A Comparative Assessment of Farmer-Managed and Agency-Managed Irrigation Systems in Northern Pakistan

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ABSTRACT

THIS PAPER FOCUSES on irrigation management in Pakistan's Northern Areas and analyzes the differences between farmer-managed irrigation systems (FMIS) and agency-managed irrigation systems (AMIS). The paper identifies the following performance indicators:

1. *The development of new systems.* Over 4,000 FMIS have been developed by local inhabitants, while only a handful of AMIS have been developed despite heavy financial backing. The ability to initiate and develop new channels is a distinct measure of performance.
2. *Maintenance.* FMIS have been unable to mobilize the users to manage them and have often failed as a result. FMIS are exceptionally well-maintained, applying maintenance systems involving all beneficiaries. Proper maintenance of irrigation schemes is a useful measure of performance.
3. *Management of scarcity.* FMIS are characterized by intricate methods of water allocation which ensure equitable distribution of water. AMIS lack equitable allocation systems appropriate to the variability in the area. The ability to manage distributional issues under highly variable conditions is critical to the performance of irrigation systems.
4. *Management of equity.* FMIS ensure the equitablity of both water distribution and the contribution of labor. The costs of construction and maintenance are shared by the beneficiaries. Where equity in water distribution, labor and cost inputs is absent, the viability of the scheme is in doubt.
5. *Innovation in design.* FMIS apply design methods appropriate to local conditions based on centuries of trial and error and local wisdom. AMIS generally apply standard textbook design criteria which are often ill-suited to local conditions. Engineering design to suit local conditions is vital to ensure that channels are constructed suitably and perform adequately.

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INTRODUCTION

This paper focuses on irrigation management in Pakistan's northern areas. Looking at Gilgit District in the Northern Areas and Chitral District in the North-West Frontier Province, it attempts to analyze the differences in farmer-managed and agency-managed systems. Through this analysis, it attempts to define variables which are critical to the performance in Pakistan's high mountain irrigation systems. In the Northern Areas there are more than 48,800 hectares (ha) mainly irrigated by small-scale FMIS. In Chitral District small-scale schemes irrigate over 18,000 ha of land.

These high mountain areas with difficult terrain have been traditionally isolated from the mainstream of development in the country. In the past, development efforts were initiated by feudal overlords and local inhabitants. With feudal authority abolished in the early '50s (Chitral) and '70s (Northern Areas) these areas were faced with an institutional vacuum, which government agencies failed to fill. More recently a host of development efforts aimed at improving agricultural infrastructure have been initiated.

Critical to these efforts is the development of irrigation infrastructure, as agriculture is entirely dependent on the approximately 4,000 small-scale FMIS in the area. For centuries, these irrigation systems have been developed and managed by farmers, but now their capacity to continue investment in this sector has been exhausted. While the government will be required to play an increasingly important role in the irrigation sector, its attempts at developing the sector have been marked by failure. In understanding the differences in the management of farmer-managed and agency-managed systems, and the reasons behind the failure of agency-managed systems, useful indicators for performance measurement will be defined.

BACKGROUND TO THE AREA AND TRADITIONAL MANAGEMENT OF IRRIGATION SYSTEMS

The Northern Areas

Pakistan in its northernmost extremities forms the meeting point of the world's mightiest mountain ranges. This area contains not only the greatest concentration of high peaks to be found anywhere on the surface of the earth, but also the longest glaciers outside the subpolar regions. The area comprises the upper watershed of the Indus, which forces its way between the Karakoram and the Himalaya through Ladakh, then to Baltistan, and onwards to the distant plains of the Punjab. Despite giving birth to this mighty river, the area itself is arid mountain desert, bearing no resemblance to the lush green of the eastern Himalaya. As the yearly monsoon moves northwestward from the Bay of Bengal, the moisture it carries is rapidly dissipated and the Hindu Kush and Karakoram are sequestered in a partial rain shadow.

