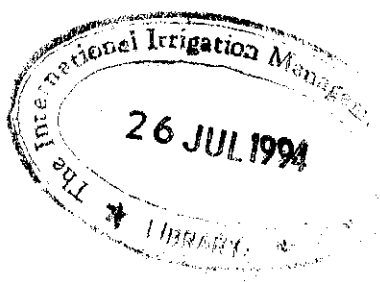


# **FARMER-MANAGED IRRIGATION SYSTEMS IN CHITRAL**



Abdul Hakeem Khan  
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## **Acronyms**

<b>AKRSP</b>	<b>Aga Khan Rural Support Programme.</b>
<b>CADP</b>	<b>Chitral Area Development Programme.</b>
<b>DRMS</b>	<b>Development Research and Management Services.</b>
<b>FMIS</b>	<b>Farmer-Managed Irrigation Systems.</b>
<b>GOP</b>	<b>Government of Pakistan.</b>
<b>IIMI</b>	<b>International Irrigation Management Institute.</b>
<b>RRA</b>	<b>Rapid Rural Appraisal.</b>
<b>VO</b>	<b>Village Organization.</b>
<b>WID</b>	<b>Women in Development.</b>

## **Glossary of Local Terms**

<i>Abadi</i>	Settlement area or built-up residential area.
<i>Bazano</i>	Silt collecting tank built near the headworks.
<i>Chakoram</i>	Measure of land; 1 <i>chakoram</i> equals 0.11 hectare (9.25 <i>chakoram</i> equals 1 hectare).
<i>Ghari</i>	Land at higher altitudes that villages usually use as pasture and, sometimes, for cultivation.
<i>Ghospan</i>	Outlet or turnout to a farm.
<i>Gol</i>	River.
<i>Hurdur</i>	Headworks of the main channel in the system.
<i>Joi</i>	An irrigation channel (usually the main channel).
<i>Joiwal</i>	Watchman employed for day-to-day operation and maintenance of a system (channel watchman).
<i>Khora</i>	Water mill.
<i>Lothoro</i>	Village leader.
<i>Madok</i>	Sluice gate.
<i>Mehtar</i>	Title of the former rulers of Chitral.
<i>Muharar</i>	Member of a committee responsible for keeping records of disputes and decisions.
<i>Musher</i>	An influential village elder.
<i>Mir Joi</i>	A person traditionally responsible for overseeing the management and maintenance of the irrigation system (irrigation system supervisor).
<i>Sarogh</i>	Roster of irrigation turns or <i>warabandi</i> .
<i>Yardoi</i>	Labor sharing.
<i>Zang Joi</i>	Big channel.

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## Foreword

TRADITIONAL FARMER-MANAGED irrigation systems (FMIS) have been an important research subject for IIMI (International Irrigation Management Institute) for many years. IIMI's Program on Locally Managed Irrigation is especially concerned with documenting technologies, institutions and management performance of FMIS, with identifying appropriate strategies for developing and supporting sustainable FMIS, and with the transition from agency-managed irrigation to local or farmer-managed irrigation.

For the Chitral region of Pakistan, there is little reliable information available about the nature of traditional farmer-developed and -managed irrigation systems. This study of three such systems in Chitral adds to the existing inventory of information available about indigenous irrigation institutions, technologies, performance, and development needs in a heretofore largely neglected area of Northern Pakistan.

It is increasingly evident that many FMIS in Asia, Africa and Latin America are being weakened by such factors as externally induced development, erosion of water rights, and increasing population pressures and resource constraints. Consequently, there is a genuine need to develop more effective support systems to enhance the viability of locally managed irrigation. We hope that this study will contribute to such efforts to strengthen irrigated agriculture in Chitral through a deeper understanding of what local farmers have already learned and done for themselves in this area.

There is also a growing awareness and acceptance of the view that sustaining irrigation system performance without the substantial, if not full, participation of farmers in system management is both difficult and costly. In many areas of the world, farmers have learned through their own experiences over decades, even centuries, which local technologies and institutions work effectively and which do not. As the transfer of irrigation system management from government agencies to local farmer organizations continues, the need to document and understand lessons already learned in traditional, indigenous irrigation systems is heightened. In the context of current proposals for such management changes in the large systems of the Indus Basin, this study of Chitral FMIS has relevance as well.

**Douglas L. Vermillion**

Program on Locally Managed Irrigation

IIMI

# **Introduction**

## **OBJECTIVES**

IN LATE 1990, the International Irrigation Management Institute (IIMI) and Enterprise and Development Consulting (EDC) undertook a collaborative research study of farmer-managed irrigation systems (FMIS) in Chitral District, North-West Frontier Province (NWFP), Pakistan. The primary objective of the research was to initiate the process of developing a knowledge base that would provide reliable information on both physical and institutional features of indigenous irrigation systems and their management in Chitral. Such information is not readily available for Chitral District, or for most other areas of Pakistan's mountainous periphery, for that matter. It is anticipated that such a knowledge base would have particular utility for those who have responsibility to design, plan, and implement appropriate and effective irrigation assistance activities in the district. Furthermore, it is hoped that this start will spur others to add to it, filling in the inevitable gaps in such a first effort, not only for Chitral, but for other parts of Pakistan as well.

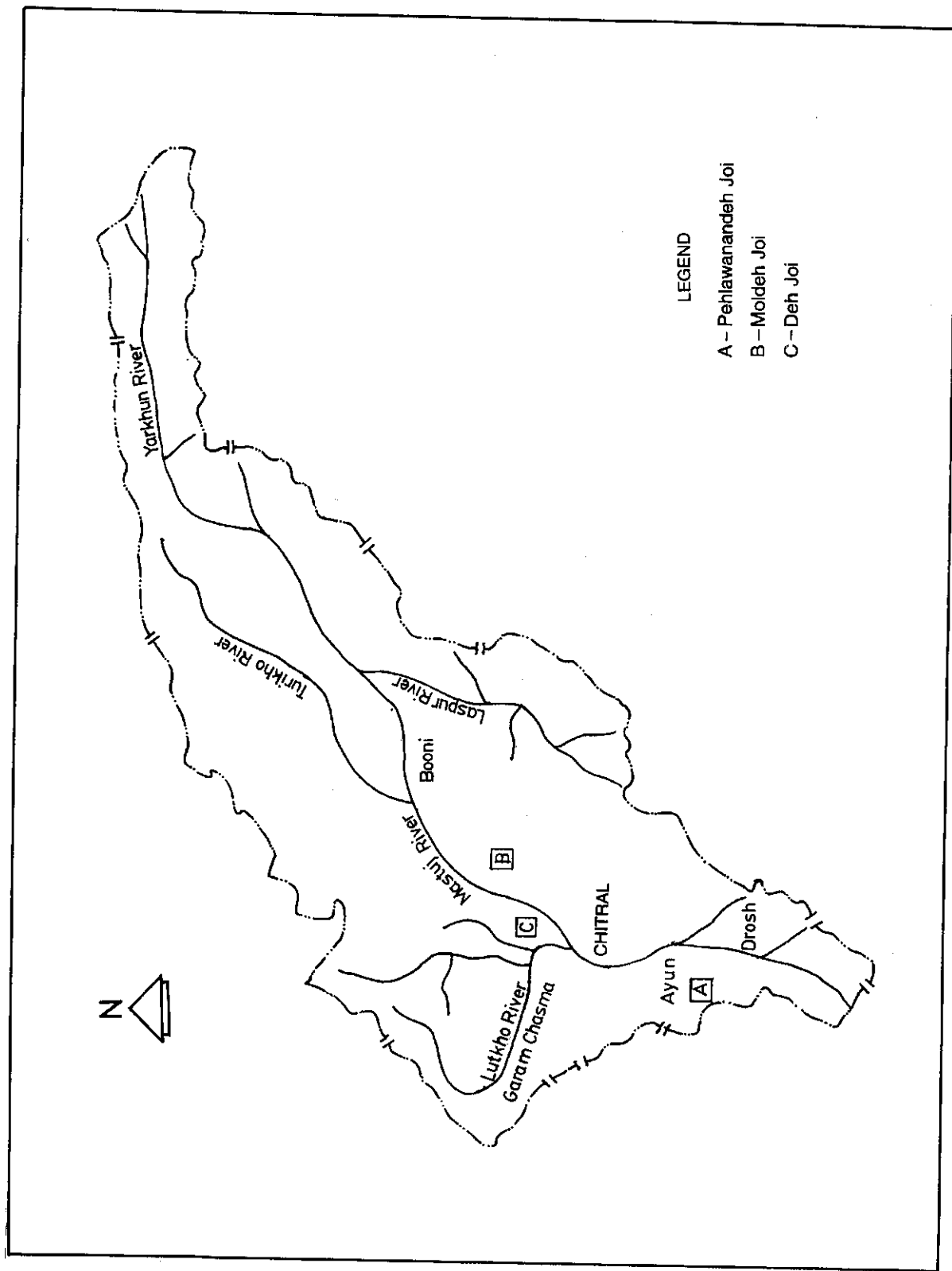
For this study, IIMI and EDC jointly fielded a research team comprising an economist and an irrigation engineer in Chitral for the field research phase of the study. Their field work was guided and supervised by senior staff of both organizations to the extent that limited funds permitted. Locally recruited field assistants also provided invaluable service as interpreters and guides during this phase of the research.

## **SCOPE OF THE STUDY**

The three irrigation systems selected for study were chosen on the basis of certain specific criteria: (i) systems could not be new ones; (ii) systems could not have received development assistance from the government or other programs at any time in the past 15 years; (iii) each system would be selected as representative of one of the three broad categories of irrigation water availability; and (iv) systems were to be "reasonably accessible" from Chitral town, a requirement that could only be rather loosely interpreted in an environment where road development remains in a pioneering phase.

The last constraint was dictated primarily by the limited resources available for this study and it necessarily restricted the study area to lower Chitral District. The approximate location of each system in Chitral District is shown in Figure I. One system is in the Bakhtoli Valley, a second is located in Bamburate Valley, and the third is in Kooch Valley. The three systems represent, respectively, conditions of relative water scarcity, adequacy and abundance.

Figure 1. Chitral District.



A glossary of local terms related to irrigation practices and management in Chitral District was also prepared as an adjunct of this research. Additional studies of irrigation systems in the region are likely to add further entries to this list. Even now, however, the glossary may have some utility for researchers unfamiliar with the irrigation systems of Chitral and/or with the local language. Many of these terms were identified by Israr-ud-Din (1989) in his studies of irrigation in Chitral's Khot Valley. Although, there is some evidence that the Khot Valley case studies may represent FMIS which are rather unique and are less indicative of systems found elsewhere in Chitral, those terms apparently are more widely generic to water scarce areas.

## **METHODOLOGY**

The systems chosen for study were selected following consultations with the staff of the Chitral Area Development Programme (CADP) and the Aga Khan Rural Support Programme (AKRSP), and through discussions with many villagers and other local informants. It proved to be fairly difficult to identify irrigation systems reasonably close to Chitral town which had not received some assistance from outside sources over the past few years. Only one of the three systems finally chosen was accessible in less than one hour by jeep from Chitral. The team utilized appropriately modified rapid rural appraisal (RRA) techniques in the field research phase of the study (P. Pradhan et al. 1988).

For each system studied, the field team began its work by initiating discussions in group meetings of villagers, including the village elders and those directly involved with the irrigation system. After the first group discussions with the village leader (*lothoro*), other village elders and farmers, the field researchers divided into two teams to study different aspects of the system, beginning with a walk along the channel accompanied by a few selected villagers. In each system, several subsequent days were devoted to semi-structured interviews with individual households in each village of the command area.

Because written records of irrigation systems are absent in Chitral, most primary background information about the channels selected for study was drawn from traditional oral history as retold by local informants. The oldest men in each village were interviewed for details of village settlement, system construction, and other historical data. Information on women's roles in irrigated agriculture proved to be a somewhat more difficult subject on which to gather data, given the practical constraints of local culture and tradition. In this case, field notes were supplemented by information provided by the Women In Development section of AKRSP, Chitral.

# **An Overview of Irrigation Systems in Chitral**

## **GENERAL**

IRRIGATION IS CRUCIAL for agriculture throughout the Chitral District. Rainfall is low during the late spring and summer seasons which are the critical periods for crop growth in the district. The main sources of irrigation water are rivers, streams and springs which are fed by snow and glacial melt. The Chitral River is the principal drainage channel of the region, and the Lotkoh, Torkhow and Laspur rivers are its major tributaries. Almost all the cultivated area of Chitral, estimated at 18,000 hectares (ha) in 1980 (International Fund for Agricultural Development [IFAD] 1986), is irrigated by about 1,000 small, community-owned and -managed irrigation channels.

Irrigation is a very old practice in Chitral, with many channels reported to be more than 500 years old. Until very recently, Chitral irrigation systems were still constructed by traditional methods. All systems in the district are gravity flow systems, and typically, each irrigation channel serves more than one village, with each village usually being served by more than one channel.

The singular features of traditional irrigation systems in Chitral are: (i) sanction by traditional authorities; (ii) development undertaken as a collective activity wherein costs are shared among beneficiaries; (iii) local technologies and tools still used in system construction; (iv) clearly specified but unwritten rules and regulations regarding the distribution of the new land and the allocation of water rights; and (v) well-defined system maintenance responsibilities linked to informal processes of sanctions to ensure compliance.

Although highly localized groups of people most probably developed the first irrigation systems in Chitral through their own meager resources, traditional irrigation development and management could not have expanded to the degree it did in the area without formal state sanction and approval. To be sure, that expansion also depended upon continued local resource mobilization, including labor sharing and other forms of mutual support, both for the construction of irrigation channels and the development of additional land for irrigated agriculture.

The withdrawal of official support in the early 1950s when the pre-independence princely states were abolished by the new government of Pakistan, appears to have been a principal reason for the subsequent slower pace of development of irrigation channels until very recently. Traditional village-level institutions were unable to cope with the sudden greater organizational and resource requirements to further system expansion, and new technologies required for such development were often unavailable as well.

In general, individual farmer-managed irrigation systems in Chitral serve command areas ranging between 10 and 70 hectares (ha). The length of the main irrigation channel varies between 2 and 8 kilometers (km), averaging about 4 km. These channels invariably traverse a stretch of difficult terrain and thus require considerable annual maintenance labor inputs to ensure their operation. There are, on average, more irrigation channels in areas with moderately steep slopes than in relatively flat lands (Masood-ul-Mulk 1992). This is related to the greater extent of such terrain in Chitral as well as its greater proximity to sources of water which can be tapped for gravity flow irrigation.

Overall, the number of channels irrigating a given area is a function of water availability, topography, population pressure and cropping practices. Reportedly, the number of irrigation channels managed by some groups of Chitrali households is as high as twenty (Masood-ul-Mulk 1992).

Major problems often encountered in Chitral irrigation systems include a substantial seasonal variability in water supplies, overall supply uncertainty, sedimentation, damage from periodic flooding and landslides, and low levels of water conveyance efficiency. The mean sediment concentration in the Chitral River is about 136 parts per million, and it is derived largely from the erosion of glacial moraines in its catchment. Sediment concentrations in tributary streams, commonly the source of Chitral farmer-managed irrigation systems are often much higher.

Generally, there have been adequate water supplies, even an abundance of water, in the lower Chitral District relative to existing system needs. But conveyance to the villages is often insufficient because of the limited physical capacity of the channel and/or because of traditional construction methods which result in considerable water loss due to seepage. The water requirements of agriculture in the area are expected to continue to grow because of the increasing population pressure on resources and the resulting expansion of cultivated area, combined with the adoption of more water intensive farming practices.

The impact of irrigation system development on the use of marginal lands is uncertain. Some studies assert that pressure on marginal lands is reduced as farmers adopt more intensive farming practices on existing land (Masood-ul-Mulk 1992). In other areas of northern Pakistan similar to Chitral, there is evidence of greater pressure on marginal lands due to extensive farming practices. A study in the Gilgit District revealed that one response to the availability of additional water supplies was an increase in area planted to perennial crops which do not require extensive land development or the intensive use of labor (M. Hussein 1987).

In the higher altitude pasture areas of Chitral, some farmers have built their own private irrigation channels. A few such farmers interviewed in the course of this study stated that this construction activity is relatively recent, having begun in the early 1980s. The purpose of this development is to bring hitherto marginalized land under cultivation, even for the shorter growing season. Possibly, this is a reflection of the growing pressure of population on the limited land and water resources of the district. The costs of these channels were variously estimated to range from as low as Rs 20,000 to as much as Rs 70,000 (approximately US\$913 to 3,196; 1990).

Here, an analogy with private tubewell development in the Indus Basin plains may be appropriate. There, the remarkably rapid increase in numbers of private tubewells has been linked to the limited possibilities of the surface irrigation system to sustain more intensive irrigated agriculture in the context of increasing population pressure on rural resources. Farmers with access to the necessary capital have responded by unfettered private development of the groundwater resources, and in less than 10 years, significant overdrafting of the apparently vast aquifers underlying the Punjab has begun.

## **DEFINING THE IRRIGATION SYSTEM**

The definition of what constitutes an "irrigation system" in Chitral was not as straightforward as it initially appeared to be. There were three clear choices which could have been adopted for this study: (i) select a single irrigation channel as the unit of study and, thereby, all villages irrigated by it are included in the system; (ii) focus on a single village and all irrigation channels irrigating lands therein become the system; and (iii) define all irrigation channels and villages in a single valley as the system.

Social scientists studying irrigation in rural agricultural societies have often defined the village (or the social unit) as the focal point of study. In contrast, physical scientists frequently define the physical

irrigation infrastructure as the central focus of the system. For his study of Chitral irrigation systems, Israr-ud-Din, a geographer and a Chitrali, chose the valley as the unit of analysis, defining all villages and all channels within that valley as comprising the system (Israr-ud-Din 1989). Regardless of which spatial unit is chosen, it is essential to accurately identify critical variables and define the system with reference to those variables.

The system definition used for this work was a single irrigation channel with an acquisition point from a natural source of water and all those villages whose lands are irrigated by it. In addition, the extent to which other irrigation resources available in each village affected water rights, maintenance arrangements, water distribution tasks, cropping practices, etc., was given general consideration.

