary said that at the intake to their canal, a 100-meter dam is constructed to divert water into the canal. In the winter when water is low they cannot divert water into their canal and they grow unirrigated crops. There are many check dams to divert water from the main into the secondary canals.

A fine of Rs 15 is collected if a farmer does not contribute his share of labor. In addition to the fine money, Rs 10 is contributed by each farmer for the annual feast when they worship the irrigation god.

ARGALI RAJ KULO, PALPA

Mr. Dolak Rahadur Rana, chairman of the Raj Kulo, described the rules and regulations of their canal to the participants. He said that their system is about 400 years old and that many generations have worked at improving the system.

At their annual meeting of all beneficiaries in Yay the canal functionaries are elected or reappointed. The chairman is responsible for organizing all the maintenance work and for calling the meetings of the organization. The secretary keeps the attendance records, accounts, 2nd the minutes of the organization's meetings. He is also the cashier for the organization. Two persons are selected from different parts of the system to assign a person from their area each day during the monsoon to patrol the canal. One person is appointed to immediately investigate if the canal discharge suddenly drops, and to report severity of breaches, landslides, or problems at the diversion to the chairman. This person also checks that the persons appointed to patrol the canal have actually reported for work each day.

The chairman explained how water in the Raj Kulo is allocated on the basis of land area designated for growing rice. Wheat in the winter and maize in the spring are irrigated by the Raj Kulo on nearly double the land area with water rights for growing irrigated rice. In the winter and spring all who use water must repair the canal the day before it is their turn to use water.

There is a Rs 8 fine for being absent from work on days of routine maintenance. At the annual meeting each year the secretary presents the accounts and announces how much each member owes the organization. Other rules and regulations are also discussed at the annual meeting and changes are recorded in the minute hook.

KATHAR IRRIGATION SYSTEM, CHITWAN

Mr. Shyam Upreti, chairman of the Kathar irrigation system described the history, operation, and maintenance of their system. Their system was constructed in 1962 and initially irrigated only 14 ha. It has since been expanded to about 40 ha. The water sources for this system are the Rapti and Budhi Rapti rivers.

A committee was formed to manage the system where the chairman plays an important role. In addition to the chairman there is a secretary and treasurer. The committee members have one-year terms. One peon is appointed by the committee for the irrigation work.

All beneficiaries must contribute labor for the annual maintenance of the system. .Attendance is taken at the beginning arid end of each day and those who are absent are fined. Water distribution was changed from continuous flow to rotation in order to allow expansion of the land area.

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