ALTERNATIVE INTERVENTIONS TO ASSIST FARMER-MANAGED IRRIGATION SYSTEMS IN NEPAL[1]

Ganesh P. Shivakoti[2]

ABSTRACT

This paper examines the consequences of various types and levels of interventions in Farmer Managed Irrigation Systems (FMIS) in Nepal. Systematic and comparative analysis of 13 FMIS interventions by 13 different agencies in the hill districts of Nepal tries to answer the question of how and why some ways of helping FMIS have had positive results and others have had no or negative effects. The important variables include intervening agencies, their process to select particular system, assistance objectives of programs, cost-sharing criteria, mode and basis of resource mobilization, and changes in agricultural performances due to intervention.

Then the paper documents the process of intervention and examines performances of 19 irrigation systems in one hill district intervened by one of the intervening agency - Water and Energy Commission Secretariat/International Irrigation Management Institute-Nepal (WECS/IIMI). After the initial discussion of WECS/IIMI action research agenda, the paper discusses the methods of selection of systems for intervention, brief description of the selected Irrigation systems; and documentation of farmer-to-farmer training process during intervention. Finally, performance of these 19 systems are compared before and after Intervention based on the analysis of changes in technical efficiency, organizational structure, resource mobilization, rules, and agricultural productivity.

INTRODUCTION

The recent efforts of His Majesty's Government of Nepal (HMG/N) to assist some Farmer Managed Irrigation Systems (FMIS) have not had uniformly successful outcomes. While some interventions have enabled farmers to maintain their Irrigation systems at lower costs and increase the overall efficiency of their irrigation systems, others have had just the opposite effects. The

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[2] Faculty, Department of Agricultural Economics, Institute of Agriculture and Animal Science, Rampur, Chitwan, Tribhuvan University, GPO Box - 934, Kathmandu, Nepal.

selection of these thirteen systems. Availability of secondary information such as Rapid Appraisals, IMC Applied studies, Baseline Studies; WECS/IIMI publications, accessibility from the IMG office at Pokhara; and also the researcher's dissertation research sites selection criteria were some of these factors. The following table summarizes the names of the systems, the districts in which they are located, the total command area and intervening agencies:

(Table-1 here)

Available background information such as rapid appraisal reports, applied and baseline studies as well as description of the systems by the Western Regional Directorate served as the background materials. Additional information was also collected by interviewing different persons working in the related agencies.

The study team consisted of a social scientist and an Agricultural/Irrigation Water Management Engineer. The two field researchers spent one day in smaller systems to two days in larger systems walking through source to the tail end with key informants in the respective system. The system intervened by WECS/IIMI, however was visited by one other member of the NIIS team during the same period; and hence the information are based on those field notes and other reports. User committee members and/or site staffs; and farmers at different locations were also consulted for information. Thus, the Information collected was through a rapid appraisal method.

INTERVENTION TYPES AND LEVELS

The public intervention process in the FMIS for the last two decades can broadly be categorized into two stages. In one case the process is initiated by the users themselves; and In the other the agency gets the process started. In the users-initiated cases, it is necessary that the users approach the intervening agency for the irrigation project. MPLD financed projects, FIWUD - supported systems, ADB/N, CARE, WECS/IIMI, Hill Food Production Program (HFPP) and also World Bank Financed Irrigation Line of Credit (ILC), up to a certain extent, fall under the user-initiated projects. On the other hand in the case of systems where agencies get the process started, it is not necessary that the users approach the agency before the agency takes the decision to implement the project. However, mostly the decisions are made through a political process where a particular group or groups of users approach or even lobby for a specific project to be Included under the departmental plan. Projects implemented by DIHM, ILO and the Hill Irrigation Project fall under this category.