The area is located in the heart of the Karakoram mountain range. "Karakoram" in Turkish means black rock, a fitting name for the most rugged range on earth. The people living amongst these desolate and barren slopes suffer from the greatest collection of natural hazards known to man including floods, glacial movements, avalanches, mudflows, earthquakes and rockfalls. The natural environment of those living among mountains is far "noisier," and far more eventful than the plains. The weather is more severe and the rapid erosion interferes with the stability necessary for a landscape to sustain agriculture, communication and domestication.

Among the valleys of the Karakoram, a community has to live on sufferance in the midst of a primal war being waged between the mountains, the glaciers and the rivers. The communities in the Northern Areas have learnt to adjust and adapt their lifestyle to the harsh environment they have to face.

In the arid intermountain valleys of this area much of the precipitation in the mountains above an elevation of 1,800 meters is in the form of snow which may take up more than 50 percent of the annual rainfall and which, above 2,400 meters, is normally persistent for several months every year. Snowmelt commences in May reaching a maximum in June and continues, at the highest snow fields, right into August. Temperature ranges are very wide and diverse and are in accordance with the elevation range. Many of the interior valleys become snow-blocked and inaccessible after October when the higher passes are snowed in.

The key concern for the Northern Area dwellers is land. Only a tiny proportion of the landscape is fit for cultivation. With scarcely any rainfall and no technology for transferring water uphill, land is viable only where it lies below irrigation channels, precarious snow-fed watercourses and glaciers.

Irrigation in these mountain areas is provided by FMIS. Villagers have relied on the forces of gravity, some rudimentary tools and an infinite amount of courage and perseverance to channel glacial meltwater across treacherous slopes to their lands below. Originally *kuhls* or irrigation channels were constructed by the early settlers, and later the *Mirs* and *Rajas* (traditional rulers) initiated construction efforts.

In the Northern Areas, the traditional system of *rajaki* (presumably from Raja) is used to mobilize labor and other farmer-owned resources for repairs and maintenance, particularly at the beginning of the year. Mountain irrigation channels require substantial amounts of investment in annual repairs: they require new diversions and weirs and regular desilting and repairs before they can be made operational for the year. Under rajaki, fines equal to the cost of absentee labor are charged from defaulters who do not show up at the prescribed time. The origins of rajaki are feudal; since the demise of the last of the feudal states (in the early 1970s), rajaki is managed by the villagers themselves.

In conjunction with rajaki, community management entails well-defined rules for water allocation (rights) as, for instance, under the *warabandi* (the rotation by which each farmer is allotted water for irrigation) the mechanisms for infrastructure maintenance (obligations); and sanctions for the enforcement of the social contract. Under the warabandi system, each household in a kuhl command takes its irrigation turn on a specific day, at a specified and equal period of time. Food crops are given priority in water use, followed by fodder crops such as alfalfa and then trees. Amongst food crops vegetables take priority over grain.

Maintenance of these small-scale systems reflects their common property origin and collective management. Traditionally, all farmers contributed annually to maintenance in the form of labor or produce. Today, cash contributions may substitute for either of these. Spring is normally the time for annual maintenance, though mid-season desilting may be necessary. A *chowkidar* (watchman) may also be employed during the irrigation season to patrol the common portion of the channel to adjust and clear debris from the intake, plug leaks, repair small breaches and monitor water supply conditions. Where chowkidars are not employed, farmers themselves take over their role. Whenever a major breach occurs, all farmers participate in the repair process.

Many of these irrigation-related institutions depended for enforcement on the authority and legitimacy of an established social institution, such as the village *numberdar* or feudal authority. With the passage of time, these social institutions have become weak and new institutions have not yet emerged in their place. Government investments in irrigation development have been marked by failure. However, by 1987 over 9,000 ha of irrigable land have been added by irrigation system development activities covering 166 irrigation schemes, by the Aga Khan Rural Support

Programme (AKRSP) (Vander Velde 1989). AKRSP investments have been notably successful in comparison to government interventions.