## DEFINITION OF WATER SCARCITY

There is both seasonal and spatial variation in water supplies in the irrigation systems in the Chitral District. As a result of these variations, it is difficult to establish, *a priori*, the actual amounts of water available, either with reference to a particular season or to a particular point along the channel. Moreover, to classify irrigation systems as water abundant, scarce or adequate clearly assumes a relationship to crop water requirements which could not be accurately defined during the short span of this survey.

Water scarcity can be a function of several, possibly interrelated, factors. For example, it can be directly related to the physical capacity of a system's conveyance channel. Thus, although water supplies may be inadequate for crop water requirements because of physical constraints, and the system thereby defined as "water scarce," available supplies at the source may be abundant. Scarcity can also be dependent upon water rights governing access to source supplies as well as a function of farmer cropping preferences, where, supplies may be adequate or abundant for one mix of crops, but comparatively scarce for another. In short, water scarcity is frequently relative to other variables not readily assessed in a rapid survey.

The seasonal variation in water supplies is a consequence of the interactions of temperature, the amount of snowfall in the winter months and rainfall at other times, and the existence and availability of other perennial and other nonperennial water sources. Generally, peak stream flows in Chitral occur in July and minimum flows in March. Seasonal shortages often coincide with the period in crop production when water requirements are at their lowest. However, variations in water availability sometimes occur unexpectedly, and farmers are unable to explain them.

Spatial variation in water supplies is usually related to the conveyance capacity of the irrigation system; in turn, this often is a function of construction techniques and resources available in a very different age. Although available water supplies in system head and middle reaches may be sufficient to meet crop needs, the long, often difficult alignments followed by many Chitral irrigation systems frequently result in a degree of tail reach deprivation because channel capacity has had to be varied enroute.

Often, some potentially irrigable area toward a system's tail remains uncultivated, or is water stressed if cultivated, because it is marginally too high relative to the distribution channel. Since these systems depend upon gravity flow and require a reasonable channel bed slope throughout, an alignment originally chosen a century or two ago may have been less than completely satisfactory for providing adequate water supplies at locations several kilometers from the intake structure.

## **INSTITUTIONAL ARRANGEMENTS**

The level of development of water rights and the system of water management in Chitral FMIS is strongly related to water supply availability. In locales where water scarcity occurs at the source, water use rights that have been evolved are very comprehensive and stipulate the allocation of water among original owners with very specific measures for each user. However, the very sophisticated system detailed by Israr-ud-Din (1989) in his study of the Khot Valley is rare. In areas where water is comparatively abundant, there appears to be no clear system of water rights. Generally, people share water use rights equitably, though head-end users invariably have better access to water than do tail enders.

The system of water distribution which is implemented in water scarce areas known as *sarogh*, which literally translated, means *warabandi* or water distribution turn by turn through a roster of shareholders. Water is allocated to the roster of shareholders either by time or by amount of flow. Original settlers have more rights than subsequent settlers, and users of the original channel have more rights than those who benefit by subsequent extensions to the original channel. Original water rights are not connected to land ownership, but sale of land rights is commonly in conjunction with water rights. Sub-division of land does not affect water rights.

No specific institution at the village level could be identified as being responsible for irrigation development or management. The operation and maintenance of a channel is commonly undertaken on an informal basis with each beneficiary household contributing labor for the physical work required for cleaning or repair. Generally, however, a distinction is made between those tasks considered the collective responsibility of all users and those tasks which are to be done on an individual basis.

There were a few roles at the village level which were assigned specifically for irrigation management. For example, the clan chief used to be designated as the *Mir Joi* or the irrigation system supervisor. However, this position was not encountered in any of the three systems studied. The practice of appointing a *joiwal* or a channel watchman is also disappearing, and there does not appear to be any formal institution replacing it.

Village-level conflicts among farmers from within the same village are usually readily settled. But disputes involving farmers from different villages or between villages are more difficult to resolve, and in most cases these require outside adjudication for settlement. Disputes between villages reportedly have become more frequent with the increasing development of and pressures on what were formerly regarded as common property resources. There is much greater ambiguity of ownership between villages of land and water resources located at higher elevations. The police are not generally involved in disputes within villages, but when they are involved, the preference is to take the case to the border police.

## **DEVELOPMENT INTERVENTION IN LOCAL IRRIGATION SYSTEMS**

The Irrigation and Public Health Department (IPHD) of the North-West Frontier Province, The Aga Khan Rural Support Programme (AKRSP), and the Chitral Area Development Programme (CADP) have assisted with recent irrigation development in the district. Limited support also has been forthcoming from the District and Union Council funds.

The focus of the IPHD has been on larger, more visible schemes. It has constructed a total of 21 irrigation systems in the district. These schemes are located at higher elevations and in more difficult terrain. Their construction has required technical and financial resources not normally available to the local population. However, these schemes suffer from poor maintenance, often as a consequence of a failure

by the IPHD to consult with beneficiaries and to reach an agreement with them on rights, responsibilities, and costs prior to system construction.

As of June 1990, AKRSP had provided assistance to 182 irrigation development schemes in the Chitral District (see Table 1). The major part of this effort was for the construction of new systems. By 1990, 106 schemes had been completed. The average cost of an irrigation system constructed or improved with the assistance of AKRSP has been about Rs 193,000 (approximately US\$8,800; 1990).

By the end of September 1990, the CADP had begun work on 8 irrigation schemes. Three of these are new systems and five involve extensions and improvements to older, existing systems. The CADP is the first program in Chitral to implement a syphon irrigation scheme; two of the three new CADP-supported schemes are syphon irrigation systems.

*Table 1. The number of irrigation channels in Chitral District funded by development agencies (September 1990).*

Development agency	Total number initiated	Number completed	New channels	Number of channels improved
IPHD	21	17	13	8
AKRSP	182	106	109	73
CADP	8	0	3	5

Notes: IPHD = Irrigation and Public Health Department.  
AKRSP = Aga Khan Rural Support Programme.  
CADP = Chitral Area Development Programme.

The FMIS experience in Pakistan and elsewhere provides substantial evidence that the successful introduction of new irrigation technology usually requires either the strengthening of existing institutions or otherwise the establishment of appropriate institutional arrangements to manage the new technology. Failure to do so greatly increases the likelihood of serious problems emerging later with system O&M, if not at the initial construction stage. Whether or not this lesson will be heeded in Chitral remains to be seen.

# Case Studies of Selected Irrigation Systems

## CASE STUDY 1: DEH JOI<sup>1</sup> IRRIGATION SYSTEM

### Introduction

#### *Area Overview*

*GENERAL.* THIS CASE study describes a farmer-managed irrigation system in Bakhtoli Valley. The Deh Joi System was randomly selected for this study from among 13 existing FMIS in the valley, none of which have received assistance from either the government or any other development agency. It is readily accessible, has not received assistance from any agency, and has the largest cultivated command area in the valley. The irrigation channel is named after the village Deh, from where its original builders came. In the beginning, Deh farmers were the only beneficiaries of this system. At present, however, the village of Deh Bakhtoli, Dhok Bakhtoli and Baleough are all beneficiaries of this system. The first two villages fall within the jurisdiction of the Shoghore Union Council, Tehsil Lotkuh; and the third is in the Chitral Union Council and Tehsil.

*Location and Access.* The Bakhtoli Valley is a side valley of the main Chitral Valley. It lies about 16 km north of Chitral town and is 16-19 km long. The Bakhtoli *Gol* (river) is the main river in the valley, and it is the source for the Deh Joi System. The Deh Joi is the sixth irrigation channel offtaking from the north-to-south-flowing Bakhtoli River and is located on its left bank (Figure 2).

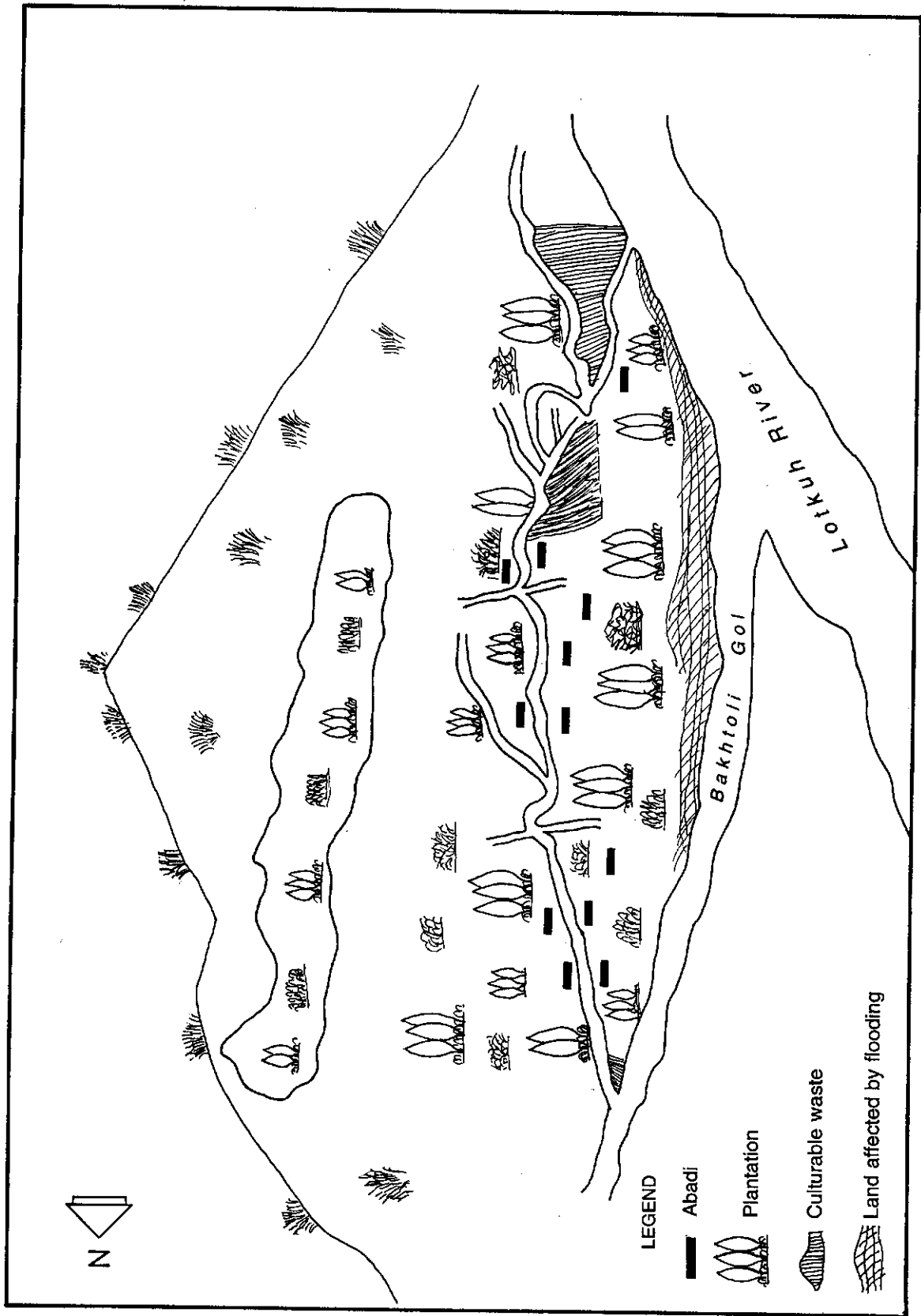
The Bakhtoli Valley can be reached by the metaled Chitral-Garam Chashma road, a few furlongs (1 furlong = 201.17 meters [m]) beyond Bilpok Village. In 1988, a bridge was constructed over the Lotkuh River by the District Council linking a 2-km long jeepable road constructed with a grant from AKRSP. This road now provides vehicles with direct access to the village. Prior to the construction of the bridge, the system was only accessible through a small track connected to the Chitral-Garam Chashma road by a bridge at Bilpok Village, near the tail reach of the system.

*Physical Information.* The settlement in Bakhtoli Valley consists of 11 villages. The valley is narrow and the villages in it are located on steeply sloping terraces which are very unstable. Much of the flat land along the river was washed away during the floods of 1976, forcing farmers to cultivate the steeper terraces. High pastures owned in common by the villagers are located at some 3 hours walking distance from the village.

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<sup>1</sup>This is the local term for an irrigation channel, usually the main channel.

Figure 2. Deh Joi Irrigation System.



## ***History and Settlement Pattern***

***History of the Settlement.*** Bakhtoli Valley was believed to have been initially settled by four persons named Jai, Malik, Sher Mohammad Khan and Rehmat Khan, before the Kalash rule in this area. Further investigations about the first settler of this valley revealed that Jai came from Virshegum (Gilgit), and was followed by Amir and Shugh who came from Madashi (Garam Chashma). Amir purchased some land from Jai and started living here. Some time later the *Mehtar* or the former ruler of Chitral forcibly took the land from Jai.

The leaders of the three villages said that this valley was completely destroyed by a huge flood about 500 years ago. The entire population left the valley and only 5 households returned after the flood. They began cultivation on a much smaller area than before, as the floods had washed away a lot of the flat land. Further land development in the valley was undertaken gradually as the need arose with increases in the population.

***Settlement Pattern.*** All the villages in the command area of this system are settled on steep, terraced valley slopes. The farmers of this system have constructed their houses along the channel. Fruit trees and vegetables are grown near or inside the houses. Parts of the *ghari* (high land) are distributed among the original settlers of the valley and are being cultivated with water from a spring. The majority of the farmers of this system own cultivated high land where they grow wheat. High pastures are located near the cultivated high land and are the common property of the farmers of the valley.

***Population.*** Among the 11 villages in Bakhtoli Valley, 3 are beneficiaries of the Deh Joi System. The current population of the villages in the command area of Deh Joi System is 62 households, of which, 57 are its beneficiaries (Table 2). An average household in these villages consists of 12 persons.

***Table 2. Distribution of beneficiary households.***

Village	Number of households
Deh Bakhtoli	22
Dhok Bakhtoli	11
Baleough	24

***Migration Pattern.*** Seasonal out-migration is very common in the area and is closely related to local economic conditions, such as the increasing inability of agriculture in Chitral to provide jobs and sufficient incomes to a growing population, to meet changing patterns of consumption. Many young men of Deh (and other Chitrali Villages) migrate to other parts of the country in September or October, usually returning the following June or July. Almost every household in the three villages irrigated by the Deh Joi has at least one member working in Chitral town. Farmers reported, however, that employment in nearby areas is preferred by the locals as it enables them to remain in their homes.

The village elders reported that 6 different clans, presently comprising 16 households in the command area of the system, are recent migrants to this valley. They have come from different parts of this region,

such as Zondrae from Sewakht; Shadiae from Torkuh; Saburae, Gulbkhae and Kunnathae from Auzer (Karimabad); Qumbrae from Bilpok and Sanglae from Lotkuh.

### ***Irrigation History of the Area***

Of the 13 systems in Bakhtoli Valley, 7 are located above the Deh Joi, while 6 are located downstream of it (Figure 3). These systems are reportedly 500 to 700 years old. Only Kandejal Joi (50 years), Ughdair Joi (35 years), and Khora Joi (8 years) were constructed more recently. The Kilishpi Joi is no longer in use because of a significant decrease in the water supply of the spring which was its source. All these systems are farmer managed, and serve comparatively small areas. After Deh Joi, Biaro Joi is the largest of the systems, irrigating about 10.8 ha, while Shotaro Joi is the smallest, irrigating merely 0.5 ha. Table 3 gives an estimate of the command areas of each system.

All of these systems have Bakhtoli River as their source of water except Kilishpi Joi (as noted, no longer in use), for which the source was a spring; and Chanjak Joi which takes off from Chuznir River, a tributary of Bakhtoli River. Water rights of these systems are based on their location along the Bakhtoli River. Upstream systems have priority over the use of water, while the downstream systems use whatever surplus water that is left.

### **History of the System**

#### ***Original Construction***

The original channel was constructed by the farmers of Deh Bakhtoli before the Kalash rule. It was constructed by the original settlers, Jai, Malik, Sher Mohammad Khan and Rehmat Khan, up to the village of Dhok Bakhtoli. According to the villagers, the internal resource mobilization for the construction of the channel was done on a household basis. Each household had to contribute an equal share of labor regardless of the area of their land which would come under the system's command. The villagers reported that all the resources required for the construction and maintenance of the channel have been generated internally by the villagers.