Recently the Irrigation Management Project has started its Intervention process in selected sites to help develop farmers' management capacities; and also to turn over the DOI systems to the farmers for their 0 & M. In order to improve the Irrigation management practices of Nepali farmers, the Irrigation Management Project (IMP) under DOI has been in operation since 1987. Important objectives of IMP relevant to this study are: to create an awareness among government entities that management is the crucial link between construction of irrigation canal and production of farm crops that presently limits the

facilities such as irrigation, fertilizers, pesticides and insecticides, improved seeds and plants through effective extension programs which have been financed by the World Bank. HFPP maintains its own cadre of technicians to implement the project. The irrigation schemes are identified, based on the collective request of the users, and the process of approval and implementation of the schemes are the same as that of FIWUD. Farmers form the construction committee and deposit 5 percent of the estimated cost in the bank in the name of the scheme and commit another 20 percent worth of estimated cost in the form of labor contribution. Like FIWUD, construction works are implemented by the construction committee under the technical supervision of HFPP technicians. Usually assistance is provided for head work, lining the main canal and the retaining wall of the existing FMIS. Once the construction is complete, a users' committee is formed and they take over the system for 0 & M.

IRRIGATION MANAGEMENT PROJECT (IMP)

The IMP is jointly funded by HMG/Nepal and USAID, and is executed by the Department of Irrigation. With an objective of developing and strengthening the capability of Water User Associations (WUAs) to assume greater responsibility and authority for the 0 & M of Irrigation systems, the joint effort has created two Institutions; the System Management Division (SMD) and the Irrigation Management Center (IMC). The primary objectives of SMD are to implement systematic operation and maintenance procedures, to facilitate the organization of WUAs and initiate monitoring, evaluation and feed back procedures. IMC on the other hand has two primary objectives of conducting training for the agency personnel and farmers and also carrying out short-term and long-term studies of Nepal's irrigated agricultural systems. Thus, the intervention process of IMC and SMD is an effort to train farmers in better Irrigation system management and organizational skills or in better agricultural practices.

WATER AND ENERGY COMMISSION SECRETARIAT/INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE (WECS/IIMI)

Indrawati River Basin in Sindhupalchok District was selected by WECS/IIMI as an action-research project site to develop and test the strategies for effective improvement and expansion of the irrigation systems during 1985-1990. Out of 119 irrigation systems, 19 systems Irrigating a total of 625 ha were selected for intervention **(WECS/IIMI,** 1990). Reliable water at source and the potential for extension **of command area were** criteria for selecting the candidate systems for assistance. There were two objectives of intervention; one was to establish low-cost procedures for identifying the relative needs of all systems **in an area, allowing** selection **of** systems for assistance where greatest impact **on food production could** be **made.** Another **objective was to develop and test methods for delivering assistance that** enhanced farmer management **capability for operation and maintenance at the same time as the physical infrastructures were being improved (Yoder, 1991). Farmer-to-farmer training were organized to expose farmers** from those system that were performing poorly to the more successful ones in other parts of the country so that the farmers could choose **new** management options.

level and the branch canal level.

The functionaries in the organization of user controlled systems are usually selected from among the construction committee members whereas in case of agency controlled systems, these functionaries were the members of village council or class organizations, in the old Panchayat system. The smaller systems with a command area of 20 - 30 ha, have mostly non-political functionaries whereas except for FIWUD intervention all other systems have village council members (political representation), as the WUG member. This arrangement of village council members to represent WUG is mostly influenced by the Decentralization Act which required elected Panchayat officials to represent every users' group formed in the village. To make room for many elected officials, the number of committee members is also higher. But the ratio of the total number of households to the number of committee members is almost the same. The changes in organizational structure before and after intervention are presented in table - 3.

(Table - 3 here)

RESOURCE MOBILIZATION

Resource mobilized for annual maintenance of the system are mainly in terms of labor contribution. The labor contribution on a per hectare basis has been reduced significantly after intervention. Only in case of the Chaurasi system, the contribution of cash has almost doubled and three times more labor has to be mobilized after intervention. The main reason for this increase is due to the construction of Hyangja system by DIHM. The same amount of resource is to be mobilized for work in the source but the number of beneficiaries is reduced to half. The DOI constructed systems are still contributing towards the annual repair and maintenance of the systems. Thus, the farmers in the lower Hyangja, Bhorletar and Handetar don't contribute any cash or labor for the repair and maintenance. Lahachok, on the other hand, although agency managed, still mobilizes labor for desilting and cleaning the canal. This is mainly due to a smaller allocation of budget by the district irrigation office. The smaller systems which mobilized a one day equivalent of labor for repair and maintenance before intervention now contribute only half a day of labor after intervention.

