TRACING THE HISTORY OF THE DEVELOPMENT AND MANAGEMENT OF TWO IRRIGATION SYSTEMS IN THE TERAI OF NEPAL

Krishna C. Prasad[1] Bryan P. Thoreson[2]
David J. Molden[3]

ABSTRACT

Significant effort has been placed on increasing irrigated area, agricultural performance and improving overall irrigation system performance. Sometimes, these efforts are successful, but often frustrations are met. A wide variety of experiences have been gained, but unfortunately many of these experiences are not well documented. These are lost learning opportunities.

The purpose of this paper is to trace the history of two irrigation systems in Nepal to help fill this gap in recording experiences. The two study systems are the Khageri system serving about 3,900 ha and the West Gandak system serving about 10,300 ha. Both systems are located in the terai, the plains of Nepal, and were originally constructed in the 1960s and 70s. They are run-of-the-river systems, originally designed to provide supplemental water to paddy during the monsoons. Main and secondary canal systems were provided for both, and farmers were expected to construct the tertiary system. Both systems have undergone significant modernization of infrastructure and institutions to provide better flow control for paddy irrigation and, at West Gandak, for winter crops. Recent efforts have been to increase the involvement of farmers in managing the irrigation system through a management transfer program. While partial success has been achieved, sustainability remains uncertain.

This presentation tracks the development history of the systems, showing significant changes and their consequences on performance. We demonstrate that a balance between institution and infrastructure development must be achieved for success. We show the need for effective institutions to support local managing agencies. Future development paths are suggested. The experiences of these two systems, while in many ways unique, are also in many ways typical of irrigation development.

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[1] IWMI Nepal Research Coordinator, International Water Management Institute (IWMI), GPO 8975 EPC 416, Kathmandu, Nepal.
[2] Project Manager, Davids Engineering, 1772 Picasso Avenue, Suite A, Davis, CA 95616-0550.
[3] Research Leader, Irrigation and Water Resources Program, International Water Management Institute (IWMI), PO Box 2075, Colombo, Sri Lanka.

IRRIGATED AGRICULTURE DEVELOPMENT IN NEPAL

Nepal's agricultural sector contributes about 40% to the total gross domestic product (GDP) and 81.2% of the total population (about 22 million) is engaged in agricultural activities (HMG/N, 1999). The agricultural sector has experienced an annual agricultural production growth rate of 1.7% over the last two years and per capita growth of agricultural GDP of 0.5% (HMG/N, 1998). Nepal continues to emphasize agricultural development to increase food security (HMG/N, 1998).

Irrigation is vital for achieving higher returns from agriculture. Run-of-the-river surface water schemes irrigate about 861,580 ha (82%) of the total 1,055,617 ha of irrigated area in Nepal (HMG/N, 1998, p 520). Optimal performance and sustainability of these irrigation schemes are crucial to increased agricultural productivity and increasing farmer income.

Farmers in Nepal have a long tradition of constructing and managing irrigation systems under their own collective initiatives. In the 17th century, an edict of King Ram Shah stated that irrigation and its management were the responsibilities of the community (Pradhan, 1989a). Thus, Nepal has a strong tradition of community-directed irrigation development and management.

These systems number in the thousands, serving about 75% of the total irrigated area in the country (Prasad, et. al, 1998). They are typically are run-of-the-river systems diverting water by means of temporary brushwood diversions or earthen dams. The canal networks are unlined with few water control structures. These systems require frequent maintenance by the farmers.

Historically, the state also has been associated with the task of irrigation development, albeit the number of systems has been much less. It is only in the last 40 years that the state has become a major player in irrigation development. During this time, Nepal's Department of Irrigation (DOI) has undergone numerous administrative changes, along with changes in development philosophy.

As we trace the history of Khageri and West Gandak irrigation systems, we can see the effects of these changes on irrigation system performance. The difficulties that both the farmers and the government have had adapting to the changes will also become evident.