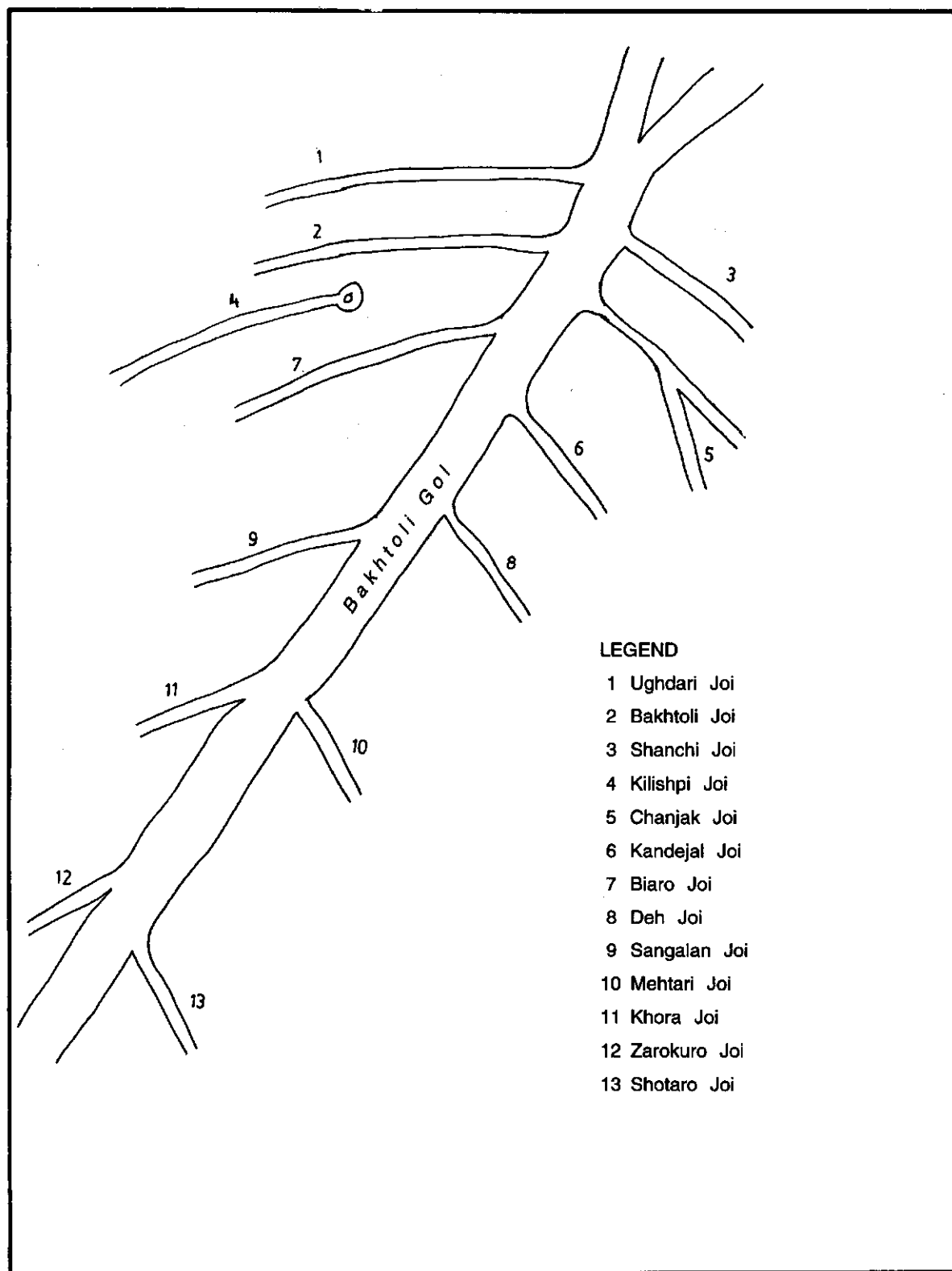
#### ***Improvements and Rehabilitation***

The first major work after the initial construction was carried out by the successors of Jai and Amir, namely Qurash, Nirash and Shugh. This was after the huge torrential flood destroyed the whole valley about 500 years ago, when the channel was rehabilitated from the *hurdur* (headworks) to Dhok Bakhtoli. The system headworks and some parts of the channel were damaged again by a flood in 1976 and were reconstructed soon afterwards.

#### ***System Expansion***

With the increase in population over time, additional land had to be developed to feed the growing population. The increase in water demand was met by improving the water carrying capacity of the channel. Mirza Ishaq, Sahib Khan, Qudmir and Khane were the farmers who carried out this major improvement about 150-200 years ago. The resource mobilization for the expansion work was on a household basis, with all beneficiaries providing labor during the improvement task. Nearby villages provided food to the farmers working on the channel.

Figure 3. Irrigation systems in Bakhtoli Valley.



**Table 3. Irrigation systems in Bakhtoli Valley.**

Number	Name of system	Location of headworks	Source of water	CCA (chakoram)
1	Ughdair Joi	Tang	Bakhtoli Gol	50
2	Bakhtoli Joi	Dasoon Gol	Bakhtoli Gol	60
3	Shanchi Joi	Bakhtoli Gol	Bakhtoli Gol	10
4	Kilishpi Joi		Spring	15
5	Chanjak Joi	Chuzmir	Chuzmir Gol	30
6	Kandejal Joi	Theon	Bakhtoli Gol	10
7	Biario Joi	Chanjak	Bakhtoli Gol	100
8	Deh Joi	Kilishpi	Bakhtoli Gol	300
9	Sangalan Joi	Khora Gol	Bakhtoli Gol	30
10	Mehtari Joi	Dhok	Bakhtoli Gol	25
11	Khora Joi	Udso Gol	Bakhtoli Gol	30
12	Zarokuro Joi	Sangan Kuro	Bakhtoli Gol	50
13	Shotaro Joi	Bangalan	Bakhtoli Gol	5

Note: CCA = Cultivable Command Area.

The farmers of Baleough used to irrigate their lands with spring water. However, as these farmers developed more land to produce food to feed the growing population, the spring water soon became insufficient to irrigate these lands. Four farmers then formally requested the farmers of Deh and Dhok to let them extend the channel to their fields in Baleough. The extension was allowed provided the following conditions were met: (i) the farmers would increase the water carrying capacity of the channel; (ii) they would not interfere with the existing water rights of the upstream farmers; and (iii) they agreed to use only the surplus water in the channel.

About 45 years ago, another farmer further extended the channel from Baleough to Doghoshaal. Recently, the village leader of Baleough, obtained control of this land through a court order and repaired that extension of the channel to irrigate those fields.

Further expansion of this system is seen as not possible because of the shortage of water. There is, however, some potential for improving the utilization of available water by strengthening the weak parts of the channel. At present, there is no regular night irrigation because it is very difficult for Baleough farmers to patrol along the narrow embankment of the channel in the dark. Users are worried that the weaker parts of the channel would be severely damaged by overflows or leakages that would not be seen in time.

## **Description of the Physical System**

### **Hydrology**

**Source and Catchment Area.** Deh Joi takes off from Bakhtoli River which carries its water from a place called Tang, 16 km upstream. The main sources of water of Bakhtoli River is a spring and snowmelt; some other small streams also feed into Bakhtoli River, but they contribute only a small amount of water. Occasional return flows from upstream irrigation systems also contribute to the flow in the River. Only

spring water is available throughout the year, especially in winter, with spring-summer flows supplemented by snowmelt.

The water from the source used to flow alongside agricultural lands of Parsan and Tang villages before 1976. However, torrential rains and floods that year washed away the fertile top soil, leaving behind a grayish stony surface. As the water passes over this surface, it picks up sediment from this material, slowly decomposing through chemical reactions, which is then deposited further downstream (see the description on water quality below).

*Water Supply Variability, Floods and Drought.* Water availability in Bakhtoli River varies substantially from season to season, largely as a function of snow accumulation and melt and occasional rainfall, the former also affecting discharge from the spring as a source of its recharge. Maximum discharge into Deh Joi from Bakhtoli River is about 6 cusecs (170 l/s), but flows in the channel clearly vary with respect to supplies in the river. The impact of irrigation activities in systems upstream of Deh Joi who have rights of prior appropriation are also significant. For example, water in Deh Joi usually is in short supply from June to August, the period of peak water demand for maize, the most important crop at this time, because flows in Bakhtoli River at Deh Joi intake have been reduced by upstream systems operating at maximum levels. At this time, water flow in Bakhtoli River below Deh Joi often ceases or is reduced to an insignificant level, and downstream systems, all very small, get no water at all. In winter, water requirements are lower and the water available in the channel is usually sufficient to meet the requirements. These relative conditions are illustrated in Figure 4, which was synthesized from farmer interviews.

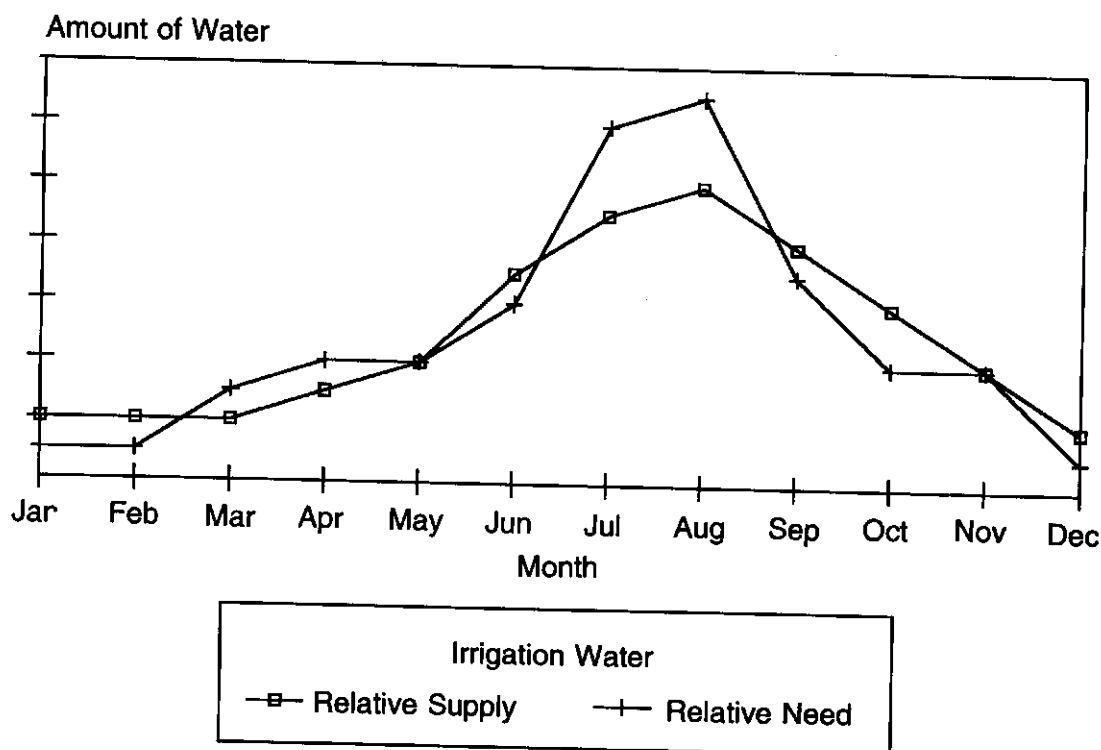
Floods reportedly may occur as often as two to three times during the rainy season, although there have been no floods affecting Deh Joi for the past two years. The recognized period for floods is April to September. When they do come, floods usually cause substantial damage to the headworks and bring large quantities of silt and debris into the head reaches of the system. Although droughts are relatively rare, two years ago there was a drought which seriously affected crops in the command of the system.

*Water Quality.* Deh Joi offtakes about midway down Bakhtoli River at which location stream flows occasionally are supplemented by drainage from the fields of upstream systems. Thus, water entering the channel is fairly silty. Farmers report that some silt deposition in the upper reach of the channel is common throughout the year, although the amount is highly variable, being dependent upon upstream runoff and soil erosion. Water in Bakhtoli River also carries some apparently harmful salts picked up from its main source, which, farmers report are damaging to their crops. The grayish, stony soil material exposed by the torrential rains in 1976 at the source slowly decomposes through chemical reactions with the water flowing over it. Since 1976, Deh Joi farmers report that rice and vegetables cannot be grown in the command area of their system. They also state that the quality of this water and the sediment deposited by it have damaged many of their fruit trees as well.

The river water is also said to be very unhealthy for people, and a throat disease related to it, locally called gillet, is common in the area. The polluted water of the system was also fatal to local children during the 1990 rains, several having died from the greatly increased incidence of gastro-intestinal diseases at that time.

*Other Uses of Water.* Apart from irrigation, water in Deh Joi is used for drinking purposes, other domestic uses (washing clothes, cooking), watering animals, and for a water mill and small cooler by the side of the channel. The water mill is located near the headworks and it only operates at night because during the day all water is used for irrigation. The gate of the water mill (*khora*) is also used as a *madok* (sluice gate) to discharge excess water during floods and in the rainy season. Drinking water from the channel is normally kept in a container for a period of time before consumption to allow sediments to settle.

Figure 4. Water supply relative to need, Deh Joi System.



Sources: Farmer interviews.  
EDC/IIMI Survey, September 1990.

### Main and Branch Canals

Generally, throughout its 6-km length, Deh Joi passes along the up-hill side of sloping to moderately terraced agricultural lands although, at some places, especially between Dhok and Baleogh Villages, it passes through uncultivable mountain slopes. The main channel and its five small downstream branches--three offtaking to the right side and two to the left--have been constructed traversing rather unstable slopes comprising of relatively sandy and stony soils, accommodating the bends and folds of local relief and resulting in both irregular shape and size.

The main channel has been constructed from generally good quality rocks and earth. Medium-to-large stones of varying size and shape have been used in building retaining walls at many key locations, especially in the channel head reach. These walls, however, are unmortared and a breach can still occur relatively easily. The length of these walls ranges from 15 m to about 90 m, and their vertical height from ground level varies from 1 m to 3.5 m. In numerous places along the left side (up-hill) of the channel, there is unstable scree subject to frequent slips and slides. Planting vegetation along the retaining walls is the preventive measure that the system users have adopted to strengthen the retaining walls of the channel.

The width of the main channel varies from 0.3 m to as much as 1.2 m and that of its branches from 0.1 m to 0.3 m. At its head, Deh Joi can intake a maximum discharge of about 170 liters per second (l/s). A greater discharge than this is likely to breach the channel, which is why irrigation operations at night in the system are not allowed. The branches of Deh Joi have a design capacity of 28 l/s or less. The gradient of the main channel is such that relatively high flow velocities (ca. 1 m/s) are sustained throughout much of its length. Relative to the extent of its service area, there is about 140 m of main channel per hectare (15.5 m per chakoram; 1 chakoram = 0.11 ha).

## Structures

**Channel Headworks (Hurdur).** The channel intake structure is an impermanent construction made of large- and medium-size rocks which are readily available in the river. Its shape and size is subject to fluctuations in water flow in the river and the changing water requirements of the users who can easily adjust the intake by changing the placement of and/or removing the rocks. This also means that the intake can be readily rebuilt whenever washed away or damaged by summer floods in the river. The location of the headworks is usually moved downstream in summer months in response to high flow conditions in the river and then back upstream in winter as discharges decline. Figure 5 shows the headworks of a standard irrigation channel.

**Sluice Gates (Madok).** This system has three sluice gates; two are near the headworks and the third is about 1.6 km downstream. One of the sluice gates near the headworks is used to operate the water mill at night. A second sluice gate is used as an escape to divert any excess water back to the river when the water mill is idle. Four flat stones are used to make each sluice gate: one in the bed, two for the sides, and the fourth as the gate. The sluice gates often leak significant amounts of water, perhaps as much as 28 l/s, under full-supply conditions. However, during periods of maximum water needs or when supplies are scarce, downstream users will plug these leakage points. Figure 6 shows a standard sluice gate.

Figure 5. The headworks (hurdur) of a standard irrigation channel.

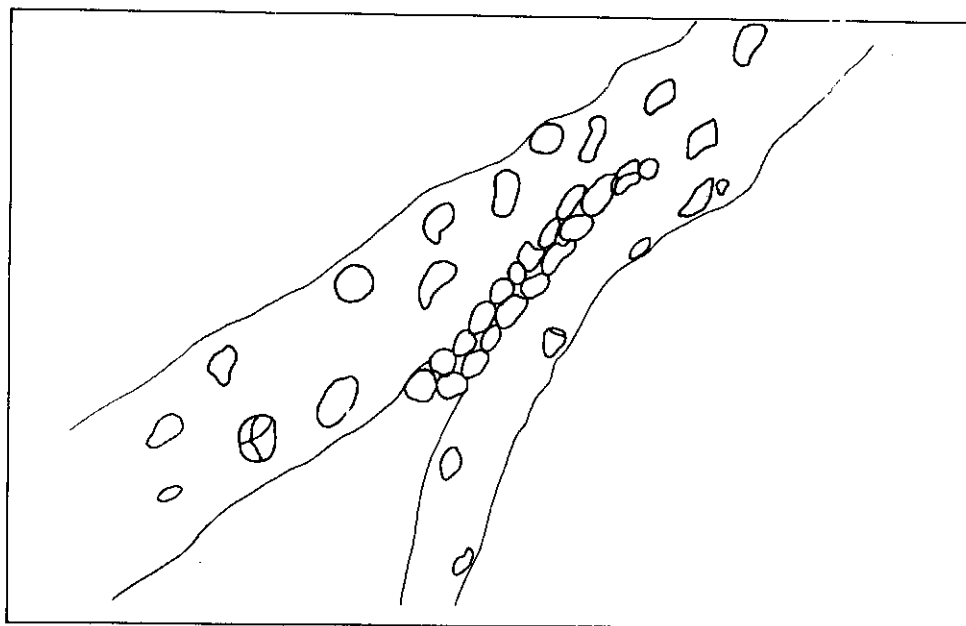
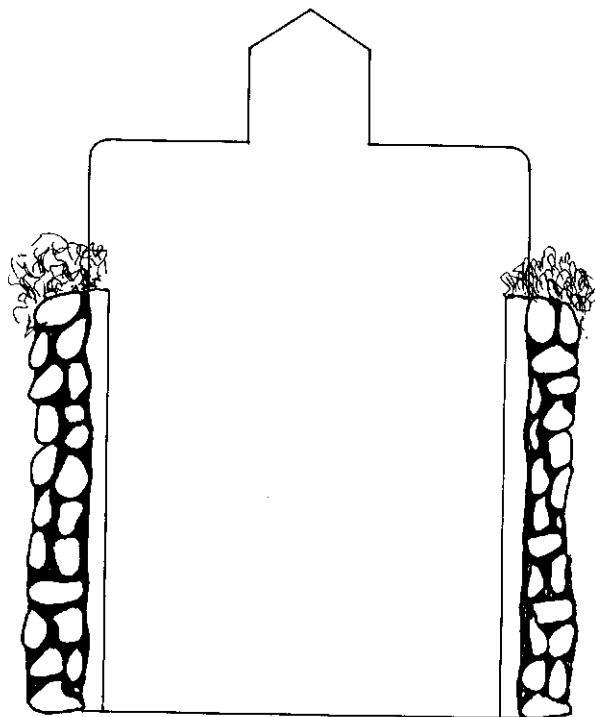


Figure 6. A standard sluice gate (madok).



*Turnouts (Ghospans).* There are about 60 *ghospans* (turnouts) in the system delivering water to the cropped fields, fruit plants and trees. These are usually in the form of a direct cut in the bank of the channel which is closed silt, sand and stones when irrigation is completed. The size of a turnout varies considerably according to the size of the farm and area to be irrigated, type of soil and slope condition. Small turnouts are used to irrigate a few trees, and large ones are used to irrigate a few hectares of land. For steep slopes and stony soils, farmers also make small outlets to avoid erosion.

A few turnouts made of tin were also observed. These tin outlets are elongated and their downstream ends are kept away from the channel embankment to avoid erosion. No wooden turnouts were found being used, however, a 3.8-centimeter (cm) diameter pipe was observed being used as a turnout to irrigate vegetables and fruit trees in Baleogh Village.