Chitral

Chitral District borders on Afghanistan on the north and west, the Northern Areas on the east and Dir and Swat districts towards the south. Surrounded by the Hindu Kush and Karakoram mountains, it is separated from the rest of the country by the Hindu Raj Range, the only access being through mountain passes of over 10,000 feet. For much of the year the area is cut off. The poor communications with the rest of the country and within the region are the main factors hampering any socioeconomic progress.

This rugged, mountainous area is characterized by deep, narrow and tortuous valleys through which run the Chitral River and its tributaries. Settlements spread from about 3,700 feet at Arandu to 12,000 feet at Baroghil, and are usually found on alluvial fans or river terraces where soil fertility coincides with easily available water. Irrigation is essential to cultivation, and in all but the extreme south-west, no crops are grown without it. Rainfall in most of the valley bottoms is too low to support more than semidesert scrub, but higher on the mountains heavy precipitation during the winter ordinarily ensures plentiful meltwater. Rainfall is low during the late spring and summer seasons, which are critical periods for crop cultivation in Chitral, and snow and glacial meltwater is diverted from streams and rivers through channels for irrigation. Irrigation systems are constructed by traditional methods and are all gravity flow.

Channel construction is a highly skilled and arduous task and maintenance is no less difficult. Channels were traditionally constructed with support from the feudal authorities. All these channels are maintained by the villagers themselves. Currently, the government is intervening in channel construction through the Irrigation Department and local self-government. AKRSP and the Chitral Area Development Programme (CADP) are also assisting with channel construction in certain parts of the district. AKRSP has initiated 182 schemes of which 106 are complete and CADP has initiated eight of which none had yet been completed by 1990 (Hussein et al. 1990). Almost all the cultivated area, which was estimated at 18,000 ha in 1980, receives irrigation water through about 1,000 small, community-owned channels. Of all the irrigated area, about 90 percent is served by private channels while only 5 percent is served by government canals (Israr-ud-Din 1989).

Channels were traditionally constructed by the original settlers of villages, with each household contributing an equal share of labor for construction. When damaged, they are maintained and reconstructed by the inhabitants of the village. Israr-ud-Din's (1989) description of the *Ra Joi* (main channel) of the Khot Valley and the study by Hussein et al. of FMIS in Chitral, are useful in understanding the physical features and management systems prevalent. This is particularly relevant as it highlights the intricate physical features and management practices which are important to a successful irrigation system. The channel may be divided into several parts:

Hurdur (headwork); this is usually located in a perennial stream. The intake structure is constructed of stone, with shape and size subject to water flow fluctuations in the source and to the requirements of the beneficiaries. An intake tank near the head of a channel ensures a sediment-free supply of water to the villages. Location of the headwork is moved downstream in the summer to avoid their being washed away by summer floods. At this point several persons perform round-the-clock duty, particularly during the flood season.

Madok (overflow and desilting sluice gate); these gates are constructed of wood or flat stones and are opened and closed to regulate flow. Again, several people perform duty at these points. The day time duty is called *wali* and night time duty *basi.*

Ghospans (turnouts); these are usually in the form of a cut in the bank of the channel and are closed with silt, sand or stones. Size varies according to the size of the farm, type of soil and slope. The size of ghospan varies according to the area to be irrigated.

Urfi (main channel); this may serve several villages. Apart from this, the channel may have several extensions and distributaries. Villagers face severe problems in channel maintenance including seepage, silting, landslides and flash floods. A constant vigil is necessary to avoid loss of property and heavy investment in repairs.

The level of development of water rights and the system of water management are directly related to water availability. In water-scarce areas, complex user rights have evolved, which stipulate the allocation of water among the original owners. The system of warabandi is locally known as *sarogh.* The sarogh allocates water by time or flow. Original water rights are not connected to land ownership, but sale of land rights is in conjunction with water rights. There are no specific institutions for irrigation development and management; these are undertaken collectively with each beneficiary household contributing the labor required for cleaning or repairs. The *Mer Joi* (chief of the channel) used to be responsible for channel management, but this institution is rarely encountered today.