KHAGERI AND WEST GANDAK IRRIGATION SYSTEMS

Khageri was built by DOI with the farmers expected to develop the tertiary level canal system (Table 1). Under the management transfer program, all of its secondary canals have been turned over to water users association (WUA) for their regular operation and maintenance (O&M). The average area of transfer unit

is 142 ha. The main system is under joint management of Narayani Lift Irrigation Office of DOI and the Khageri WUA.

Table 1. Salient features of Khageri and West Gandak.

Details	*Khageri*	*West Gandak*
Location	Central Plains	Southwestern Plains
Construction	1961-68	1976
Design Discharge	8 cumecs	8.5 cumecs
Design Area	6000 ha	10300 ha
Source	Khageri River	Narayani River
Average Annual Rainfall	1832 mm	1463 mm
Annual Water Diversion	62 million cubic meters	64 million cubic meters
System Type	Run of the river, weir with side intake,no storage	Run of the river, barrage with side intake, seasonal storage
Length of Main Canal	23 km	32 km
Total Canal Length	90 km	740 km
Turnout Type	Gated Outlets	Gated Outlets
Water Measurement	Along Main Canal	Main and Secondary Canals
Measurement Type	Structures calibrated gages	Structures calibrated gages
Farm Families	5578	7500
Land Owners	90%	80%
Average Farm Size	0.7 ha	1.4 ha
Water Rights	At System Intake, within system farmer rights not legally established	At System Intake, within system farmer rights not legally established
Water Distribution	Roughly in proportion to area	Roughly in proportion to area

Prior to construction of the West Gandak Irrigation System, some farmer-managed irrigation systems were taking water from small drains and rivers lying within the present service area (Mishra and Molden, 1996). The Indian government constructed the main, branch and minor canals greater than 620 l/s. Farmers were expected to develop infrastructure with smaller capacities. The system, except the intake, was fully transferred to the WUA in November 1997. Accordingly, the WUA is carrying out operation and maintenance. Before the transfer, Nepal West Gandak Canal Irrigation Office of DOI managed the system.

CHANGES IN MANAGEMENT INSTITUTIONS AND INFRASTRUCTURE

Early Years (Construction to 1991)

During this time, both systems were under agency management. DOI was responsible for the collection of water use fees from the farmers, and operation and maintenance of the main and secondary canals. Although the farmers did not concern themselves with the O&M of the main and secondary systems, they did mobilize labor to make repairs in some extraordinary situations. Also, although

DOI was to be collecting water use fees, the total collection was nearly zero (Prasad, et al, 1998).

Operation and maintenance at the tertiary level and below was the responsibility of the farmers. Also, the agency did not take an active role in assisting the farmers to organize.

A change in philosophy occurred in the 1980s when it was felt that the major constraint to irrigation performance was lack of development and farmer management of tertiary infrastructure[4]. The West Gandak system experienced a transformation from 1982 through 1989, due to the Command Area Development Project (CADP) implementation. The purposes of CADP were to increase: 1) water utilization, 2) farmer involvement in construction of tertiary structures and system management, and 3) the living standards of farmers. The project designed and built farm ditches serving 7–12 ha and developed water user groups to facilitate system management.

Although farmers were expected to participate in O&M as part of the CADP, most water user groups were not formed until near the end of the project. Thus, during the years of the project and also after the project O&M was mainly performed by DOI.

Joint Management (1992 to 1994)

In 1992, the DOI initiated a Joint Management (JM) program in both the Khageri and West Gandak irrigation system to allow the farmers to play a greater role in system management. The JM program was expected to reverse the deteriorating conditions in the systems (Laitos and Shakya, 1992). It involved the creation of system-wide water users associations (WUA) at both systems. The program focused on structural improvements in the physical system, and efforts to build up the farmers' institutional capacity for effective participatory irrigation management. The WUA was also given a legal status through registration with the government's administration office under the prevailing law.

As part of capacity-building efforts, various kinds of training programs were organized by the DOI for farmers, farmer leaders, and DOI personnel on different aspects of irrigation system management. Farmer participation was sought at all levels of system management. The main activities carried out jointly by the agency and the farmers included preparing operational schedules and limited conflict management.

[4] Tertiary infrastructure includes canal conveyance, regulation and control structures to deliver water to farms, as opposed to main and secondary canals that deliver to the tertiary system.