*Cross Drains.* Three dry rivers, the Udso, J alas and Baleough, cross the main channel. Udso and J alas rivers flow only in the rainy season while Baleough River supplements the channel flow with about 14 l/s of spring water. In the rainy season discharges from these rivers may damage the channel. Two other small, dry rivers between Deh and Dhok villages also cross the channel.

*Regulators and Measuring Devices.* There is no regulator, as such, in use in this system. Discharge into the system is regulated by "opening" or "closing" the headworks by adjusting the position of rocks in this structure, or by using the escape sluice gate which is opened at night to divert water back to Bakhtoli River to avoid breaching and damage to the channel. Sometimes the flow is stopped at the headworks by removing a few stones and letting the water flow to the river. No measuring devices are used in this system, perhaps because water allocation and distribution are not done according to discharge condition or on a volumetric basis.

*Aqueducts, Siphons and Drop Structures.* There are no aqueducts or siphons in the Deh Joi System, although there are 6 small drop structures in place throughout its length, mainly in the head and middle reaches. These drops are constructed from small rocks and stones, but have no specific size or shape.

## **Drainage**

Since cultivated fields and village houses are invariably located on fairly steep, terraced slopes, drainage is not a problem in this area. Any excess water drains readily into the Bakhtoli River either rather directly, or through other small rivers which cross the command area at different points and are tributaries of the Bakhtoli River. Sluice gates, as noted previously, have been provided in the head section of the channel to discharge excess water into that stream. These sluice gates are usually kept open in the flood season so that discharge into the main channel is regulated at an acceptable level. Sometimes the headworks itself is blocked or closed by the farmers to prevent water from entering into the system in the rainy season.

## **Irrigated Area**

*Command Area.* Deh Joi only commands fields below its right bank throughout its length, and the total cultivable area in the command of this system is 388 chakoram or 42.7 ha. The first field served by the system is located about 300 m from the head. Much of the service area comprises small, terraced fields constructed on rather steep hill/mountain sides, with terrace risers ranging in height from about 0.2 m to 1.5 m. These terraced fields remain poorly leveled in their upslope extents, becoming more level toward the downslope riser of the next field below. There are a few well-leveled plots near Bakhtoli River where rice was grown before 1976; now these plots either produce fodder or are left fallow.

There are some patches of land below the channel which remain undeveloped because they are too steep and stony. Consequently, if converted to fields, they would need much more water for irrigation as compared to other parts of the command area, and water is already scarce in this system.

*Soils.* The soils in the command area are generally light, sandy to stony, gradually becoming more stony toward the tail end of the system. Better soils are concentrated in the system's head reach command, and quality gradually declines toward the tail. Because of these physical soil conditions, the frequency of irrigation is quite high in the *kharif* season, ranging from a 3 to 8 day interval, depending on field-specific soil and crop conditions as well as the weather. Fields with more stony soils and with steeper gradients need more frequent irrigation for the same crop than do those comprising lighter sandy soils that are better leveled.

## **Institutions and Social Environment**

### ***Social Institutions***

*General.* All farmers in the command of this system are owner-cultivators and their landholdings are very small and fragmented. The average household was estimated to comprise 12 persons. There are very few opportunities for off-farm employment in this valley, and the majority of the surplus labor migrates to other parts of the country, either elsewhere within or outside Chitral for employment. Family income levels are very low, and it is very difficult for a family to survive without cash remittances from outside employment.

*Ethnic Composition in the Command.* The majority of the households belong to the Ismaili community; only seven households belong to the *Sunni* sect of Islam, all of whom live in Baleough Village in the tail reach of the Deh Joi. Nine different clans were identified as resident in the command area of the system, namely Amirae, Shahbazae, Jai, Zonderae, Suburae, Kunnathae, Gulbkhae, Shadiae and Qumbarae. There are no barriers to social interaction among these different clans, all of whom inter-marry.

*Institutional Development.* In 1954, a Nigran Committee was appointed by the Tehsil Office consisting of 5 members including one *muharrar*, the member responsible for keeping records of disputes and decisions. This committee was charged with hearing and settling disputes among the farmers of this valley. In the early 1970s, these Nigran Committees were abolished, and cases were referred to the Courts instead. In 1986, Deh and Dhok Villages established separate Village Organizations (VO) through the assistance of AKRSP.

*Conflict Management.* As in other Chitrali locales, here too the village leader plays an important role in assisting in the resolution of most local level conflicts. However, land disputes are now commonly taken to the courts, and personal fights stemming from social disagreements or disputes may be taken to the police. The farmers of Deh Joi Villages reported that there have been few conflicts among them over the past generation. In fact, the only major conflict cited occurred about 12 years ago when there was a dispute over the land of Kilishpi and Deh with a farmer of Parsan. Otherwise, disputes or disagreements apparently are minor and easily resolved internally.

## **Institutional Aspects of Irrigation**

### ***Irrigation Institutions***

There is no formally constituted organization for the operation and maintenance of the Deh Joi. All maintenance and repair activities for the channel are carried out mainly through the organization and supervision of the village leader of Deh, assisted by the village leaders of Dhok and Baleough. Their decisions concerning system O&M are usually acceptable to the villagers.

The beneficiaries of Deh Joi also formerly employed a channel watchman (*joiwal*) during the water scarce season to check and control water losses in the system. The watchman would patrol the main channel 2 to 4 times a day, plugging leaking sluice gates and turnouts and adjusting the headworks as needed. Farmers in the system's middle and tail reaches especially benefitted from these activities as it ensured them a more reliable water supply. The watchman was paid about 400 kg of maize in exchange for 3 months' services, toward which each household contributed equally. The practice of hiring a watchman, however, was stopped about two years ago for two reasons. First, the channel watchman was demanding an increase in his annual compensation, and second, head-end farmers were unwilling to increase their own contribution to the watchman's total compensation. It remains unclear why alternative arrangements to replace this apparently useful function have not emerged.

It proved impossible to differentiate the effects of the Village Organizations upon the less formal organizational structure for irrigation O&M. This was because the village leaders, who are the main organizers of Deh Joi System management activities, are the very same persons who hold leadership positions in the VOs.

## ***Water Rights and Allocation***

Water rights in Deh Joi are very well defined, consistent with the initiation and expansion of the system as noted previously, and understood by all of its users. Farmers of the Deh Village have superior water rights resulting from their having first constructed the channel. They can use as much water as they wish, even diverting water to fields during the turns of downstream farmers. Only when these farmers complete their irrigation is water available to downstream users, defaulting first to farmers of Dhok and finally to Baleough farmers.

Upstream farmers can use as much water as they need and is available in the system at any time. Occasionally farmers of Deh Village will irrigate their farms excessively, resulting in water draining directly from their fields back into the Bakhtoli River; such over-irrigation accentuates water scarcity in the system's tail reach.

Farmers in Baleough Village practice a local system of rotational water distribution according to a roster of users. This non-timed, farm-based roster of turns begins with the first farmer in the tail reach, following in spatial order to the lands of the tail-most farmer in Baleough. Each farmer, in his turn, is entitled to use the entire available supply until his crop water needs are met before handing over to the next farmer in the roster. If a farmer's turn is interrupted by the irrigation activities of an upstream Deh or Dhok Village farmer, he resumes his turn once water is again available in the system's tail reach.

In periods of system water shortage, Deh farmers again have superior rights to water over all other users, followed by the farmers in Dhok and, lastly, the farmers of Baleough. To increase the supply of water in the system, the farmers of Baleough often walk to the head of the channel to capture more water from the river, if possible, by adjusting the headworks. Such journeys cover a distance of at least 10 km in a single roundtrip; sometimes as many as three trips are made in a day.

## ***System Operation and Maintenance***

***Routine Maintenance.*** There is a clear division of labor and maintenance responsibility among users along the length of the channel. Tail farmers are obligated to work throughout the channel length, from head to tail, middle reach farmers provide necessary maintenance to the head- and middle-channel reaches, but head-end farmers participate in the maintenance of the channel head reach only.

Regular cleaning and desiltation are necessary to ensure a reliable flow of water in the channel, and this seasonal maintenance task is initiated and supervised by the village leader of Deh Bakhtoli. He is responsible for informing the village leaders and other farmers of Dhok and Baleough Villages whenever he determines the channel needs cleaning. Generally desilting and cleaning are undertaken twice a year; first during the *rabi* (winter) season in March or April and second during the *kharif* (summer) season in June or July. Desilting and cleaning the channel from head to the tail normally takes two days.

Minor damage to the channel from minor landslides, animals, erosional processes, etc., is usually repaired by individual farmers alongside whose land the channel passes. If repair work is beyond the capacity of the individual household, however, other farmers of the same village will join in. In short, system maintenance is basically understood to be a collective responsibility, and the burden of repairs should not exceed the resources available to any one farmer.

***Emergency Maintenance.*** Emergency repair work to the system caused by floods, major landslides, etc., is also organized and directed by the village leader. River floods are the major cause of damage to the headworks and breaches in the system. Major landslides may occur as a result of heavy rains or earth tremors, though their frequency is not more than 2 to 4 times a year. In such cases, households of all system users are expected to contribute labor equally to repair the damage. Such emergency maintenance

is usually completed in a few hours within a day depending upon the severity of the situation and the workforce available.

### ***Irrigation Conflicts***

Reportedly, there have been no severe conflicts among the beneficiaries of the system. However, it was noted that about 200 years ago, the farmers of Parsan, a settlement located about 16 km upstream along Bakhtoli River from Deh Joi, tried to construct a separate irrigation system to irrigate their lands. Their effort was stopped by the forceful intervention of the beneficiaries of Deh Joi on the grounds that they were the oldest settlers of the valley and had more rights on the water source of Bakhtoli River than did the farmers of Parsan.

The second conflict regarding irrigation water took place two years ago when a farmer of another upstream system tried to increase its intake of water to enable him to increase his cultivated area. This dispute was solved through the intervention of the village leaders who successfully persuaded the farmer to stop that activity.

## **Agricultural System and Support Services**

### ***Agricultural System***

*Farmsize and Land Utilization.* Agriculture is the mainstay of the population of the valley, and 90 percent of the households in the command area of Deh Joi are farmers. Landholdings throughout the command area are small and fragmented with farm sizes varying from less than 0.2 ha to 5.5 ha (1.5 to 50 chakoram). The average farm size for the system is slightly less than 0.6 ha (5.3 chakoram). All the farmers in the command area are self-cultivators, but there are 5 households in the command area who do not own any agricultural land. These households work as labor on road construction or obtain any other employment available.

Pastures and grazing lands are owned jointly by the community and they are located near the respective villages in the command area. The original residents of this valley also have developed some culturable lands near the mountain tops which are individually owned.

As noted in Table 4, the total command area of Deh Joi System is approximately 42.7 ha (388 chakoram) of land. Only 33 ha (300 chakoram) of this cultivable area is currently irrigated by the system; the remaining 9.7 ha (88 chakoram) of command area is not cultivated because of persistent water shortages in the system. Most of this potentially cultivable land, about 5.5 ha (50 chakoram) is in Baleough Village, at the tail of the system. The remainder of this modest additional cultivable area is in Deh, 1.3 ha (12 chakoram); and Dhok, 2.9 ha (26 chakoram).

*Cropping Pattern, Yield and Intensity.* Bakhtoli Valley is an area of double cropping. Wheat and maize are the principal crops grown in the rabi and kharif seasons, respectively. These two cereal crops account for more than 90 percent of the cropped area, highlighting the subsistence farming orientation of agriculture here. Other minor crops grown are vegetables, fodder, potato and pulses. Rice was previously grown in a small area irrigated by this system, but after the previously noted flood of 1976, farmers gave up its cultivation because the quality of water was no longer suitable for rice and the floods severely damaged many of the relatively leveled fields on which rice was grown. In all three villages served by the system, wheat is grown on the largest portion of cropped area. An improved wheat seed, Maxi-Pak, was introduced to this area 15 years ago. Before that farmers used to grow barley in about 75 percent of their cultivated

Table 4. Deh Joi Irrigation System Summary.

Number of systems in the area	13
Number of households in the area	123
Length of main channel (km)	6
Maximum discharge (l/s)	170
Number of branches	5
System command area (chakoram)	388
Number of settlements in command area	3
Number of beneficiary households	57
Average number of man-days contributed for:	
Routine maintenance	50
Emergency maintenance	60

Note: 1 chakoram = 0.11 ha.

land, planting the remainder to an old wheat variety called *tuifgum*. After the introduction of Maxi-Pak, however, most of the barley area was replaced by wheat. As best as can be determined, the present annual cropping intensity is virtually 200 percent, with all cultivated area reportedly being sown in both kharif and rabi seasons (see Figure 7).

Figure 7. Crop Calendar, Deh Joi System.

CROPS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WHEAT (1)			Irrigation			Harvest					Sowing	
WHEAT (2)					Irrigation		Harvest	Sowing				
BARLEY			Irrigation		Harvest						Sowing	
SHAFTAL				Irrigation		Harvest			Sowing			
MAIZE						Sowing	Irrigation		Harvest			
MASH					Sowing		Irrigation		Harvest			
LOBIA						Sowing	Irrigation		Harvest			

Notes: WHEAT (1) = Grown in the command area of the system.

WHEAT (2) = Grown in fields at mountain tops owned by the farmers of this system.

Average yields, determined from farmer interviews, for the major crops are identified in Table 5. These yields are nearly double the estimates of average yields for the same crops reported in *Agricultural Statistics of Pakistan 1986*. Deh Joi farmers reported that their yields had essentially doubled following the introduction of improved seeds and use of chemical fertilizers.

*Table 5. Agriculture in Deh Joi Command Area.*

Yield (tons/ha)		
	Maize	3.4
	Wheat	4.0
	Barley	3.4
	Pulses	1.0
Fertilizer use (kg/chakoram)		
	Maize	20-30
	Wheat	34-40
Cropping intensity (%)		200
Average farm size (ha)		0.74

Source: Farmer interviews.

Note: 1 kg/chakoram = 9.90 kg/ha.

**Agricultural Practices.** Land preparation, ploughing and leveling, is carried out using wooden ploughs and bullock power. Fields are normally ploughed 2 or 3 times prior to sowing, followed by laddering to level the field. Weeding and thinning by hand are also done once or twice during the crop cycle. Plant protection measures are not yet common in this area. All crops are harvested by hand using traditional hand tools. Traditional methods for threshing remain in use, although in 1989, a tractor powered wheat thresher came to this area for the first time and most farmers used it.

**Input Use.** The farmers of Bakhtoli Valley reportedly first heard about commercial fertilizers 20 years ago, and the village leader of Baleough was the first to use them, five years later. The NWFP Department of Agriculture also encouraged using fertilizer and improved seeds through demonstration plots on the roadside near the valley. By the early 1980s, most farmers of Deh Joi had begun to use commercial fertilizers, and its use is now common for all crops.

Farmers in Deh and Dhok report using a mix of DAP and urea at the rate of 40 kg per chakoram, while those in Baleough use the same mixture at a somewhat lower rate. Applications of chemical fertilizer are also supplemented by compost comprising animal manure, crop residue and household refuse. Most farmers retain their own seed for sowing. Seed rates are very high in order, farmers say, to compensate for reduced germination in their poor soils. Pak-81, an improved wheat variety, is now being grown by almost all the farmers.

**Support Services.** Chitral Town is the nearest market for purchasing inputs, notably seed of improved varieties and commercial fertilizer, and selling surplus farm produce. Access to Chitral Town from Bakhtoli Valley has improved greatly following the construction of a bridge and link road in 1988.

No support services are provided to farmers of the valley by the NWFP Agricultural Extension Directorate. After Village Organizations were first formed in the valley in 1986, AKRSP has arranged for the supply of improved seed and fertilizer with six month credit facilities to farmers through their VOs.

Before the organization of VOs, the farmers used to get support services from the National Fertilizer Corporation's sales agent and other retailers of Chitral Town on cash payment.

**Self-Sufficiency.** Generally food grains produced are insufficient to meet the household needs of farmers in the system because of their small farm size. Most households must purchase wheat from the market every year, and some farmers reported that their farm produce met household food requirements for as little as six months. Such food grain purchases are financed by selling livestock, locally made woolen cloth, wages earned from construction jobs, and/or remittance received from family members working in other parts of the country.

Wheat, rice, and pulses are the major food imports, and other essential items such as ghee, sugar, salt, soap and tea are also purchased from outside. Locally made woolen cloth, some livestock, very small amounts of vegetables, grapes, and mash are exported to Chitral Town. When surplus permits their sale, mash is sold at Rs 480 per 40 kg, maize for Rs 60-70 per 40 kg, and wheat for Rs 100 per 40 kg.

### **Labor Availability**

No hired agricultural labor was identified during the field survey; rather, all the farmers do their own farm work. When someone needs help, he asks for it from other farmers and gives them food in return for the time worked on his fields. This arrangement is called *yadoi* or labor sharing. Should any farmer need to do so, he can hire as much labor as he requires at the prevailing daily wage rate of Rs 50.

Local nonagricultural employment opportunities are very few, but some people work on road construction. Most surplus labor migrates to Chitral or beyond the district to the larger cities of Pakistan to find jobs. Such out-migration takes place in September-October, with migrants usually returning to their homes in March or April.

### **Key System Insights**

#### ***Apparent Strengths***

- \* Water rights are well defined and understood by the users.
- \* Operation and maintenance is carried out according to understood and accepted traditional procedures.
- \* Conflicts over water distribution or allocation are absent.

#### ***Potential Weaknesses***

- \* Water distribution is not undertaken on the basis of landholding.
- \* Significant amounts of water are lost to the system from leaks in the sluice gates and turnouts, or by occasional over-irrigation of fields.

- \* There is no management for a more efficient use of water (e.g., no watchman has been appointed to control leakages and wastage of water). Water scarcity in the system could be partly solved by reducing the wastage of water by upstream farmers.
- \* Water quality is unsatisfactory for rice and fruit trees; farmers have stopped growing rice because water quality is so poor.
- \* The channel is weak at many points throughout its length, and farmers must invest much labor annually to keep it operational.
- \* Despite water scarcity, night irrigation is absent because of the fragility of channel structures.