DIFFERENCES IN CHARACTERISTICS BETWEEN FARMER-MANAGED AND AGENCY-MANAGED SYSTEMS: THE IDENTIFICATION OF PERFORMANCE INDICATORS

Definition of a System

To understand the characteristics of a system it is important to, first, define the term. An irrigation scheme together with all the villages irrigated by it may be considered a system; or a village with all its irrigation channels may be considered a system. Another alternative would be to view all the irrigation channels and villages in one region (e.g., one valley) as a system. Israr-ud-din in his study of Chitral focused on a valley. Social scientists have tended to focus on the village or the social unit, while physical scientists have preferred the physical unit. What is important to note, however, is that regardless of the unit chosen, it is crucial to identify the critical variables and define a system with respect to those variables (Hussein et al. 1990).

In the complex irrigation systems that have developed in the mountain areas of Pakistan, it is essential to study the entire system of irrigated agriculture in order to understand the institutional aspects of the irrigation system under study. Government agencies have viewed irrigation from a technical perspective and have considered an irrigation system as comprising a channel, while farmers have always had to consider the whole system and not the channel in isolation. It is crucial to view the system from the farmer's perspective to be able to identify meaningful indicators for measuring performance in irrigation systems.

Construction and Maintenance

Construction holds different implications for farmers and agencies. While an agency may view the construction of a channel as an end in itself, farmers would view it as a means to an end. For the farmer the ultimate goal is to increase his water supply or bring new lands under cultivation. The construction of the channel, therefore, is only the beginning of the story. Even effective construction does not imply appropriate water supply or the provision of other necessary inputs for the farmer. In the village of Passu a kuhl was completed in 1985. After three years, only 10 percent of the command area had been developed (Vander Velde 1989). Successful construction of the channel is only one of the factors which determines its performance. New irrigation systems require adjustment before water supplies are adequate. Moreover, other constraints such as labor or input delivery play an equally important role in land development, which to the farmer is the ultimate objective.

Local inhabitants have accumulated generations of expertise in the construction and maintenance of channels in this precarious environment. Villagers have mobilized their internal resources and constructed channels through collective efforts. Later, the Mirs assisted in this construction. However, just prior to the abolition of the Mirdoms this system had reached its capacity. It required more than just collective endeavor to blast through the mountains to reach more distant water sources. After abolishing feudal rule, the government took over the development needs of the area. In the Northern Areas, the Northern Areas Public Works Department (NAPWD) began constructing some 20 large irrigation schemes, each at an average cost of 1.85 million Pakistani rupees. Only one of these schemes is still functioning (Hussein et al. 1986).

Successful construction requires a combination of local wisdom and contemporary engineering technology. On their own, neither will be successful; the failed NAPWD schemes bear testimony to this. The failure to involve the farmers in the planning and design of schemes has led to the construction of poorly performing or failed systems after considerable investment of scarce resources. The traditional method for determining the slope of a channel was the use of water as a level. Beginning from the source, water flowed along the channel as it was dug on a carefully estimated but unsurveyed line, with the objective of achieving the desired command (Vander Velde 1989). Village elders were consulted for advice on past glacial movements, avalanche and mudflow paths and stream flows from glacial and snowmelt or springs. Modern engineering science, often designed to suit uniform conditions found in the lowlands, has not, under these diverse conditions, been able to produce the results that these age-old, tried and tested technologies have.