Farmers participated in the maintenance and system improvement construction management and contributed labor, or fees to these activities. However, the final O&M decision remained with DOI during this program.

Irrigation Management Transfer Project (1994 to 1998) [5]

In 1994, both systems were selected to be part of the Irrigation Management Transfer Project (IMTP) of DOI. The project emphasized transfer of irrigation management responsibilities over to the organized farmers while improving the system's physical condition (CADI, 1995). The aim was to gradually transfer the management of canal networks up to the secondary level to the WUA. The headwork and main canal were to remain under the joint management of the irrigation agency and the WUA. The WUAs were allowed to retain a portion of the collected fees for covering the O&M costs of the part of the system they were managing.

Again, the paths of these two irrigation systems diverge. At Khageri, the WUA has assumed the full management responsibilities of the canal networks up to secondary level and the headwork and the main canal are being canal jointly managed with the irrigation agency. The WUA fixes the operational schedules in the branch canals and has a greater voice in operational decisions at the main canal level. The WUAs are maintaining the secondary canals and also contributing more resources to the main canal maintenance. The WUAs also contributed to the cost of system rehabilitation.

At West Gandak, the farmers were eager to take over the management of the main canal also. Based on the past performance of the West Gandak WUA, DOI decided to hand over the main canal in November 1997. Since then, the WUA has been managing the entire system by itself with the exception of the intake gate. DOI operates the intake gate to match the WUA's water allocation schedule. The WUA mobilizes farmer labor for maintenance. It also uses income from fees, penalties, land rental and canal bank trees and service road tolls.

Both WUAs are expected to receive technical and some financial support, especially in case of emergency, from the government in the future. Farmers often give feedback that government support systems are weak.

Major changes in legislation and the events that have taken place in these two systems are summarized in Table 2. The table shows the shift from construction to management and the government's response in changing legislation.

[5] Phase I of IMTP. Beyond this, only post transfer supports would be extended in these systems. Phase II of IMTP will concentrate on the other eight systems.

Table 2. Major events at Khageri and West Gandak

Year	Changes in Legislation	Major Events in	
		Khageri	West Gandak
1961	-	Construction begins	-
1963	Irrigation Act 2018 providing legal provisions concerning water use, construction and maintenance of canals, distribution of water, collection of water charges, etc.	-	-
1967	Irrigation, Electricity and Related Water Resources Act, 2024 with legal provisions related to irrigation, electricity production, and other matters concerning water resources	Construction ongoing	-
1968	-	Construction completed	-
1974	Introduction of Canal Operation Regulation to govern water use for irrigation	-	-
1976	-	-	Construction completed
1979	-	-	India handed over the system to Nepal
1982	-	-	Commencement of CADP
1988	New working policy on irrigation development through participatory approach and enactment of Irrigation Regulation, 2045 to provide legal provisions for formation of water user groups, water distribution, water charge collection, etc.	-	-
1989	-	-	Conclusion of CADP
1992	Adoption of Irrigation Policy, 2049 clarifying the government's policy on participatory irrigation development and management	- Commencement of Joint Management program - Formation of WUA and its registration	- Commencement of Joint Management program
1993	-	- First WUA election - Various training programs	First election of WUA and registration - Start of gradual turnover of secondary canals
1994	-	- Conclusion of JM - Commencement of IMTP - Household surveys	- Conclusion of JM - Commencement of IMTP - Household surveys

Table 2. Major events at Khageri and West Gandak (cont.)