## **CASE STUDY 2: PEHLAWANANDEH JOI IRRIGATION SYSTEM**

### **Introduction**

#### ***Area Overview***

*General.* This case study covers a farmer-managed irrigation system in the Bamburate Valley, one of the three main Kalash valleys in Chitral District. Pehlwanandeh Joi was selected for this study because it has not received any assistance from government or other agencies since its construction and it was identified as a system having sufficient water supplies in its source river throughout the year. Bamburate Valley consists of 16 villages irrigated by 19 different irrigation systems. One system is managed by the District Council, but all others are managed by the farmers themselves. A majority of the systems here have received some assistance from the Aga Khan Rural Support Programme, the District Council and/or the NWFP Irrigation Department.

*Location and Physical Overview.* Bamburate is a narrow valley with cultivated land located both on steep mountain slopes and along the relatively flat, narrow river banks and terraces. Over time, much of the latter has been eroded forcing the farmers to move to the steeper valley-side slopes for cultivation. Pehlwanandeh Joi comes under the Ayun Union Council and is situated about 30 km southwest of Chitral Town (see Figure 8). The system is accessible through a 16-km metaled road and a 14-km jeepable track from Chitral through Ayun Valley. Before these roads and their bridges were constructed in the past two decades, travel to Chitral in the summer was via a mountain track, and in winter, when the water level was lower, a path along the main stream was used.

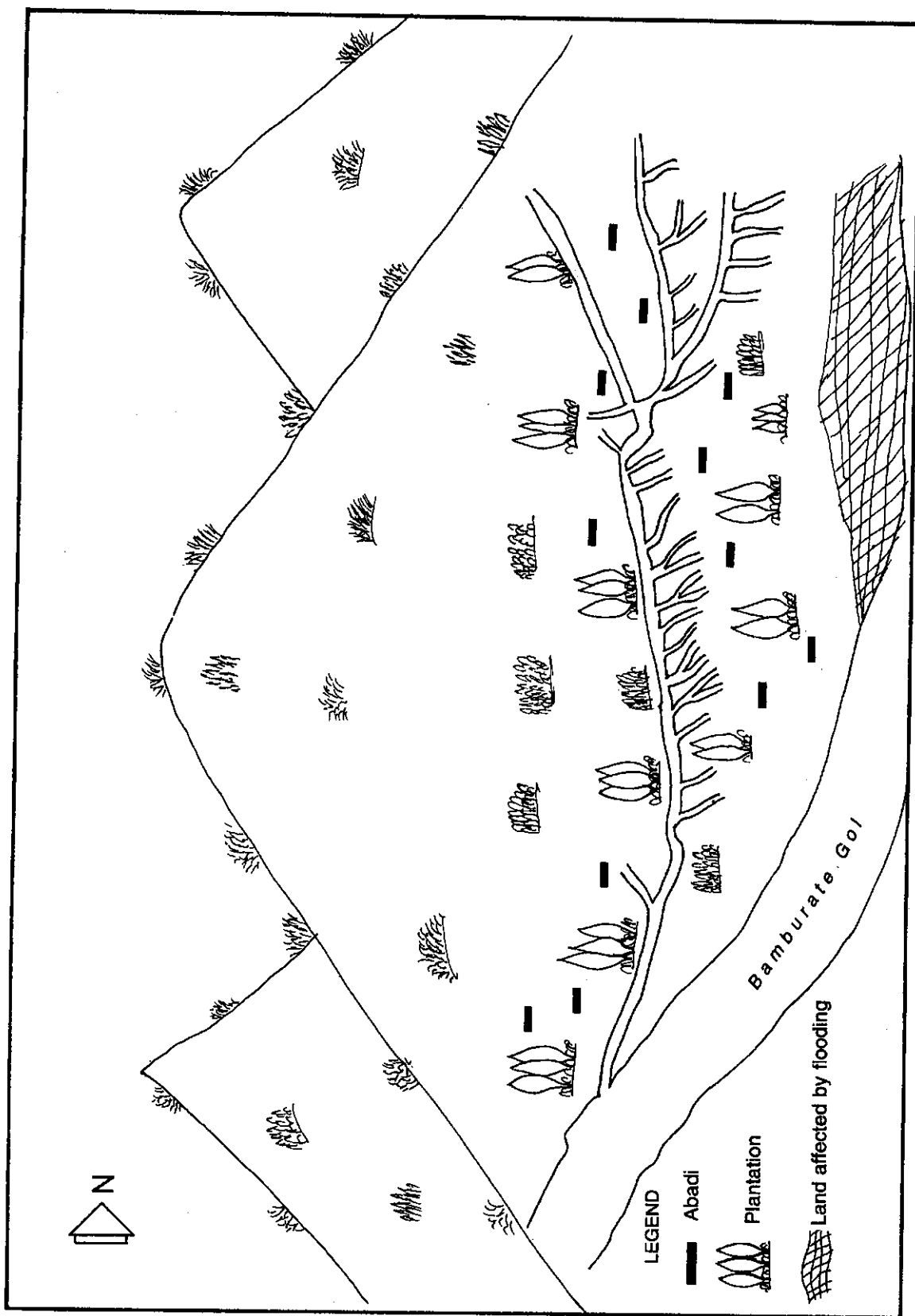
#### ***Settlement and Population***

*Settlement Pattern.* Locally, verbal accounts of the settlement history of the area varied greatly. While some farmers said that the valley was inhabited some 2000 years ago, others thought that the area had been inhabited since ancient times. There was general agreement that the Kalash had developed the area, perhaps only 700 or 800 years ago. However, the origins of the non-Muslim Kalash in these valleys of Chitral significantly pre-dates that time.

Most beneficiaries of the Pehlwanandeh Joi, the long-resident Kalash, have constructed their houses on steeper, terraced valley slopes, although the farmers of Gudayandeh Village have their houses on a relatively flat area. Kitchen gardens and fruit trees have been planted inside the residential compounds as well as close by, outside. More recent Sheikh (Muslim) immigrants have tended to settle along the river and on the roadsides.

*Population.* Of the 16 villages in Bamburate Valley, 5 directly benefit from the Pehlwanandeh Joi System. The total number of households in these 5 villages is 101 with an average of about 10 persons per household (see Table 6).

Figure 8. Pehlavanandeh Joi Irrigation System.



**Table 6. Distribution of Pehlwanandeh Joi beneficiary households.**

Village	Number of households
Gudayandeh	14
Matangi	22
Aung	30
Pehlwanandeh	30
Teewish	5

There continues to be substantial migration in and out of the valley. About 40 households of the Gadaie tribe immigrated to this area about 80 years ago from Mulkuh; these people were farmers. Following the rapid influx of Afghan refugees into Chitral during the past decade, about 150 Afghan households have migrated into the area. Forty households have settled within the command area of the Pehlwanandeh Irrigation System and 15 of them now directly benefit from it. Many young men seasonally emigrate to cities down-country for employment during the winter months, returning in April-May.

### ***Irrigation History of the Area***

Most of the cultivated land in Bamburate Valley is irrigated by a network of 18 irrigation systems (see Figure 9), and a majority of these systems were apparently constructed more than five centuries ago. Their source of water is either Bamburate River or its two tributaries, Lat River and Zinore River. The command areas of the systems range from 50 to 2,000 chakoram (5.5 to 220 ha). Table 7 gives some details of the irrigation systems in the valley, derived from farmer interviews.

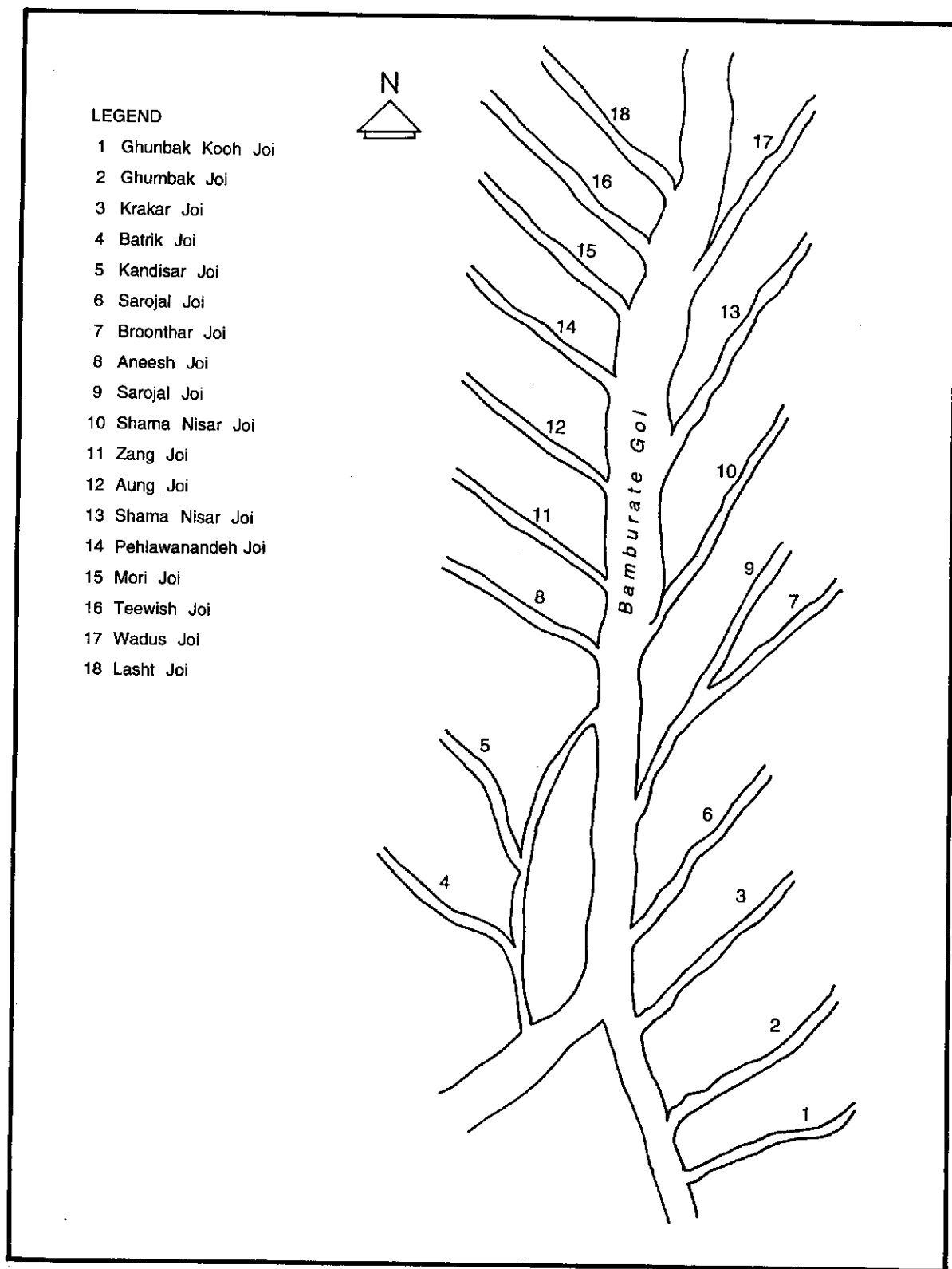
One irrigation channel, Krakar, in the head reach of Bamburate River, was constructed by the Irrigation Department and then turned over to the District Council. In the past decade, 3 systems have been improved and 4 new systems have been built with the assistance of AKRSP.

Fifteen new settlers (Gudayandeh people), who purchased land in the command area of the system, were allowed to settle in this area and were given the same water rights as the original settlers had been given. The new settlers have only 10 chakoram (1.1 ha) of land in this system and are located in its middle section.

### **History of the System**

It is not known when Pehlwanandeh Joi was first constructed, but by all accounts it is a very old system, and the huge walnut trees along the channel banks testify to its age. About 40 years ago, the system was extended about 1 km beyond its tail end by farmers of Lasht Bukht who wanted to bring additional land under cultivation. They were granted permission for this expansion by the other beneficiaries on the condition that they would only use the surplus water. Five years after this expansion, the farmers of the original command area developed their remaining uncultivated land, as a result of which, there was no further surplus water left for the Lasht Bukht farmers who had extended the system. Although there has been no expansion of the system since, a disastrous flood in 1978 which damaged many parts of the channel, including the headworks, necessitated major rehabilitation. The headworks was collectively rebuilt by the beneficiaries located about 30 m downstream of its original location.

Figure 9. Irrigation systems in Bamburate Valley.



**Table 7. Irrigation systems in Bamburata Valley.**

System number	Name of system	Location of headworks	Source of water	CCA (chakoram)
1	Ghunbar Kooch	Sheikhanandeh	Bamburata Gol	100
2	Sarojalic	Sheikhanandeh	Bamburata Gol	50
3	Krakar	Krakar	Bamburata Gol	200
4	Kandisar	Krakar	Bamburata Gol	200
5	Batrik	Krakar	Bamburata Gol	2,000
6	Sarojal	Gambak	Bamburata Gol	250
7	Broonthar	Batrik	Bamburata Gol	100
8	Sarojal	Batrik	Bamburata Gol	300
9	Aneesh	Batrik	Bamburata Gol	1,500
10	Aneesh	Broon	Bamburata Gol	1,000
11	Shama Nisar	Broon	Bamburata Gol	100
12	Aung	na	Bamburata Gol	400
13	Shama Nisar	Sarojal	Bamburata Gol	200
14	Pehlawanandeh	Aneesh	Bamburata Gol	1,200
15	Wadus	Shotar	Bamburata Gol	300
16	Mori	Gurjandeh	Bamburata Gol	600
17	Teewish	Teewish	Bamburata Gol	100
18	Lasht	Teewish	Bamburata Gol	200

Source: Farmer interviews.

Notes: CCA = Cultivable command area.

1 chakoram = 0.11 ha.

na = Not available.

## **Description of the System**

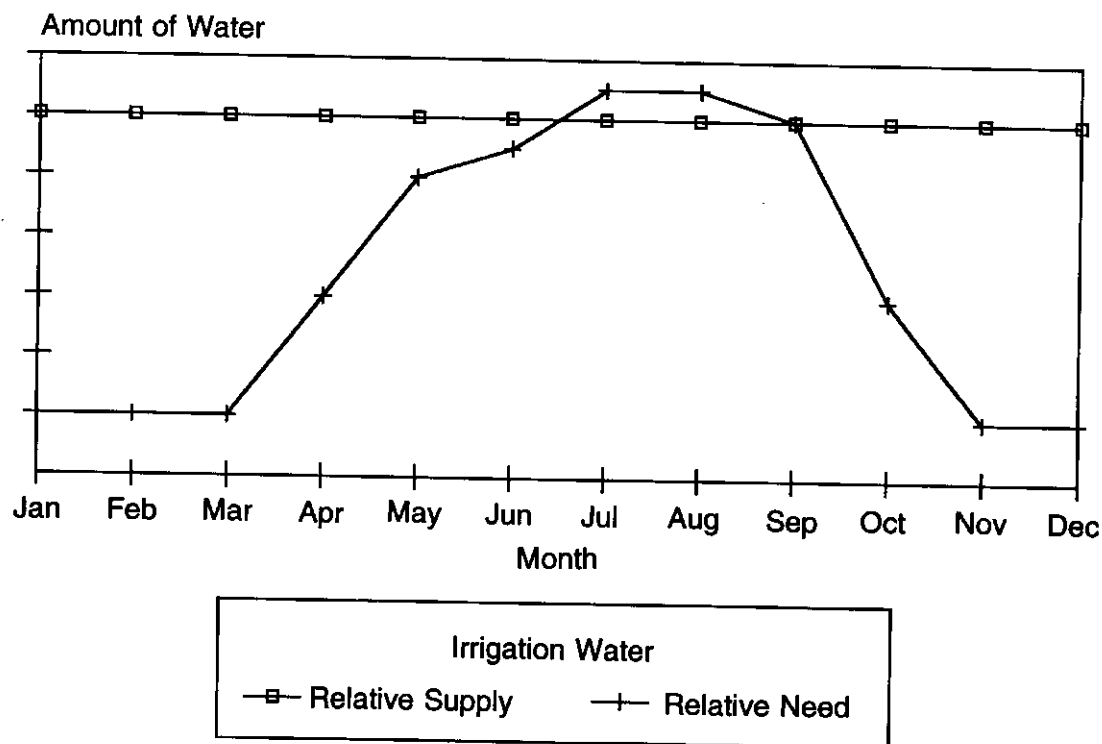
### **Hydrology**

**Sources of Water.** Pehlawanandeh Joi offtakes from Bamburata River about 4 km below the confluence of its two main tributaries; Lot River flowing from the south and Zinore River from the southwest. The major tributary, Lot River, originates at Otak about 26 km further upstream and its sources of water are glacial melt, snow melt and springs. In addition, Lot River is joined in its upstream reach by five smaller streams: Kaulak River, Shawal River, Bahubirat River, Ustui River and Brunzik River. Zinore River derives its flow mainly from snow melt and a few springs. About 85 l/s of water from a watermill just near the Pehlawanandeh headworks also enters Bamburata River; the watermill has a different source of supply.

**Water Supply Variability and Regulation.** The flow in Bamburata River fluctuates seasonally, with the highest flows occurring from late spring through late summer; low flow conditions occur in winter. This variation in flow does not pose a significant problem of water supply to the Pehlawanandeh Joi, insofar as system needs are largely met throughout the year (see Figure 10). Flow in the system is regulated either by changing the location of the headworks in the river or by adjusting a wooden sluice gate near the system head. Normally, the headworks is shifted to an upstream location in the winter months to maintain the required flow into the system and relocated downstream in summers to avoid excessive water flows which could damage the channel.

**Floods and Drought.** Monsoon rains reportedly cause occasional floods. Floods may occur 2 or 3 times in a year, usually in the summer. Flood damage generally is limited to Pehlwanandeh Headworks and others in the river, as well as terraced fields on the steeper slopes. Droughts apparently are not common insofar as no users from any part of the system acknowledged experiencing water shortages. Farmers at the tail of Pehlwanandeh Joi even have another small system that supplements the supply of irrigation water available to them.

Figure 10. Water supply relative to need, Pehlwanandeh Joi System.



Sources: Farmer interviews.  
EDC/IIMI Survey, September 1990.