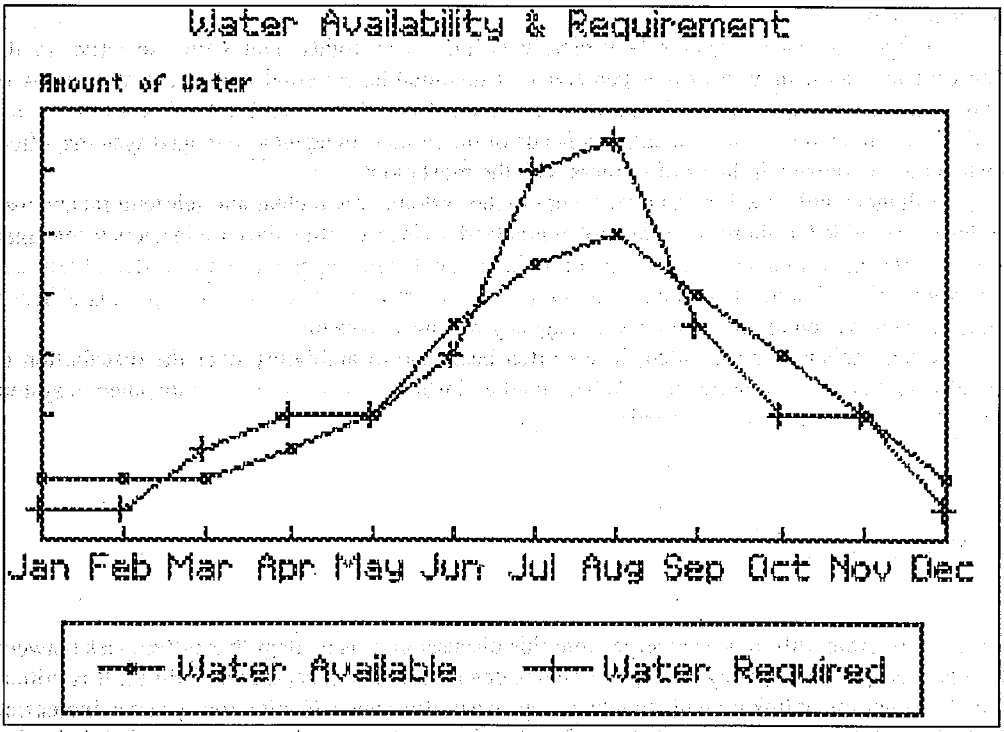
Construction by agencies is further characterized by bureaucratic delays, corruption and inefficiency. Delays in payment of installments were responsible for the failure of some irrigation schemes initiated by the Local Bodies and Rural Development Department (LB&RD). The piecemeal method of disbursement meant that no scheme could be completed. The previous years' work would be washed away before the next installment was received. Farmers had neither the capacity nor the incentive to maintain an incomplete channel which gave them no economic returns (Hussein et al. 1986).

The previous section highlighted the intricate procedures necessary to maintain channels in the mountain environment. Village communities have developed complex maintenance and repair systems that are responsive to the needs of their environment. It is not possible for an agency to respond to the maintenance needs of these channels with the immediacy that is required. A critical factor in the failure of NAPWD schemes was the department's inability to devise a system to transfer maintenance responsibilities to the beneficiary households. The AKRSP has devised such procedures.

Scarcity and Variability

Both seasonal and spatial variation can be found in the irrigation systems in these areas. It is, therefore, difficult to establish a priori the availability of water in a system. Water availability is considered always with reference to a particular season and a particular point along the length of a channel (Hussein et al. 1990). Seasonal variation is influenced by temperature, amounts of snowfall in winter months and the availability of perennial and other non-perennial water sources. Peak flows occur in July and minimum flows in March. Seasonal shortages coincide with the period in crop production when water requirements are at their lowest. Figure 1 shows the seasonal variation in water availability in an irrigation channel in Chitral. Occasionally, variations in water availability also occur, which farmers are unable to explain.

Figure 1. Seasonal variations in water availability.



Source: DRMS/IIMI Survey.

Spatial variation occurs due to the low conveyance level of the irrigation systems in their tail reaches. While water supply in the head and middle reaches may be sufficient, the tail end of a channel is often water-short due to the varying design capacity along the channel length. An additional reason for water shortages in the tail reaches of the channel is the fact that with gravity flow there must be a gradual slope all along its length. As a result of the slope the location of the tail reach is often above the channel (Hussein et al. 1990).