The Rapti-Nawalpur system has a separate arrangement for resource mobilization. In this system, on an average Rs. 270 per ha are collected from the beneficiaries. The criteria for collecting cash varies (from Rs. 180 to Rs. 360 per ha) with the minimum being for the head farmers and the maximum being for the tail enders. This amount also includes the salary of the water monitor (pani pale) for four months during the monsoon rice growing season.

In almost all the systems which mobilize labor resources for annual maintenance still contribute on a per household basis. But for the emergency repairs, the labor mobilization criteria in all the systems is based on size of land irrigated by the system. Except for Chaurasi, none of the systems have major emergency labor mobilization problems, as the sources are either perennial or the Intake diversion structures are permanent. Resource

extent wheat cropped area due to availability of irrigation facilities during the dry seasons. There is also changes in the cropping intensities. The changes in cropping intensities are higher in those systems where there are support agricultural services. Rangdi Khola and Bhorletar irrigation systems have support service from the Hill Food Production Program. Similarly, Thuli Besi and Bhalutar systems which are supported by CARE'S agricultural development programs. The most significant increase in cropping intensity has taken place in Rapti-Nawalpur which is mainly changes in cropping patterns mainly due to availability of water throughout the year.

Table 7 shows changes in average yields of major crops before and after intervention. Significant yield gains have been achieved in paddy, maize and wheat yields in those systems where there was also significant changes in cropping intensities. Except Rapti-Nawalpur and Bhorletar, all the systems recording higher productivity are the smaller systems which are also Operated and managed by the users themselves.

INTERVENTION THROUGH FARMER-TO-FARMER TRAINING

In this section the process of intervention and performances of 19 irrigation systems in Sindhupalchok district intervened by one of the intervening agency - Water and Energy Commission Secretariat/International Irrigation Management Institute-Nepal (WECS/IIMI) is discussed. We base our discussion on both published work [Yoder, (1991a, 1991b); WECS/IIMI, (1990); Naresh Pradhan, (1987); and Hydro-Engineering Services, (1987)] and original field work. Besides the secondary sources, the quantitative analysis of the changes after intervention is based on Nepal data-base In which all the data of these 19 systems analyzed; were collected by Naresh Pradhan during December, 1991. After the initial discussion of WECS/IIMI action research agenda, we discuss the methods of selection of systems for intervention, brief description of the selected irrigation systems; and documentation of farmer-to-farmer training process during intervention. Finally, performance of these 19 systems are compared before and after intervention based on the analysis of changes in technical efficiency, organizational structure, resource mobilization, rules, and agricultural productivity.

ACTION RESEARCH AGENDA

The Water and Energy Commission Secretariat (WECS) of Nepal, with assistance from the Ford Foundation and International Irrigation Management Institute (IIMI), initiated an action research project in 1985 along the Indrawati river basin in the Sindhupalchok district. The objectives of the action research was two-fold; one being "to establish low-cost procedures for identifying the relative needs of all systems in an area allowing the selection of systems for selection where the greatest impact on food production could be made," and the second was "to develop and test methods for delivering assistance that enhanced farmer-management capability for operation and maintenance at the same time as the physical infrastructure was being improved (WECS/IIMI, 1990 p.12)." The intention of the project designers was that the systems would remain farmer-managed after intervention. From the very beginning this intervention anticipated full participation of the users in

Identification of the project, share contribution of the resources, and the limitations in the exploitation of the resources so that farmers did not develop high expectations from the interventions. The details of these procedures is discussed in a later section of this chapter.