**Water Quality.** The water in the channel is relatively clean and clear throughout the year. The exception is during the rainy season when some sediment carried by run-off persists for 2 to 4 days after the rains, depending upon the intensity of rainfall.

**Other Uses of Water.** Aside from irrigation purposes, water in the channel is used for drinking, other domestic purposes and for livestock. Channel supplies are also used to operate 6 water mills. Four mills are located in the head reach and 2 in the tail reach. Some people in this area also have access to tap water brought by pipe from a nearby spring.

## **Main and Branch Canals**

Pehlawanandeh Joi is about 5 km long and serves a command area of about 132 ha on both sides of the channel. Along its alignment in the head and middle reach, the main channel passes through an area irrigated by other irrigation systems on its left (up-slope) side. Those systems have stable beds and command fields on stable slopes; hence they do not pose a threat to the operations of Pehlawanandeh Joi. At the tail, the left side branch traverses an area of steeper terrain and stony soils. Here, the embankments are relatively weak, especially on the right side, and exposed to breaching from soil slips.

The main channel and its three branches at the tail end are made of good quality rock and earth, with the size and shape of rock varying from place to place. In the head reach, especially near the headworks, the channel has been constructed using large and rather regular shaped rocks; further downstream, a mix of round, flat and irregular rocks have been used to shape the channel. Retaining walls of 1.8-m height and about 60-m length near the head have been built from both irregular and round shaped large rocks. In addition, planting of trees and bushes have been carried out near the intake to strengthen and protect the channel from flood effects.

At full supply, the discharge into the system is approximately 255 l/s (see Table 8). Farmers say the flow in the system is essentially constant throughout the agricultural year. Because the water requirement during the off-season winter months is moderate, the users themselves decrease discharge into the system then. Near the tail and the Pehlawanandeh Village, the Pehlawanandeh Joi divides into three short branches. The capacity of each branch is a little less than 30 l/s. Relative to its service area, there is about 38 m of main channel per irrigated hectare (4.2 m per chakoram).

**Table 8. Pehlawanandeh Joi Irrigation System Summary.**

Number of systems in the area	19
Number of households in the area	565
Length of main channel (km)	5
Maximum discharge (l/s)	255
Number of branches	3
System command area (chakoram)	1,200
Number of settlements in command area	5
Number of beneficiary households	101
Average number of man-days contributed for:	
Routine maintenance	45
Emergency maintenance	25

Note: 1 chakoram = 0.11 ha.

## **Structures**

**Channel Headworks (Hurdur).** The headworks are made of good quality regular shaped rocks placed side by side, one upon the other, without any cementing material. Large and small gaps between these rocks leak water back into Bamburate River. The location of the headworks is shifted from season to season in response to fluctuations in the flow condition of the river; therefore, it is not a permanent or fixed structure. Usually the headworks are shifted upstream in winter, the low flow season, and back downstream in

summer when flows in the river peak. It can be easily damaged or destroyed by floods, but can also be readily repaired.

*Sluice Gates (Madok).* As noted, there is no gate at the headworks to regulate flows into the system, however, there are 7 wooden sluice gates or sluice gates provided elsewhere along the main channel. Six sluice gates are used primarily to regulate water supply to water mills, and only one, near the headworks, can be used effectively to escape excessive flows into the channel. These sluice gates are constructed from wooden boards, about 0.5 m x 0.75 m, held in wooden frames which are then set into the channel embankment. Most of them are well shaped and firmly fixed in to their frames, but occasionally a small amount of water would leak. They are maintained and repaired by the watermill owners.

There are two additional points along the right bank in the channel head reach where surplus water can be directed back into the river. These points, though roughly constructed, serve the purpose of an escape, with flows regulated by removing or replacing rocks in the embankment cut.

*Turnouts (Ghospans).* There are 30 main turnouts in the system. The majority of the turnouts are made of flat rock with others having no definite shape. Two of the turnouts are constructed of wood. Turnouts are plugged by farmers with rock, sand and/or soil when water is not needed in their fields.

*Other physical features.* Aung River crosses Pehlwanandeh Joi far downstream where the main channel bifurcates (see Figure 9 above). This river also carries the water of the right branch for about 70 m before the constructed channel is re-entered. Water supplies in the left branch are carried over the river in a wooden aqueduct. No drop structures were observed except those for the watermills.

### ***Drainage***

No drainage problems were noted. The command area has a well-developed natural gradient which ensures easy and quick drainage into Bamburute River.

### ***Irrigated Area***

*Command Area.* There are 1,200 chakoram (132 ha) of land irrigated by the Pehlwanandeh Joi System, and all of this area is cultivated. The distance of the first fields from the headworks is about 100 m. The system serves the agricultural lands of Gudayandeh, Matangi, Aung, Pehlwanandeh and Teewish Villages, and now also irrigates the command of another small channel whose headworks were destroyed by floods 2 years ago. As landholdings in the Bumburute Valley are often fragmented, many farmers have land in the command of more than one system. Here, some farmers of Pehlwanandeh Joi have land formerly served by this small channel, and ad hoc arrangements were made to irrigate those fields from the larger system until the headworks were rebuilt.

*Soils.* Pehlwanandeh Joi serves very fertile land in both the steep slopes and the flat terraces. Soils are generally silty loam in which small stones are occasionally present.

## **Institutions and Social Environment**

### ***Social Institutions***

*General.* Landholdings in the command area of this system are very small, fragmented, and self-cultivated by their owners. The average household was estimated to be comprising 10 persons.

*Ethnic Composition in the Command.* The population of Bamburata Valley is divided between two religious communities, Muslim and Kalash. There are about 400 Muslim and 200 Kalash households in the valley. The main Muslim tribes are identified as Zandurae, Raza Khel, Quresh, Gujar and Katoor; and the principal Kalash tribes are Bamburdar, Rachikusdar, Rajowaen, Bazikeh, Bullasingeh, Barmukh, Uspaeen and Gunasharae. The ethnic composition of Pehlwanandeh Joi Command approximates that found elsewhere in the valley.

*Institutional Development.* Historically, village and valley elders were called upon to solve disputes and provided leadership and supervision for such development tasks as irrigation system construction. After independence, the Nigran committees appointed by the government adjudicated significant disputes. By the mid-1970s, this system was abolished and replaced by the legal system in force elsewhere in Pakistan.

There are now 9 Village Organizations (VOs), including one Women's Organization (WO) in Bamburata Valley, all of which, have been formed through the activities of the Aga Khan Rural Support Programme. These institutions have undertaken the improvement of 3 old irrigation channels and the construction of 4 new ones with funding assistance from AKRSP. About 55 ha (135 acres) of additional land has been brought under cultivation as a result. The Chitral Area Development Programme has assisted with the formation of another 7 Village Organizations, but as yet, these have not begun any specific program activities.

*Conflict Management.* The first appeal for conflict resolution is made either to an influential village elder (*musher*) or the village leader. If a conflict is among members of different clans, the influential elders of the concerned clans will meet together to solve the dispute. Major land disputes are now generally brought before the Civil Courts. Other minor disputes are solved by the village elders.

## **Institutional Aspects of Irrigation**

### ***Irrigation Institutions***

Institutions to handle issues related to irrigation are not formalized nor do they appear to be well established in Pehlwanandeh Joi. There is no one specifically charged with the responsibility for maintenance work, and small repairs and channel maintenance are done either collectively or individually as the need arises. Disputes regarding irrigation are usually resolved by village or tribal elders, but if they are unsuccessful in a major case, it will be taken to an outside civil authority for resolution.

### ***Water Rights and Allocation***

The villages in the head and middle reach of the system (Matangi, Aung and Pehlwanandeh) have water rights based on their location in the system, i.e., upstream users have superior rights to downstream

farmers. An upstream farmer in these villages can use water at any time, whereas downstream farmers only have the right to surplus water in the channel.

The farmers of Tewish Village in the tail reach, however, follow a different allocation principle compared to other villages. Any Tewish shareholder, regardless of the location of his fields, who first brings water to his farm has the right to complete his irrigation turn before another farmer of the village can begin his turn.

### ***Operation and Maintenance***

*Routine Maintenance.* Cleaning of the channel is undertaken three times a year: in March-April, June-July, and November-December. Accumulated sediment and other debris is removed from the channel bed and the channel banks are strengthened. Maintenance of the channel from its headworks to the first fields served is a collective responsibility of the shareholders. Thereafter, individual farmers do maintenance to those portions of the channel passing by their fields.

Because sluice gates mainly serve as regulators for watermills, their maintenance and repair is done by the mill owners. The third seasonal channel cleaning is also done only by the mill owners as other farmers have little need for water during these months. Additional small repairs to banks and turnouts are carried out individually whenever required. Sometimes in winter, infiltrating water weakens the channel banks near Matangi and Aung villages causing a breach and thus damage to the adjoining agricultural lands. Repairs in this case are done only by the affected farmers.

*Emergency Maintenance.* Damage due to floods and landslides is the most common reason for emergency channel maintenance. Floods following heavy rainfall usually cause some damage to the headworks and sometimes other parts of the channel as well. Infrequently, an especially heavy flood will completely destroy the headworks. Landslides can occur almost anywhere along the channel. Any damage to the headworks due to flooding is repaired collectively by all beneficiary households; similarly, all households also contribute labor toward its relocation whenever circumstances so require. Otherwise, it is mainly the affected farmers who are responsible for rebuilding any damaged portions of the channel.

### ***Irrigation Conflicts***

No major conflicts related to irrigation were identified through this field study. Again, small disputes related to the use of water and other common property resources usually are settled by the village elders.

## **Agricultural System and Support Services**

### ***Agricultural System***

*Farm Size and Land Utilization.* Agriculture is the primary economic activity of Bamburath Valley, and more than 90 percent of the population in the service area of Pehlwanandeh Joi depends on agriculture for their livelihood. Generally landholdings are small throughout the valley, varying from as small as 0.5 chakoram (< 0.06 ha) to 60 chakoram (6.6 ha). Average farmsize in the command area of the system is 11.8 chakoram (1.3 ha). Farms in the command of different systems in the valley are also fragmented, largely as a consequence of inheritance practices, wherein, property is distributed among all the heirs of the deceased.

Self-cultivation as well as share cropping are practiced in the command of Pehlwanandeh Joi. Usually, small farmers are self-cultivators, but larger landowners will rent out land on a contract basis, i.e., for a fixed amount, or on a 50-50 share cropping agreement. Eleven households in the Pehlwanandeh System are landowners-cum-tenants; 10 have rented in land on contract and one household has taken land on a share cropping basis.

*Cropping Pattern, Yield and Intensity.* About 60 years ago, single crop (wheat, barley) agriculture dominated this area; but double cropping has now become common, and cropping intensity in the command area is estimated to be about 170 percent. Primary crops are maize, wheat, barley, rice, pulses, fodder and tree crops (grape, apple, pear, walnut). Vegetables, mainly tomatoes and potatoes, are also grown.

In rabi, wheat, barley and pulses are grown; maize, rice and beans are grown as kharif crops. Sowing, irrigation and harvest periods for these crops are shown in the crop calendar for Pehlwanandeh (Figure 11). Average yields and typical fertilizer inputs reported by farmers are given in Table 9.

Rice is generally cultivated in relatively level fields, and pulses, which need less water, are usually planted in terraced fields on steeper slopes. Fodders are grown on the most marginal land. Some farmers also intercrop beans and maize. Tomatoes are the most common vegetable grown in kharif, and much of the crop is dried and preserved for winter consumption.

Figure 11. Crop calendar, Pehlwanandeh Joi System.

CROPS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WHEAT (1) Improved variety				Irrigation			Harvest			Sowing		
WHEAT (2) Traditional variety				Irrigation			Harvest		Sowing			
BARLEY				Irrigation	Harvest					Sowing		
SHAFTAL					Harvest			Sowing	Irrigation			
MAIZE					Sowing	Sowing	Irrigation			Harvest		
RICE (1) Transplanted						Sowing	Irrigation			Harvest		
RICE (2) Broadcasted						Sowing	Irrigation			Harvest		
PULSES							Sowing	Irrigation		Harvest		

Source: Farmer interviews.

Table 9. Agriculture in Pehlwanandeh Joi Command Area.

Yield (tons/ha)		
	Maize	5.1
	Rice	4.0
	Wheat	4.0
	Barley	4.0
	Pulses	0.7
Fertilizer use (kg/chakoram)		
	Maize	20-30
	Rice	35-38
	Wheat	30-40
	Barley	30-40
Cropping intensity (%)		170
Average farm size (ha)		1.29

Source: Farmer interviews.

Note: 1 kg/chakoram = 9.90 kg/ha.

**Agricultural Practices.** Traditional methods are followed to prepare land for cultivation. Normally 2 ploughings are done for seed bed preparation for maize, wheat, and rice, with each ploughing followed by a planking to break the clods and roughly level the field. Broadcast sowing of maize and wheat is practiced, but rice is generally transplanted. However, an older variety of rice is also sown by broadcasting.

**Input Use.** Farmyard manure is used by all farmers in their fields. Commercial fertilizers and improved seed have been used only for about the past 10 years, with the former becoming more common recently because of increased access to supplies. Commercial fertilizers are applied at the rate of 30-40 kg per chakoram (272.7-363.6 kg/ha) to rice, wheat, and maize; urea, DAP and ammonium phosphates are being used. Commercial fertilizers reportedly have helped double crop yields from previous levels. Use of threshing machinery is a very recent development which has helped farmers by reducing labor requirements at crop harvesting time.

**Access to Support Services and Markets.** Farmers of Bamburate Valley were introduced to improved seeds and fertilizers by the activities of the Agriculture Extension Wing of the Agriculture Department in the early 1980s, when it began distributing these inputs free of cost. Ultimately new varieties spread over the area by local multiplication of seed. Presently, AKRSP provides fertilizers and seed of improved crop varieties on 6 months credit through local VOs. A few progressive farmers who are not members of these VOs arrange such inputs for themselves. Although commercial fertilizer is also available in local shops, farmers incur an additional cost of Rs 50 per bag as transportation charges. Input prices are generally higher in Bamburate Valley than in Chitral and Ayun because of transportation costs.

The NWFP Agriculture Extension Wing has established demonstration plots in Bamburate (maize) and Ayun (wheat) to show farmers new agricultural methods and improved varieties of crops. So far, however, it has not provided direct training to farmers on these subjects.

**Food Sufficiency.** Overall, it does not appear that enough food can be produced in Bamburate Valley to meet self-sufficiency requirements. A mere handful of farmers produce sufficient food to meet their household needs and only a very few group of larger farmers produce a marketable surplus of food grains.

Although grapes, walnuts, apples and pears are grown in sufficient amounts for export outside the valley, substantial amounts of food grains and vegetables are imported, as are sugar, tea, edible oils and other basic commodities not locally produced.

**Labor Availability.** Labor is locally hired throughout the year either on a daily wage or contract basis. The daily wage rate varies between Rs 40 to 50. During the wheat harvest period, any labor shortage is met by hiring Afghan refugees who usually work at wage rates lower than those prevailing for local labor. Off-farm employment opportunities are restricted to teaching in local schools, shop keeping, tailoring, road construction, or service with the police or the army. Some people migrate down-country in September or October for winter season employment, usually returning to Bamburate by April or May.

There is a dramatic change in the role of women in agriculture in Bamburate when they convert from the Kalash faith to Islam. Kalash womenfolk are active participants in farming in the valley, meeting much of the agricultural labor needs of Kalash farms except that for livestock management. Even land preparation (ploughing) is said to be done by Kalash women. By contrast, the main agricultural activities of Muslim women in the area are picking vegetables and fruits from kitchen gardens, flaying maize, and tending cattle at home.

### **Key System Insights**

The Pehlwanandeh Joi System could be expanded to serve perhaps an additional 300 chakoram (33 ha) of uncultivated land located in its tail reach. Water availability at the source is sufficient to meet the irrigation needs of such an enlarged service area, but the physical capacity of the system most likely needs to be increased to accommodate the greater flow required.

### **Apparent Strengths**

- \* The system has a reliable source of water.
- \* Water supplies are sufficient to meet the needs of irrigated agriculture and other uses.
- \* Although there is no formal management structure, there are no major conflicts in the system. Most of the beneficiaries belong to the same community.
- \* The system is well constructed; apparent weak points have been deliberately left so that surplus water can be diverted back to the river.
- \* The quality of water is good.
- \* Soil in the command area is fertile.

### **Potential Weaknesses**

- \* There is no formal organization for system operation and maintenance.
- \* There is no formal process of water distribution.

## **CASE STUDY 3: MOLDEH JOI IRRIGATION SYSTEM**

### **Introduction**

#### **Area Overview**

*General.* This case study describes the farmer-managed irrigation system of Moldeh Joi in Kooh Valley (Figure 12) which irrigates a portion of the lands of Koghazi Village. It is the only system among the 5 in the valley to have never received formal assistance from government or other development agencies.

*Location and Physical Overview.* Moldeh Joi is located about 19 km northeast of Chitral in Kooh Valley, a side valley off the Chitral-Booni-Mastuj road. It is readily accessible via this jeepable road, currently being widened and metaled under the Chitral Area Development Project (CADP), from Chitral to Booni, 72 km up the valley. The area comes under the jurisdiction of the Union Council of Kooh, Chitral Tehsil.

Koghazi Village and the surrounding locale have relatively better facilities compared to many other areas of Chitral District. There is a high school for boys, a rural health center built in 1985 and a veterinary hospital. A pipeline to deliver potable water was constructed by the government in 1986. CADP is assisting the construction of another irrigation channel that will command still uncultivated land on the mountain slopes adjoining Koghazi Village.

#### **Settlement and Population**

*Settlement Pattern.* Information on the settlement history of Koghazi Village was scanty. Local informants stated that a person named Hunar settled here about 500 years ago, having migrated with the Mehtar of Chitral from Afghanistan (Shaghnaar). Subsequently, others also migrated from surrounding areas to settle here. Houses of Koghazi Village are distributed in settlements differentiated by mosque communities on less steeply sloping land on either side of the Chitral-Boni road, both north and south of the Koghazi River. Characteristically, kitchen gardens complete with fruit trees have been constructed inside the mud and stone walled residential compounds. Descendants of original residents of the valley and Koghazi also maintain pasture lands (high land) on the nearby mountains.