Year	Changes in Legislation	Major Events in	
		Khageri	West Gandak
1995	-	- 2nd WUA election - Joint walk-thru for identifying the rehab needs	- 2nd WUA election - MOU signing for management transfer - Rehab work started
1996	First amendment of Irrigation Policy, 2049 giving a bigger thrust on participatory irrigation development and management	- MOU signing for management transfer - Rehab works started	- Gradual turn over of secondary canals started
1997	-	3rd WUA election gradual transfer begins	- Complete turn over of all secondary canals - Turn over of the main canal
1998	Discussions for revising the Irrigation Regulation started to make it more practical	-	- O&M by WUA - Post transfer support by the agency
1999	-	All secondary canals transferred to WUA - O&M of the secondary canals by the WUA - Main canal under joint management	-

RESULTS AND PERFORMANCE

Khageri Irrigation System

Service Area: Khageri was originally designed to serve 6,000 ha (ICON, 1995). An impact assessment study conducted in 1978 indicates that the system served only 3,714 ha (APROSC, 1978). Several studies (ICON, 1993; GITEC, 1993; IWMI and RTDB, 1998) show that the irrigated area has been far below the design area (Figure 1). However, the service area has slightly improved with the joint management program and IMTP.

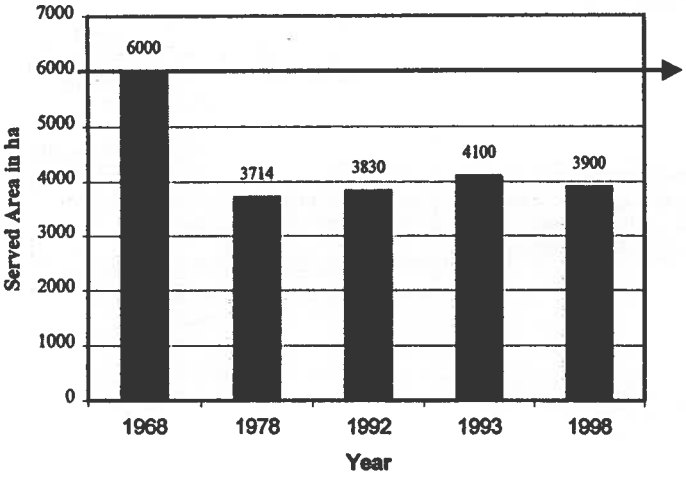

Figure 1. Change in Khageri Service Area.

Resource Mobilization for O&M: Table 3 compares the amount of resources mobilized by the WUA including labor mobilization during last few years to the government's O&M budget allocation.

Table 3. Resource Mobilization for O&M in Khageri

Year	Govt. O&M Expense	Resource Mobilization by Farmers
1991	254,000	-
1992	158,000	-
1993	213,000	-
1994	404,000	481,660
1995	300,000	117,048
1996	300,000	438,074
1997	300,000	73,990

Source: DOI and WUA records. Amounts are in Nepali Rupees unadjusted for inflation (in 1994, $1 = Rs 47, in 1999, $1 = Rs 69)

The WUA, thus, has been able to mobilize on an average of 40.4 % of the incurring total O&M costs compared to nothing before IMTP. The figure includes farmers' contribution to the rehabilitation works under IMTP. Nevertheless, from sustainability point of view, the resource mobilization by farmers needs to be further increased.

Agricultural Productivity: The Khageri irrigation system has experienced continuous increases in agricultural productivity of major crops grown in the service area (Table 4). Although rice varieties grown and management practices have also changed some over this period, much of the rapid yield increase in the past few years is likely attributable to improved irrigation management.

Table 4. Yields of Major Crops in Khageri (t/ha)

Year	Paddy	Wheat
1977/8	2.0	1.2
1992/3	2.5	1.1
1994/5	2.5	1.4
1995/6	2.8	1.5
1996/7	3.4	2.1
1997/8	3.9	2.1

Source: DOI records.

West Gandak Irrigation System

Service Area: The West Gandak irrigation system was handed over to the Government of Nepal in 1979. At the time of hand over, the main canal system covered about 4,300 ha as against the targeted area of 8,700 ha. A socioeconomic study conducted in 1982 indicates that the total service area reached 13,200 (APROSC, 1982). Irrigation Master Plan prepared in 1988 mentions that the developed service area in 1988 was 13,400 ha. Another study reports that in 1992, the system served only 4,000 ha (GEOCE, 1996). Yet another study just before IMTP mentions its service area as 10,100 ha (GITEC, 1993). This indicates quite a variation in the assertion of the service area (Figure 2).