METHODS OF SELECTING FMIS FOR INTERVENTION

WECS/IIMI selected the Indrawati river basin in the central hills of Sindhupalchok District for intervention due to its proximity to Kathmandu for supervision. The project staff could travel from Kathmandu to the Indrawati river in about 1.5 hours by car. It then took anywhere from 1 to 3 hours to travel on foot to the irrigation systems located in the hills on either side of the Indrawati river. The river basin hydrologic boundaries were used to define the 200 square kilometer project area. An inventory of all existing FMIS was prepared to fulfil the objective of determining relative needs among systems and establishing criteria for selecting final candidates for assistance. Out of the 119 Irrigation systems Identified with canals longer than 0.5 kilometer In the area, 23 FMIS met the following criteria decided in the beginning due to limited resources:

1. Only those systems were to be selected for assistance where expansion of area was possible which would have high impact on food production and for use by additional number of families.

2. The existing users of these systems were willing to allow their systems to expand and to accept additional farmers as members of the WUO.
(Yoder, 199]a:56)

A rapid appraisal study was carried out to collect information about the physical and agricultural systems and about the organizations' management practices. Based on the information from rapid appraisal and discussion with the farmers, final selection of the systems for assistance were reduced to a total of 19 Irrigation systems.

(Location map of the systems here)

During the same period, a dialogue was initiated between the field supervisors and the water users of each system. As part of a design process, the farmers were asked to help rank all of the desired physical improvements into three groups according to priority:

1. highest priority was placed in improvements necessary for expansion of the system but difficult for farmers without assistance,

2. second priority was assigned to work that would improve system operation and maintenance, and

MANAGEMENT IMPROVEMENTS THROUGH FARMER-TO-FARMER TRAINING

A major problem identified during rapid appraisal according to the WECS/IIMI was that "the water users of the systems selected for assistance did not function as organized bodies to manage the operation and maintenance activities of their canals(1990:18)." Thus, during the rapid appraisal study, farmer training for irrigation management in each system was identified as a priority in implementation of the project. Although the field supervisors provided a major input to improving farmer management by assisting committee members in group decisions, keeping records, and mobilizing labor; the result was not satisfactory. The project decided to try a series of farmer-to-farmer training tours as a method of extending ideas about effective governance and management of irrigation systems.

The purpose of the farmer-to-farmer training program, according to Naresh Pradhan "is to stimulate the transfer of experience from farmers in well-managed systems to those in poorly-managed systems through site visits, informal exchanges, and guided discussions (1987:1)." The project organized farmer-to-farmer training for five groups of farmers from these 19 irrigation systems each group constituting 15 farmers. Each group was accompanied by two facilitator; one being a member of host system and the other being research assistant who were hired by WECS/IIMI for the project period. The host farmer form the well-managed system worked also as a consultant. This consultant farmer also inspected the canals and structures of the systems and discussed the similarities and differences In their own systems and made suggestions for improvements.

During the tour, the trainee farmers were taken to the Intake and canal of the system guided by a group of host farmers. The timing of the tour had been arranged to coincide with the annual meeting of the canal's organization. But the trainee farmers were taken first to meet the host system's committee members. These host farmers described the ways they had devised to deal with issues such as labor mobilization for emergency maintenance, water allocation and distribution, conflict management, and the structure of the organization. The facilitator usually raised the questions to cover the adequate issues. However, in the general meeting the visiting farmers were only observers who witnessed the whole procedures of a general meeting.

The trainee farmers were also exposed to the constitution, minutes and attendance records of the labor contributed by the farmers. By the end of second **day,** the farmers **had clear idea about the management problems in their own systems. The farmers were taken to more than one system; and during the** second successful system visit, **the farmers started comparing their** systems with these ones **and** exchanged **their problems with the farmers.** This is reflected by the farewell advice **of the host farmer as follows:**

> "You farmers have described **your irrigation systems as having an illness. Now you realize that you have the medicine for the illness in your pocket. Other members of your systems still don't recognize that there is medicine available. You must step forward and explain that unless you all take the medicine your system will not improve. It may be bitter medicine to take but after your system operates effectively all**

will be happy that you have taken the medicine."
(Yoder, 1991b:ll)