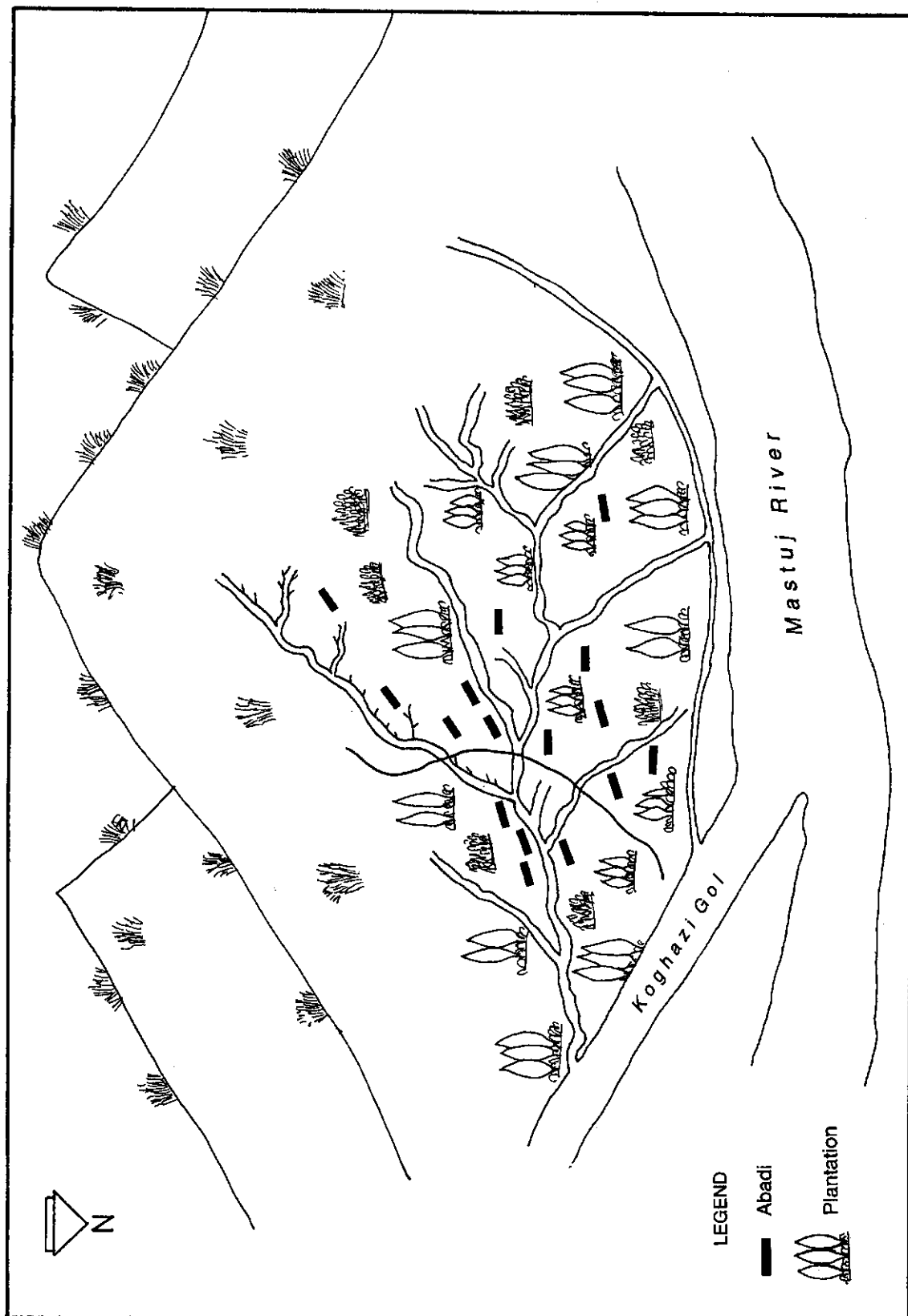
*Population.* There are an estimated 250-300 households in the area of Koghazi Village, most varying in size between 8 and 12 persons per household. Eighty of these households are the direct beneficiaries of the Moldeh Joi System, including 10 nonfarm households that use its water only for domestic purposes, and they are located south of the Koghazi River (see Table 10).

There is some down-country migration of residents seeking work, and a few households have family members working in the Middle East. Recent Afghan refugee migration into Chitral has not been locally significant.

#### **Irrigation History of the Area**

Irrigated agriculture in Koghazi Village is dependent upon water from five irrigation systems, all having their source in Koghazi River (see Table 11). Zang Joi, Mozo Joi and Pust Joi take off on the right bank of the river, within a distance of about 50 m of one another. Moldeh Joi and Ragh Joi take off on the left bank (see Figure 13). The headworks of Moldeh Joi are located nearly opposite the right bank systems, while

Figure 12. Moldeh Joi Irrigation System.



Ragh Joi draws its water about 1,000 m further downstream. Four of the five systems are well established, reportedly having been constructed centuries ago by the farmers and subsequently managed by them. Zang Joi, however, is a new system constructed about 25 years ago under a village aid program with "self-help" labor from the farmers and implements provided by the government.

*Table 10. Distribution of Moldeh Joi beneficiary households.*

Settlement	Number of households
Moldeh	48
Torideh	32

*Table 11. Irrigation systems in Koghazi Village.*

Name of system	Location of headworks	Source of water	CCA (chakoram)
Zang Joi	Koghazi	Koghazi Gol	na
Moldeh Joi	Koghazi	Koghazi Gol	300
Mozo Joi	Koghazi	Koghazi Gol	na
Pust Joi	Koghazi	Koghazi Gol	na
Ragh Joi	Koghazi	Koghazi Gol	na

Notes: CCA = Cultivable command area.  
na = Not available.  
1 chakoram = 0.11 ha.

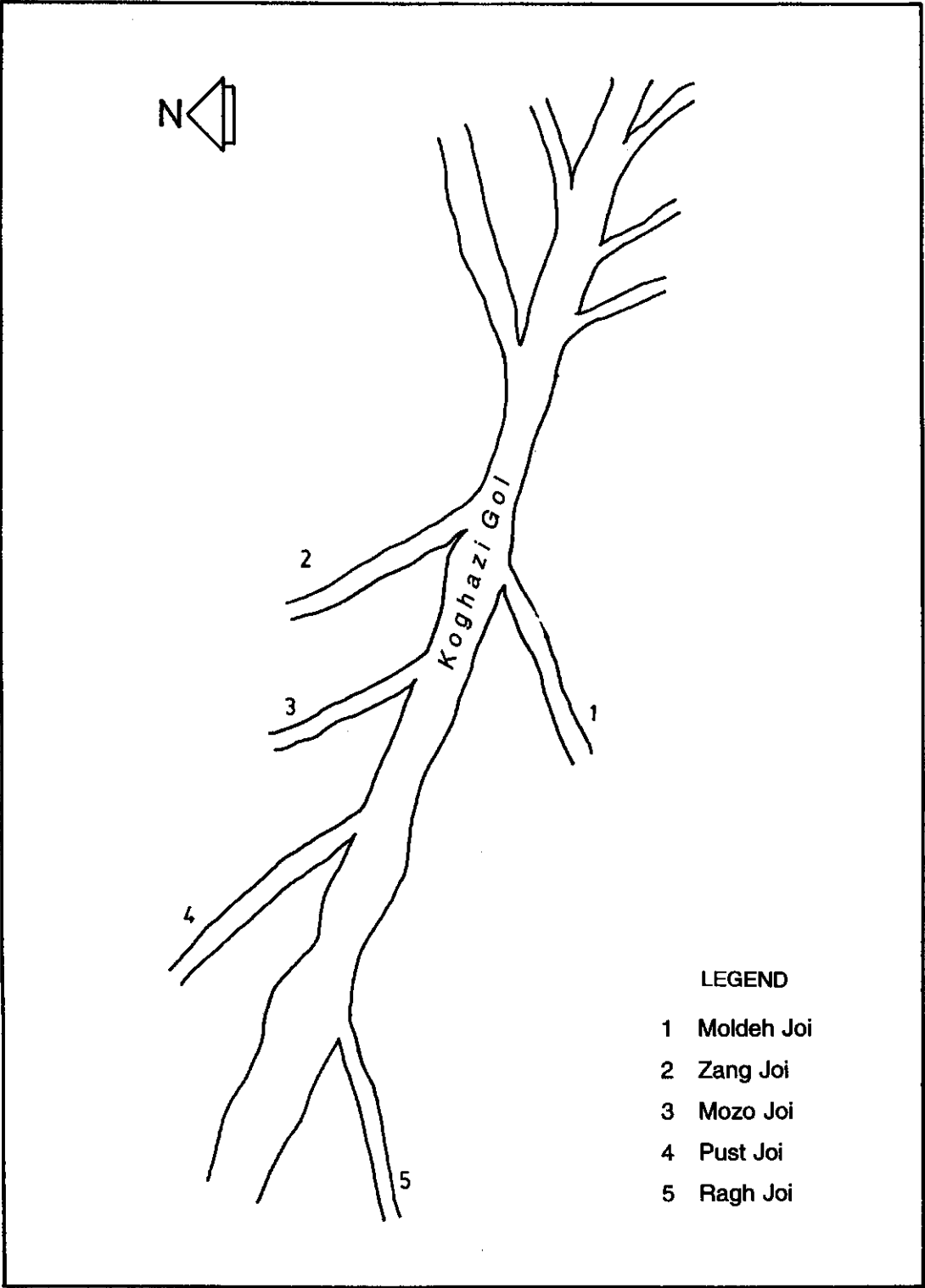
Of the five systems, only Moldeh Joi has not received some sort of assistance from either the NWFP Irrigation Department or the local District Council. For example, part of the lining on Mozo Joi was undertaken by the District Council, and the Ragh System has been improved with the help of the Irrigation Department.

Ragh Joi passes along the bottom of the Moldeh Joi Command Area, intersecting the tails of subsidiary channels and utilizing any surplus water from the latter system. This is a significant source of water for fields in the tail areas of the Ragh Joi Command. A sixth channel is being constructed on the left bank of Koghazi River, upstream of all these systems, through the CADP. However, its water right does not allow it to affect the flow condition of the five pre-existing channels.

## History of the System

Very little is known of the history of Moldeh Joi other than that it was constructed perhaps 500 years ago by members of the Mirkaleh and Shaghnia tribes. The rock used for its headworks and its bund in various reaches were readily available locally, and the necessary labor was provided by the beneficiaries.

Figure 13. Irrigation systems in Koghazi Village.



Apparently, there have been no major improvements or rehabilitation works carried out in Moldeh Joi, except for the headworks whenever it has been damaged or destroyed by floods.

The channel intake is a crude structure made of rocks, and its exposed condition in the river means that it is susceptible to frequent damage during high flow periods. Its reconstruction is said to be a regular event that usually takes no more than 2 to 3 hours. Nor has there been any significant expansion in the command area of Moldeh Joi System since its inception. Reportedly, its boundaries have changed very little, if at all, over time.

## **Description of the System**

### ***Hydrology***

*Sources of Water.* Stream flow in Koghazi River is derived mainly from springs and snow melt beginning about 8 km upstream of Moldeh Joi. Five small tributary streams--Sarato Khan River, Mashghushi River, Matak River, Shah River and Dong River--also join Koghazi River upstream, but, excepting Dong River, they carry water only in the summer from snow melt.

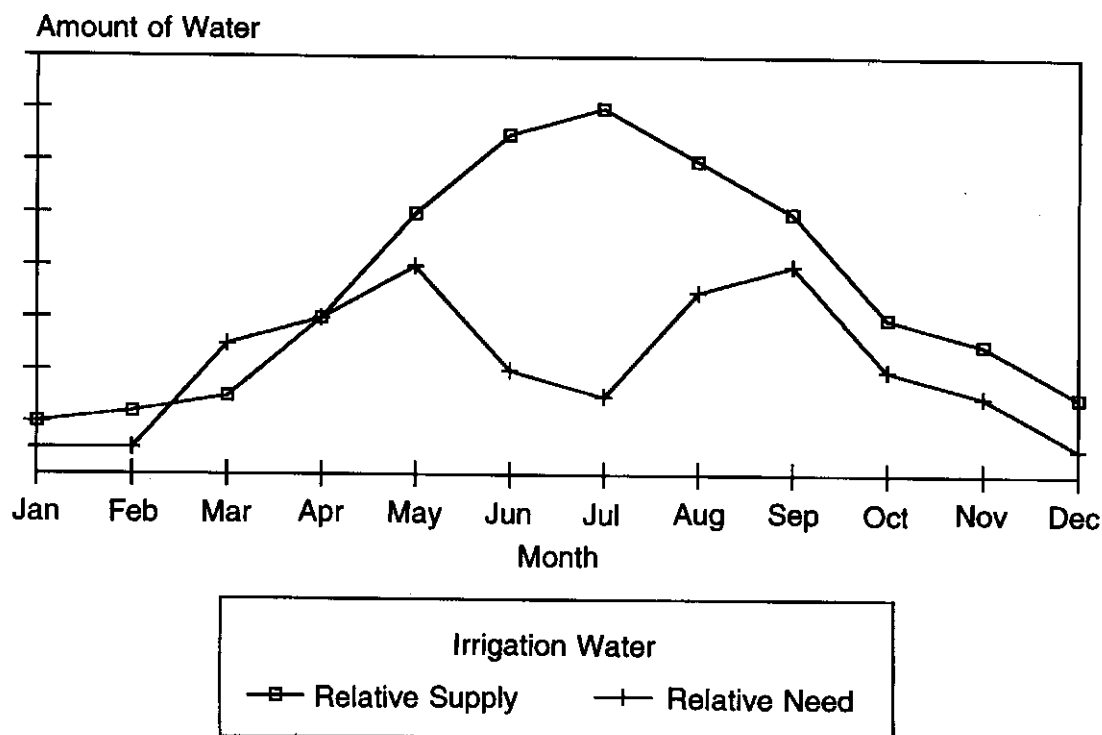
*Water Supply Variability and Regulation.* Flows in the Koghazi River are subject to seasonal fluctuation with peaks in the summer months resulting from snowmelt and rainfall, and low flows coming in winter. This variability in flow, however, does not appreciably affect water supplies to its different irrigation systems because Koghazi River has sufficient water throughout the year to meet their requirements (see Figure 14). Moldeh Joi draws approximately 7 cusecs (198.24 l/s) of water at its offtake to meet maximum agricultural and domestic needs. Its beneficiaries did not report any shortage of water. Whenever water flow into the system is too great, stone sluice gates provided at the headworks are opened to divert necessary amounts back into the river.

*Floods and Drought.* Floods are not a common occurrence, with none reported for the past three years. Whenever heavy rains occur, usually between May and August, runoff is swiftly drained down Koghazi River into the Mastuj River. Village informants did not report the existence of any drought conditions.

*Water Quality.* Moldeh Joi generally has clean, clear and good tasting water, excepting for brief periods during the rainy season when the water contains silt and other sediment resulting from runoff into the Koghazi River. Farmers did not report any negative water quality effects on their crops.

*Other Uses of Water.* Water carried by Moldeh Joi is used for drinking, for other domestic purposes, by animals and for refrigeration of food stored in small wooden boxes which are placed in the channel. Water has been taken from the channel through a pipeline to supply for the domestic needs of various households located some distance away from the channel. Formerly, the system was also used for power generation at night, but this ceased about 15 years ago after a fault developed in the small turbine used for this purpose.

Figure 14. Water supply relative to need, Moldeh Joi System.



Sources: Farmer interviews.  
EDC/IIMI Survey, September 1990.

### Main and Branch Channels

The main channel of Moldeh Joi is about 2.5 km long and its seven off-taking branches range from about 0.75 to 1.75 km in length (see Figure 12 above). Both the main channel and its branches have modest but well constructed bunds from head to tail. Good quality, rounded rock and stone from Koghazi River were used for this purpose over time, incoming silt and sediments have further stabilized and solidified the channel structure. Aside from inconsequential leaks at the headworks, there was no apparent significant leakage throughout the main distribution system.

The width of the main channel varies from reach to reach, from a maximum of 1.2 m in the head reach and gradually decreasing to about 0.2 m in the tail reach. At some locations in the off-taking branches, channel widths become as small as 0.15 m. Main channel depth varies from a maximum of 46 cm in the head reach to about 10 cm at the tail, and the velocity of the flow in the channel was estimated to range between 0.9 to 1.2 meters per second (m/s). Because of this relatively high velocity, there has been some downstream erosion at a few locations resulting in sediment deposition in tail reaches where flow velocities are much lower. However, none of the tail farmers identified this condition as posing a significant problem.

Moldeh Joi also has a 45-m long guide or retaining wall constructed below the headworks on the right side, varying in height from 0.6 to 1.5 m. The wall was constructed with different size rock taken from Koghazi River, and its purpose is to further direct the flow entering the headworks into the main channel of the system.

Maximum discharge into Moldeh Joi from Koghazi River is about 198 l/s during the agricultural season. Because flow conditions in the channel are not significantly affected by discharge fluctuations in the river, channel discharges vary only as farmers choose to regulate them. In the winter months when much less water is needed, excess flows are diverted back into Koghazi River through the stone sluice gate at the head of the system.

Two of Moldeh Joi's 7 branches carry less than 28 l/s during peak flow periods; each of the remaining branches have a maximum capacity of about 28 l/s. The head reach of Moldeh Joi passes through the residential compounds of several users, and small orchards and vegetable plots maintained in these compounds are irrigated from the passing channel. The overall ratio of main system length to service area is about 79 meters per hectare (8.3 m/chakoram).

### **Structures**

*Head Intake (Hurdur).* Although the headworks of Moldeh Joi has no apparent regular shape, it is a well-defined structure strongly made of good quality, carefully selected and placed, rounded rock and stone taken from the river. No cementing material has been used in its construction. Hence, while water leaks out between these rocks, inflow is not materially affected. Moreover, the intake can be readily shifted as river discharge varies and easily reconstructed whenever it is damaged by high discharges in the river. Discharges into the irrigation system are also regulated by removing or placing stones in the headworks as necessary.

A small sediment tank (*bazano*) has been built about 0.5 km below the head of the channel which ensures a water supply to the villagers that is relatively free of sediment. Although local informants reported such tanks to be rather common near the heads of irrigation channels in the area, this was the only system in which it was encountered during the reconnaissance survey.