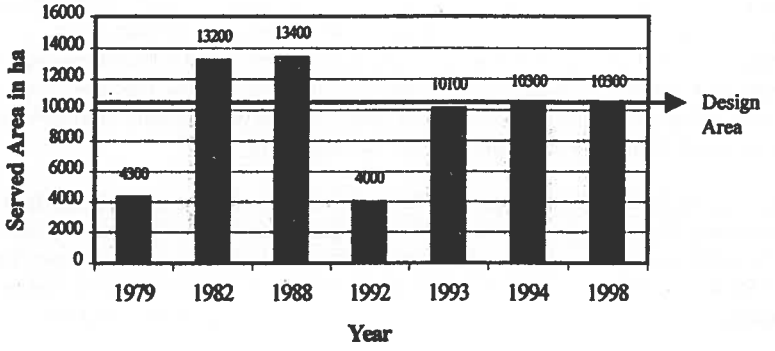

Figure 2. Change in West Gandak Service Area.

At the time of system hand over to Nepal the system was not fully developed and served only about half the targeted area. With the CADP, the system was able to serve more than the designed command area. But the area decreased drastically after conclusion of CADP to 4,000 ha. Again with joint management program, the service area increased to 10,100 ha. Later with IMTP, it was further increased to 10,300 ha.

Resource Mobilization for O&M: Encouraged by the labor mobilization in the desilting works of the main canal, farmers in West Gandak became more willing to contribute toward O&M of the system. More and more farmers became members of the WUA and paid membership fees, share fees, and irrigation service fees (CADI, 1996). The resources required for O&M of the system are now coming from three sources: 1) the agency as transitional financial support after the management transfer, 2) the farmers as various fees and penalties, and 3) land rentals, trees on the canal banks, canal service road tolls, etc. The resources in NRs. allocated by the government and mobilized by the WUA in West Gandak have varied tremendously over the last few years (Table 5).

Table 5. Resource Mobilization for O&M in West Gandak

Year	Govt. O&M Expense	Resource Mobilization by Farmer
1994	2,366,732	184,086
1995	2,352,329	479,730
1996	971,806	111,164
1997	1,040,229	253,712

Source: DOI and WUA records. Figures are in Nepali Rupees, unadjusted for inflation (in 1994, $1 = Rs 49. In 1999, $1 = Rs 69)

The figures include cost incurred during the rehabilitation and labor contributions made by farmers in the deferred maintenance works and income from other sources. The WUA has been able to mobilize an average of 13.5 % of the total O&M cost of the system compared to almost nothing in the past. However, the figures still are much below the required level of resource mobilization by farmers for giving it continuity under the farmers' management.

Agricultural Productivity: In general, West Gandak also has experienced notable increases in the agricultural productivity of major crops in the service area (Table 4). In addition, some cash crops like sugarcane and oilseeds are becoming popular (IWMI and RTDB, 1997). Similar to Khageri, increases in yield are likely due to improved management, although other factors could have led to the increase.

Table 6. Agricultural Productivity of Major Crops in West Gandak (t/ha)

Year	Paddy	Wheat
1982/3	1.3	0.7
1992/3	2.0	1.7
1993/4	3.7	2.0
1994/5	3.4	2.4
1995/6	3.7	1.5
1996/7	4.0	2.9
1997/8	4.5	3.0

Source: DOI records.

Sustainability: Changes in management have not yet proven to be sustainable. The WUAs are changing and adapting, but it is still not clear whether they will survive. Resource mobilization is insufficient. There is a dependency on cash generation from non-irrigation service related sources such as tree cutting and collecting road tolls. Thus there is not a good link between service provision and resource mobilization. The strength of WUAs is often challenged by political influences. Politicians try to get popular by promising free government services. The government has been slow in their transformation to a service-oriented agency, thus support services to WUAs are lacking. In spite of this, the WUA at Khageri is most likely to be sustainable[6] as indicated by the mobilization of 40% of the O&M costs. Although at West Gandak, the WUA has been able to undertake management of the main canal, the mobilization of only 13% of the O&M costs raises sustainability questions.

LESSONS

We can identify three periods in Nepal's irrigation development.