ANALYZING THE EFFECTS OF INTERVENTION IN SINDHUPALCHOK

Table 9 arrays the headend intensity, tailend intensity, and area growing irrigated crops in winter season immediately before and after intervention. A survey of different productivity indicators in Table 8 and 9 shows that the intervention process was successful. Improvements in the indicators are significant. While increases in values of productivity indicators are obvious, some interesting questions remain unanswered. First, even though there was an increase in productivity, can we draw the conclusion that such an increase was caused by the intervention effort? Is it possible that the increase is only a result of chance? Second, what is the magnitude of different factors in affecting productivity? Specifically, how substantive is the effect of the intervention process on productivity? Third, how does the effects of intervention operate to affect productivity? Did the intervention process bring along a one-shot effect and cause an abrupt increase in productivity? Or did the intervention effort manifest its impact through mediating the effects of other input factors such as the number of labor days spent on the maintenance of the canals on productivity? This question relates to a broader issue concerning government assistance to farmer managed irrigation systems: How should the intervention proceed?

There have been two major perspectives of what government intervention means and, hence, how it should operate so as to achieve a high level of effectiveness. The first perceives government intervention as a process of transferring resources to farmers by government agencies. The assumption of this perspective is that if only farmers are given adequate resources, irrigation water will flow automatically. An intervention process is seen as a one-shot process. Thus, the major concern of an intervention process Is to make sure that the magnitude of the shot is strong enough. The second perspective posits that intervention is more likely to be effective when it enhances farmers' ability to manage their systems. Through intervention, farmers are enabled to better mobilize themselves to maintain the resources, and to engage in self-governing activities concerning appropriation and maintenance. From this perspective, both the direct and mediating effects of an intervention process are Important.

In a technical report by Lam and Shivakoti (1992) have used the technique of regression analysis to examine the relationships between productivity and various input factors, of which intervention is one, in the context of Sindhupalchok. Two regression models with different specifications were set up, each of which represented one of the two perspectives of intervention discussed above.

The data used in the analysis are from the "sindhu" database extracted from the larger Nepal database at the Workshop in Political Theory and Policy Analysis at Indiana University. In the database, there are a total of nineteen systems. As each of the systems has two time slices, one before the intervention and one after, the total number of observations in the "sindhu" database is thirty-eight. Because some of the observations have variables

which have missing values, after listwise deletion, only twenty-eight cases were used in the analysis.

Each of the coefficients for interaction terms has an opposite sign to that of the respective variable. It means that the interactive terms tend to attentuate the effect of the respective variables. For instance, before intervention, a one unit increase in the condition of a canal will bring about an increase of more that 233% in tailend crop intensity. However, after intervention, a one unit increase in the condition of a canal only increases the tailend intensity by approximately 22%. For the variable of the number of labor days spent on maintenance, the interactive term even changes the sign of the coefficient from 0.0810 to -0.0016.

The increase in the intercept and the decreases in the slopes of various input variables after intervention can be interpreted as signs of a successful intervention process. The high value of the coefficient for "inter" suggests that the intervention process has generally enhanced the productive capabilities of the systems. As the productivity of the systems after intervention is high on average, its variations depend less on the change in various input variables. The levels of productivity of the systems after intervention have become higher and more stable.

CONCLUSIONS

The following conclusions can be drawn from the discussion of this paper on effects of public intervention in Farmer Managed Irrigation Systems in Nepal:

The public intervention process in the FMIS for the last two decades can broadly be categorized into two stages. In one case the process is initiated by the users themselves; and in the other the agency gets the process started. MPLD financed projects, FIWUD - supported systems, ADB/N, CARE/N, HFPP and also World Bank financed ILC , up to a certain extent, fall under the user-initiated projects. Projects implemented by DIHM, IL0,and the Hill Irrigation Projects fall under the agency-initiated projects.

In comparing the major rehabilitation/construction costs, higher per hectare of costs are incurred in those systems where the quality of works are higher. Other systems which are based on low cost technologies are also smaller in size and per hectare costs are relatively lower.

The cost sharing criteria of each of the Intervening agencies are different. Farmers have contributed upto 66 percent of the total costs in some cases, to no cost In the other cases. Cost sharing in all systems is mainly in terms of labor. The cash contributions in terms of loans from the bank is as high as 32 percent of the total costs.