*Sluice Gates (Madok).* Only stone sluice gates have been provided in Moldeh Joi at three points in the head section near the headworks. At each location, excess water can be escaped back into the Koghazi River by temporarily removing rocks from the right bank retaining wall. Presumably because flows into branches also can be more easily regulated at their offtake points along the main channel by placing or removing stones, there are no formal sluice gates at branch heads either.

*Turnouts (Ghospan).* Moldeh Joi has countless turnouts along its seven branches. There are 10 large ones, each serving more than one field; usually however, a single turnout serves only one field. At a few locations, 2 or 3 turnouts have been provided to irrigate one farm due to differences in field elevations. Turnouts in Moldeh Joi do not have any specific size or regular shape and they are closed with mud and stones as soon as field irrigation is completed. Smaller outlets also have been provided along the channel to irrigate kitchen gardens and fruit trees. All surplus water drawn by these turnouts typically re-enters the main canal or branch further downstream.

*Other Physical Features.* No special structures are used to regulate water supply either into or between channels or into farms. Even the more traditional wooden sluice gates observed elsewhere in Chitral are not in evidence in Moldeh Joi. The only exception is where the main channel or its branches cross the

Chitral-Booni road to serve command areas on the opposite side. At three locations, concrete pipes have been installed as culverts for this purpose.

There are also three small drop structures made from rocks in the system. One is in the head reach near the offtake of the first branch. The others have been constructed where the main channel crosses the Chitral-Booni road (Figure 12), one immediately before the road crossing and another just after it.

### ***Drainage***

The command area of Moldeh Joi has a marked natural gradient downstream toward the Mastuj River. Consequently, drainage easily occurs throughout the service area without difficulty. There are no cross drains in the system. Any surplus water at the tails of Moldeh Joi and its branches has been allowed to flow into the Ragh Joi for use in that system, for the past 60 to 70 years. (Previously, it had been passed as unutilized excess water into the Mastuj River.) Drainage of household waste water into the irrigation channel takes place wherever it passes through a residential compound. The potential health hazard posed by this arrangement could not be assessed.

### ***Irrigated Area***

*The Command Area.* The total command area of Moldeh Joi is about 300 chakoram (33 ha), all of which is cultivated. There has been no change in the size of this command area for as long as informants could remember, nor is there any evident culturable waste nearby which could be brought under system command. The first field irrigated from the system is a little more than 75 m from the headworks on the right bank. Before this first turnout, there are only a few walnut trees which are irrigated from the channel.

*Soils.* Soils throughout the command are a silty clay loam with small stones interspersed. Some farm plots in the upper reach command tend to be more sandy than those elsewhere. Part of the service area of the second left-side branch is a more stony, shallower soil and the fields here are arranged in fairly steep terraces. Elsewhere in the command area, fields spread out in larger, more flat terraced plots. Overall, farmers consider the soil to be fertile and very suitable for irrigated agriculture.

## **Institutions and Social Environment**

### ***Social Institutions***

*General.* As noted previously, there are between 250 to 300 households in the surrounding area of Koghazi Village. Of this number, 80 households are beneficiaries of the Moldeh System, 70 of them as landowning farmers (see Table 12).

*Ethnic Composition.* Six different clans reside in the command area of the system; they are Mirkaleh, Shaghanae, Mohammad Baigae, Khuzeravey, Ghaibae and Rakhanae. The Mirkaleh are the oldest settlers in the valley, and the Mohammad Begae the newest, having arrived only about 20 years ago from Mulkoh Tehsil (Chitral). The first Khuzravae came 150 years ago from Behrcenze (Chitral), with the Ghaibae beginning to settle here about 50 years later; the Rakhanae began migrating to Koghazi from Buner District in lower Swat after about 1870. Some smaller tribes such as Dashmanae, Sangalae and Katoorae are also represented by a few households in the area.

**Table 12. Moldeh Joi Irrigation System Summary.**

Number of systems in the area	5
Number of households in the area	300
Length of main channel (km)	2.5
Discharge (l/s)	198
Number of branches	6
System command area (chakoram)	300
Number of settlements in command area	2
Number of beneficiary households	80
Average number of man-days contributed for:	
Routine maintenance	30
Emergency maintenance	10

Note: 1 chakoram = 0.11 ha.

**Institutional Development.** In this area, the *Imam* of the mosque also functions as the village or settlement leader and its representative, having been unanimously selected by the members of the mosque committee. There are also seven influential elders in Koghazi Village, one from each mosque community, who comprise the membership of the *Deh* (village) Committee. These committees were sanctioned by the government about 50 years ago.

In 1974, the farmers of the settlements comprising Koghazi Village established a cooperative society. Subsequently, in 1989 and in 1990, Village Organizations were also established through the AKRSP and CADP Programmes respectively. None of these village organizations, however, has played a significant role to date in either the operation or maintenance of Moldeh Joi.

The *Pesh Imams* of the mosques do play an active role in initiating and directing community work. Each household is expected to contribute labor to such collective village level activities. Otherwise there does not appear to be any formal, well-established local institution to address the issues and problems of the area.

**Conflict Management.** Conflicts or disputes in Koghazi Village are brought first to the influential elder for arbitration and settlement, and most of them are solved at this level. Land disputes are viewed as major concerns and are taken to the formal courts; personal fights and tree thefts are usually reported to the police. The frequency of minor disputes over water rights and trees is reported to be low, usually no more than 2 or 3 per year. The former are likely to occur, if at all, whenever there is a temporary shortage of water in the system, which can happen for brief periods between March and June.

## **Institutional Aspects of Irrigation**

### ***Irrigation Institutions***

Although there is no formal organization for the purpose, maintenance and repair activities for the irrigation system are organized and supervised by the influential elder (*Musher*) of the Moldeh mosque. All system beneficiaries reportedly participate in these relatively informal arrangements for system operation and

maintenance. Many farmers in Moldeh Joi are also shareholders in one of the other irrigation systems in the area.

### ***Water Rights and Allocation***

Moldeh Joi is normally a water abundant system and periods of water shortage are seldom experienced. Because Koghazi River usually has had sufficient flows to meet the water requirements of all the systems off-taking from it, no specific upstream or downstream rights to water have been defined. Members of clans more recently settled in the system command have exactly the same rights to water as do descendants of the original settlers.

The normal practice of irrigators in the Moldeh System is to use water on a "first come, first served" basis, and no restrictions are imposed on head- or tail-end users. If available water is more than the needs of the first user, then other farmers can and do use it simultaneously, up to as many as 4 at a time in some locations. Whenever there is a temporary water shortage, however, distribution among beneficiaries is supervised by the community elders or the Pesh Imam of the village mosque. Night irrigation is not practiced in the system.

Moldeh Joi also delivers any surplus water into Ragh Joi at its tail. When the right to use this surplus water was given to Ragh Joi shareholders, it carried the condition that they would not interfere in the operation of the upstream system. Many Ragh Joi users prefer to use the surplus water of Moldeh Joi because they then do not have to go to the headworks of their own system to adjust its flow.

### ***Operation and Maintenance***

***Routine Maintenance.*** The shareholders of Moldeh Joi operate and maintain the system. Maintenance involves both individual and collective responsibility for specific sections of the channel, and it normally is organized by the local Pesh Imam with an announcement in the mosque that such work is to be undertaken on the channel on a specified day. All users participate if the work is done collectively, e.g., repairs to the headworks or to the portion of the channel near the headworks where no user owns land. Shareholder participation in such work is on a household basis with each household expected to provide one man for the job; exceptions are made for households where men are not available. It was estimated that about 35 person-days per year are spent on ordinary system maintenance in such collective work.

Below the first outlet of the main and branch channel, maintenance is the responsibility of individual shareholder households, with each one doing all the cleaning and repair work in the channel reach adjoining its own fields. Weeds, grass and shrubs are cleared from the banks during the annual cleaning in March or April, usually requiring 2 to 3 hours each from the various shareholder households. Any other minor damage, (e.g., animal holes) is repaired whenever necessary throughout the year.

***Emergency Maintenance.*** Emergency repairs to the system are similarly organized and implemented. However, if the damage to the channel is such that it cannot be repaired by the concerned farmer easily, others will help him on a *yardo*i (labor sharing) basis, i.e., he will feed the farmers when they are helping him; in turn he is obligated to help other farmers whenever they need his assistance. Although floods and landslides are not very common, they do occur, as in the case of a serious landslide which occurred in the tail-end of the system about 15 years ago. There are two places in the head reach near the headworks which are susceptible to damage or destruction depending upon the severity of a flood. Repairs here can take up to a maximum of two days to complete, with all the shareholders working 6 to 7 hours per day.

*Irrigation Conflicts.* Both the informant farmers and the local influential elder reported an absence of any severe conflicts over water or related issues among the farmers of this system. The minor conflicts are on such issues as water rights or irrigation turns during a period of water shortage which, though uncommon, is most likely to occur during the wheat season (March to June). Such disputes are settled by the Deh Committee through consensus.

## **Agricultural System and Support Services**

### **Agricultural System**

*Farm Size and Land Utilization.* The economy of the Kooh Valley depends on agriculture. Landholdings in Moldeh Joi Command are very small and fragmented, ranging from 0.5 chakoram (< 0.06 ha) to a maximum of 15 chakoram (1.6 ha) (see Table 13 for average farm size in Moldeh Joi Command). Merely 5 or 6 farmers own as much as 6 chakoram (0.7 ha) of land, and only one household has 15 chakoram (1.65 ha). Because of fragmentation of ownership, some Moldeh farmers also own land in the command areas of other irrigation systems in the valley. Marginal land on the steeper mountain sides is planted with trees in order to stabilize the slopes and reduce landslides. These trees are subsequently harvested for both timber and fuelwood.

*Table 13. Agriculture in Moldeh Joi Command Area.*

Yield (tons/ha)	Maize	4.0
	Rice	3.0
	Wheat	3.7
	Pulses	3.0
Fertilizer use (kg/chakoram)	Maize	20-30
	Rice	30-40
	Wheat	34-40
Cropping intensity (%)		200
Average farm size (ha)		0.46

Source: Farmer interviews.

Note: 1 kg/chakoram = 9.09 kg/ha.

*Cropping Pattern, Yield and Intensity.* This is a double-crop agricultural area. Maize, rice and wheat are the primary crops within the command of Moldeh Joi, with barley, shaftal, onion, potato and pulses being of secondary importance. Barley cultivation has nearly ended following the introduction of new higher yielding varieties of wheat, the only crop where improved seed is being used. Previously Moldeh farmers used to grow barley instead of tuifgum, a local wheat variety, because the yield of barley was higher. The condition of crops in the command area appeared to be very good. Average yields reported by farmers range between 300-525 kg/chakoram (approximately 3,409-4,773 kg/ha) for wheat, 375-525 kg/chakoram

for maize, and for pulses, 110-150 kg/chakoram (approximately 1,000-1,364 kg/ha) (see Table 13). Figure 15 shows the crop calendar for the Moldeh Joi Command.

Figure 15. Crop calendar, Moldeh Joi System.

CROPS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
WHEAT				Irrigation		Harvest				Sowing		
BARLEY				Irrigation		Harvest					Sowing	
SHAFTAL				Irrigation		Harvest			Sowing	Irrigation		
MAIZE							Sowing	Irrigation		Harvest		
MASH							Sowing	Irrigation		Harvest		
RICE							Sowing	Irrigation		Harvest		

**Agricultural Practices.** Although the traditional wooden ploughs and bullocks continue to be used by a few farmers for land preparation, the use of tractors has become dominant since the mid-1980s. Mechanical harvesters, however, remain poorly suited to the small, uneven fields, so most harvesting and threshing is done manually. Broadcast sowing of the main grain crops is practiced.

**Input Use.** Farmers reportedly began using commercial fertilizers in 1978 following their introduction to the area by the NWFP Agriculture Extension Directorate. DAP, urea and ammonium sulphate are the main commercial fertilizers used; farm yard manure also continues to be utilized, normally applied at the field preparation stage. Improved seed of high yielding wheat was introduced into Kooh Valley about 10 years ago. Until then, farmers raised barley on about 75 percent of their rabi season planted area, with the remainder planted to a traditional wheat (tuligum). Nearly all the barley area was replaced by wheat, however, following the initial introduction of Maxi-Pak wheat. Commercial insecticides and pesticides have not been adopted by most farmers so far.

**Access to Support Services and Markets.** The extension service of the NWFP Department of Agriculture has established demonstration plots for fertilizer and improved seeds along the roadside near the Moldeh System, otherwise, no other information, training or agricultural assistance has been provided to farmers here. Improved wheat seed and commercial fertilizer are available only from Chitral town. Fertilizer prices range from Rs 120 per bag (ammonium sulphate) to Rs 235 per bag (DAP); transport costs are low because of relatively easy access to the area via the Chitral-Booni road.

**Food Sufficiency.** Because most farms are small, food grain production is insufficient to meet local food requirements. Only a very few farmers produce enough grain to meet household needs and still have some surplus to sell. The majority of beneficiary households in the Moldeh System must purchase additional supplies of wheat, rice and pulses to meet their requirements. Other necessities such as sugar, edible oils, cloth, salt, etc., are also purchased, mainly from stores in Chitral town. A small amount of vegetable surplus is sold outside. Several fruits--grape, apple, pomegranate, apricot, pear and mulberry--are marketed by a quarter to a third of the farmers. These farmers reported that their earnings from fruit sales ranged between Rs 500 to Rs 1,000 per season.

### ***Labor Availability***

Because landholdings in Moldeh Joi are very small, the need for additional hired labor is very low. Most farms in the system are labor self-sufficient within the household. Women contribute to agriculture here through kitchen gardening, tending the household livestock and fruit trees, picking maize, weeding rice nurseries and assisting with rice transplantation.

Nonagricultural employment in Kooch Valley is very low. Quite a few people from this village are working in different government departments. Employment on either the Chitral-Booni Road Construction Project or the CADP-assisted Irrigation Channel Project are the principal sources of off-farm employment in the area.

### **Key System Insights**

#### ***Apparent Strengths***

- \* The source of water is reliable and the quality is good.
- \* It is a well-constructed physical system except for the headworks which can be readily repaired or rebuilt.
- \* Water supplies are normally sufficient for irrigated agriculture and other user needs.
- \* The system has little exposure to landslides.
- \* There are no significant disputes over water rights or distribution.

#### ***Potential Weaknesses***

- \* There is no formal organization for system operation and maintenance.
- \* Landholdings are very small and fragmented.

## **Study Summary and Conclusions**

THE THREE IRRIGATION systems selected for rapid appraisal study and described in greater detail in the above case studies--Deh Joi, Pehlawanandeh Joi, and Moldeh Joi--appear to reasonably reflect the range of conditions encountered for most FMIS in the lower Chitral District. All three systems are several centuries old according to local informants, and stable, with well established traditions of operation and maintenance. Although the command area of Pehlawanandeh Joi is rather larger than otherwise usually found among Chitral FMIS, those of the other two systems are well within the typical size. In none of the cases studied was there convincing evidence of further opportunity for expansion or growth.

In their basic design and construction, the three systems are markedly similar. All have the same type of physical structures--headworks, sluices to regulate flows, and farm outlets--constructed out of locally available material. The emphasis is on low material cost and relatively easy repair. In a physical environment marked by seasonal weather extremes and where disruptive natural events such as flash floods, landslides, and earthquakes are relatively common, if often localized, and accessibility remains difficult at best, such an approach appears to be rational and reasonable. However, it comes at some tradeoff in annual maintenance inputs, which range from a high of an estimated 110 man-days per farm in Deh Joi, where physical conditions are least stable, to a low of 40 man-days per farm in Moldeh Joi, where environmental conditions are most stable.

In all three systems, there exists a low level of formal institutional development for irrigation or water management. Water rights of users are most clearly defined in the system which most frequently experiences conditions of relative water scarcity, Deh Joi. But in none of the systems did there appear to be a pattern or history of any significant conflict among users in accessing their right to water. Traditional, community-based and -sanctioned mechanisms of negotiation and arbitration remain in use whenever water disputes do occur. Similarly, well understood and long accepted practices continue to govern both routine and emergency maintenance responsibilities among system shareholders with informal mechanisms of sanctions ensuring compliance.

These conditions contrast sharply with those characterizing system O&M at the distributary canal and watercourse outlet level in the large public irrigation systems of the Indus Basin. Whether or not a formal codification of such traditional, often informal institutional arrangements, is now necessary or desirable in the context of increasing population pressure on water and other common property resources, coupled with well-intentioned development interventions and other economic changes underway in Chitral District, is not clear. Certainly that is one important issue which could be addressed by further research focused upon a careful assessment of the actual relationships between system O&M and traditional institutional practices.

The patterns of irrigated agriculture in the systems' commands are broadly similar in type and diversity of crops as well as in cropping calendar, with two crops per year common in each case. Average farm size is small, ranging from 0.5 ha in the smallest system, Moldeh Joi, to less than 1.3 ha in the largest system, Pehlawanandeh Joi. Crop yields appear to compare very favorably with those obtained in the most productive areas of irrigated agriculture in the Indus Basin. For example, reported average wheat and rice

yields in the three systems are 50 percent to 100 percent greater than the present national averages for these crops.

The high cropping intensities and crop yields encountered on the small farms in these three FMIS in Chitral would suggest that the available water supply is not a significant production factor constraint. The implication is that further increases in agriculture production in the command areas of these and similar systems will most likely have to come from improvements in input use and other irrigated farming practices. This suggests the need to strengthen and otherwise improve agricultural extension activities and other input supply services in the area.

Finally, whether or not existing FMIS in Chitral can provide appropriate models to guide the further expansion of small-scale irrigation in the district, now underway through the development activities of various government and nongovernment agencies, is an issue which could and perhaps should be addressed through comparative research linked to more sustained system monitoring. Careful measurement and assessment of the irrigation and irrigated agriculture performance of essentially unchanged traditional systems, such as those in the following case studies, as well as several new systems resulting from more recent development interventions would be desirable. It is likely that the results would provide a more informed basis than is presently available for determining if additional inputs will be necessary to sustain returns on the irrigation development investments now being made in Chitral.

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