1. A pre-modern period where Nepali farmers were largely responsible for development and management of irrigation.
2. A construction period between 1960 and 1990 where huge investments were made in infrastructure development. Construction of new facilities in Nepal is still in progress.
3. A period from 1990 to present where more efforts were placed on better management of infrastructure.

From the relatively short 1960s to 1990s, there have been many changes in views on development and management of irrigation. Traditionally, farmers were

[6] At Panchkanya, another IMT site, the WUA is progressing very well and is likely to sustain (Starkoff et al, 1999).

expected to build, operate and maintain irrigation. Thousands of systems built with this philosophy are still functioning well, although there is certainly scope for improvement.

During the construction period, the responsibility for construction and management shifted to the government agency. Beneficiary farmers were expected to pay for services received from the government. During this period, there was considerable expansion in irrigated area country-wide. There were over-optimistic estimates of area that could be irrigated, and results that could be achieved. As characterized by Khageri and West Gandak, maintenance proved to be difficult because of insufficient funding. The area served by these systems rapidly declined due to poor maintenance. Rehabilitation programs aimed at modernizing infrastructure and management were no help, as area and production would go up, then drop again soon after rehabilitation. There appeared to be an endless cycle of construction, decline, then rehabilitation, decline, and then rehabilitation.

Meanwhile, during the early years of the construction phase, farmer managed irrigation systems were not even recognized as irrigation by irrigation officials. Later, important studies re-discovered these systems and found them to be vibrant, with farmers making decisions, and covering costs of operation and maintenance. It was increasingly recognized that farmers could and should play a more important role in managing irrigation. As characterized at both Khageri and West Gandak, in the 1980s, farmers were given a minor role in managing irrigation in primarily agency run schemes. In the 1990s, more radical experiments took place where farmers assumed significant responsibilities for running irrigation systems.

Approaches to infrastructure design has also changed during that period in modern systems, first from development of main canals delivering water to deliver supplemental irrigation water, to intensive development of infrastructure to deliver water directly to farms (called tertiary or command area development). Within various rehabilitation programs other experiments took place. Some infrastructure allowed for changes in timing and amount of water deliveries by relying on gated outlet systems. Others focused on simpler, but supposedly easier to manage infrastructure, with proportional flow dividing devices. Some irrigation systems in Nepal indeed look like large testing grounds for a variety of infrastructures.

Since the 1960s, policies for development and management have shifted course in large ways. Policies shifted from farmer management to agency management, then back. Infrastructure designs changed, sometimes within one system in very drastic ways. Irrigation officials trained in one manner of development and management were expected to make important changes in their attitude and implementation. Farmers had to adjust to an uncertain environment in

development. How could they know what would happen next? It is no wonder that expected gains from irrigation have been less than expected. It is also likely that these cycles of trial and error will be repeated unless we can learn from lessons of the past.

The experiment in the 1990s with turnover of agency schemes to farmers can be rated as a partial success. There has been an increase in productivity that is likely due to improved management by farmers. With resource mobilization still far less than required to run these irrigation systems, it is questionable whether gains can be sustained. Progress to sustainable and productive management at these turnover sites has been much slower than expected. Perhaps this is not surprising when farmers have passed a period where there have been so many changes in policies and philosophies of management.

Some lessons derived over this time period are that:

- Development efforts focusing on infrastructure can easily lead to expensive and non-productive cycles of construction, decline then rehabilitation, decline then rehabilitation. This is a cycle that needs to be broken.
- Farmers of Nepal clearly have the capability of developing and managing irrigation. While this was ignored in the past, it provides an important component of Nepal's development. Right now finding the right mix of farmer management and government support is important.
- Recovering from the cycle of construction and rehabilitation has been positive, but much more difficult than perceived. It is vital to get new irrigation development started right. It is also important to continue efforts to improve management – of both farmers and government – in these systems.

Clearly, development of Nepal's water resources is critical for the country's development. It should be expected that there is much trial and error to get the development process right. Somehow we have to reduce the time it takes to reach the potential for managing these systems. One important part of the process is to document and understand trial and error and success and failure to make sure we improve how development takes place.

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