Many public agencies have required organization in the system as qualifier for the intervention. Thus, many informal organizations have formalized themselves, and in the systems with 200 ha or more to be irrigated there are sometimes even two tiers of organizational structures, at the system level and the branch canal level.

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Table 1: Basic Information on Selected Irrigation Systems

Name of System	District	Command Area (ha)	# of Household	Intervening Agency	Initiated by	Controlled by
Chaurasi	Kaski	100	285	Dept of Canals/Minor Irrigation Program	F	F
Manechhango & Pangduri	Gorkha	32	68	Gorkha 3268 ADB/N; MPLDA/FF	A/F	F
Rangdi Khola	Gorkha	20	55	HFPP-Hill Food Production Program	A/F	F
Ghachok	Kaski	200	650	ILC/DOI/ISP	A/F	F
Thuli Besi	Kaski	20	52	CARE/Nepal; MPLD	A/F	F
Bhalutar	Makwanpur	31	64	CARE/ADB/N	A/F	F
Rapti-Nawalpur	Makwanpur	175	208	FIWUD/MPLD	A/F	F
Majh Kulo -Baguwa	Sindhupalchok	33	116	WECS/IIMI; MPLD	A/F	F
Malebagar	Tanahu	22	59	IMC/DOI	A	F
Hyangja	Kaski	300	545	DIHM, Hill Irrigation Dev. Program-ADB	A	A
Lahachok	Kaski	100	410	ILO/DIHM; DOI/MPLD	A/F	A
Bhorletar	Lamjung	220	194	ILO/DIHM; DOI	A/F	A
Handetar	Lamjung	260	513	DIHM; IMP/DOI	A	A

A=Agency; F=Farmers

Data Source: IMC 1990, WECS/IIMI 1991, Laitos et al. 1986, and Field Survey.

Table 3: Changes in Organizational Structure of Irrigation Systems

Name of System	Type of Organization		No of Committee Members		Chairman/members of WUG Selection Procedure	
	Before Inter-vention	After Inter-vention	Before Inter-vention	After Inter-vention	Before Inter-vention	After Inter-vention
Chaurasi	FO (1)	FO (2)	11	11 30*	VPC Members -	VC Members SEL/ELE
Manechhango & Pangduri	IN (1)	FO (1)	3	7	SEL	SEL/ELE
Rangdi Khola	IN (1)	FO (1)	3-5	6	JIM/SEL	SEL/ELE
Ghachok	IN (1)	FO (1)	3-5	7	JIM/SEL	SEL/ELE
Thuli Besi	IN (1)	FO (1)	5	9	JIM/SEL	SEL/ELE
Bhalutar	-	FO (1)	-	11	-	SEL/ELE
Rapti-Nawalpur	IN (1)	FO (2)	3-5	11 70*	SEL -	SEL/ELE SEL/ELE
Majh Ko Kulo Baguwa	-	FO (1)	-	9	-	SEL/ELE
Malebagar	IN (1)	FO (1)	3-5	7	SEL	SEL/ELE
Hyangja	-	FO (2)	-	9 25*	- -	VPC Members SEL/ELE
Lahachok	In (1)	FO (1)	11	9	VPC Members	VC Members
Bhorletar	IN (1)	FO (2)	5	9 32*	VPC Members -	VC Members SEL/ELE
Handetar	IN (1)	FO (2)	5-7	10 53*	JIM/SEL -	- VC Members

Note: Figures in the parentheses indicate number of tiers in the organization. IN=informal; FO=formal; VPC=Village Panchayat Council; VC=Village Council; SEL=selected; ELE=elected; JIM=Jimwala (land revenue collector at the village level); *=branch canal committee members.
Data source: Field survey.