It is also important to define the concept of scarcity within the system. Scarcity is not only an economic concept, but also a technical one depending on the physical capacity of the channel. While water supply may be inadequate for crop water requirements it may be entirely adequate given the carrying capacity of the channel.

While agency-managed systems recognize the aspect of technical scarcity, they rarely consider it in relation to the needs of the farmer and the entire farming system. Similarly, they are unlikely to take into account the seasonal variability in water flows and differential availability of water for head and tail users. FMIS, on the other hand, tend to be sensitive to these issues and have evolved complex systems of use rights, particularly where water is scarce.

Equitability and User Rights

Water management systems that have evolved in these areas are very sophisticated and complex. Rules and regulations regarding the allocation of water rights and the distribution of land are clearly defined. Where water supplies are scarce and uncertain, property rights must be asserted for survival. Formal and informal institutions have evolved to meet the needs of specific ecozones. Distribution is sensitive to issues of variability and scarcity. There is a degree of equity inherent in the system.

Agency-managed systems lack clearly defined user rights. Not being sensitive to the appropriate issues, they are often perceived as inequitable. External and artificial systems of management are imposed which are alien to the local populations and not suited to the highly variable local conditions and fluctuating needs of the farmer. In agency-managed systems, often, distribution is skewed in favor of farmers with the most clout.

Villagers will be willing to invest labor in the system, only if clear and fair tenurial and user rights are provided. If these rights are not guaranteed, as is most often the case in agency-managed systems, the agency cannot expect local participation in the management of the system. Failure to recognize this and understand the different types of ownership patterns and rules guiding different resources have been major weaknesses in agency-managed systems.

Where schemes have failed, it has often been due to ambiguity over the distribution of benefits and issues of maintenance. Where land and water property rights are disputed, a system cannot succeed (Hussein et al. 1986).

CONCLUSIONS

Several important differences emerge from this discussion. It is evident that differences between farmer-managed and agency-managed systems determine their successes or failures. It is critical that the government link up with people to improve performance of irrigation systems. Increasing high channel disrepair is testimony to the fact that the people can no longer manage their irrigation channels on their own. New construction is entirely beyond their financial and technical means. This is mainly the result of the disintegration of certain parts of the socio-agricultural system, with declining gains from agriculture. Similarly, the government is constrained in its financial and human resources and cannot succeed without the participation of communities. The role of the government and its linkages with the people, therefore, become increasingly important.

Irrigation management is a sociotechnical process. Agencies initiate irrigation schemes when they have funds, and their concerns are primarily technical. The farmer, on the other hand, has a host of different needs. Approaching irrigation systems with a weak technical viewpoint has resulted in several disasters in the agency management of schemes. The siting of villages on geologically unstable terrain and the variation of channel flow due to dependence on snowmelt demonstrate the fragility and unpredictability of mountain environmental systems. Choosing to impose their own textbook engineering standards under these circumstances has served only to enhance the failures of government schemes despite considerable investment. The government approach was divorced from the wealth of traditional knowledge built up over centuries. It attempted to address technical and distributional issues in its own way.

The AKRSP which has demonstrated success in the construction and maintenance of channels provides a useful model for government agencies to follow. By working together with existing social organizations it has access to an organization with procedures for decision making, patterns of communication and means for building consensus and resolving conflicts. These are capabilities which would ordinarily take a considerable time to develop. Farmers have demonstrated their willingness to fine-tune their traditional methods for greater efficiency. Agencies that impose an external management structure tend to alienate local people from the system (Dani and Siddiqi 1987). Such attempts are bound to fail. It is beyond the capabilities of an agency to develop on its own the intricacies of water management that users have evolved over generations.

A high level of village participation is crucial to future successes in irrigation development. Agencies cannot expect local communities to share resources and responsibility for channel maintenance unless they are willing to share authority and the powers of decision making over financial and natural resources.

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