Table 4: Resource Mobilization for Annual Maintenance

Name of System	Before Intervention		After Intervention	
	Cash (Rs)	Labor (man days)	Cash (Rs)	Labor (man days)
Chaurasi*	373/ha	2/hh (3/ha)	746/ha	3/hh (9/ha)
Manechhango & Pangduri	156/ha	1/hh (4/ha)	-	0.5/hh
Rangdi Khola	-	14/ha	-	2.0/ha
Ghachok	-	1/hh (2.25/ha)	-	1.5/ha
Thuli Besi	-	1/hh (2.6/ha)	-	0.5/hh (1.3/ha)
Bhalutar	-	1/hh (2/ha)	-	1/hh (2/ha)
Rapti-Nawalpur	-	1/hh (2/ha)	270/ha	-
Majh Ko Kulo Baguwa	-	1/hh (8/ha)	-**	1/ha
Malebagar	-	0.5/hh (1/ha)	-	0.25/hh (0.5/ha)
Hyangja	373/ha	2/hh (3/ha)	-	-
Lahachok	-	3/hh (3/ha)	18/ha	1/hh (1/ha)
Bhorletar	-	7/ha	-	-
Handetar	-	1/hh (0.5/ha)	-	-

Note: hh=household. Figures in the parentheses ( ) are the labor equivalent to per hectare of land. *=In Chaurasi system both the number of households and the area under the scheme decreased after intervention. **=Three water monitors paid in kind equivalent of Rs.380/ha annually who not only do the minor maintenance work but also are responsible for allocation and distribution of water.

Data source: Field survey

Table 5: Institutional Arrangements for Water Distribution

System	Mode	Basis	Roles
Chaurasi	Rotation (m,w,s)	Land area	Village Council peon & WUG
Manechhango & Pangduri	Continuous (m) Rotation (w,s)	- Land area	User committee
Rangdi khola	Continuous (m,w,s)	-	User committee
Ghachok	Continuous (m)* Rotation (m**,w,s)	- Land area	Pani pale
Thuli Besi	Rotation m,w,s	Land area	Pani pale (water monitor)
Bhalutar	Continuous (m)* Rotation (m**,w,s)	- Land area (tailend to head)	Pani pale
Rapti-Nawalpur	Continuous (m,w,s-head) Rotation (m**,w,s-tail)	- Land area	Pani pale
Majh Ko Kulo Baguwa	Rotation (m,w,s)	Land area	WUG
Malebagar	Rotation (m,w,s)	Land area	Pani pale
Hyangja	Continuous (m)* Rotation (m**,w,s)	- Land area	DOI water monitor & WUG
Lahachok	Rotation (m,w,s)	Land area (head to tail)	vill. council peon
Bhorletar	Continuous (m)* Rotation (m**,w,s)	- Land area	DOI water monitor & WUG
Handetar	Rotation (m,w,s)	Land area	DOI water monitor and WUG

Note: m=monsoon, w=winter, s=spring, *=water allocation upto branch canals level, **=water distribution at the field level

Data Source: Field survey.

Table 6: Changes in the Command Area Following Intervention

Changes in Area (ha)								
Name of System	Rainfed	Irrigated	Paddy Spring	Paddy Monsoon	Maize	Wheat	Other	Change in CI
Chaurasi*	0	-100	-15	-100	-15	0	-5	45
Manechhango & Pangduri	-12	12	0	0	0	12	2	44
Rangdi Khola	-4	4	8	4	4	6	1	75
Ghachok	-30	30	30	30	5	35	-16	37
Thuli Besi	0	0	5	0	-2	4	1	40
Bhalutar	-16	16	0	6	4	5	-6	29
Rapti-Nawalpur	-75	75	38	75	10	107	-22	119
Majh Kulo Baguwa	-23	23	0	20	-23	20	14.5	60
Malebagar	0	0	3	0	0.1	0.9	-1.5	11
Hyangja	-200	200	75	120	50	75	-5	72
Lahachok	-20	20	10	15	-4	23	-3	41
Bhorletar	-110	110	110	110	108	25	-25	51
Handetar	-130	130	26	130	108	3	-9	11

Note: CI=Cropping intensity. * decrease in cropped area is due to loss of land when the original Chaurasi system was divided into two to create the lower Hyangja system.

Data source: IMC 1990, Laitos et al. 1986, WECS/IIMI 1991, and Field Study.

Table 7: Change in Average Yields of Major Crops Following Interventions

Name of the System	Pre-Intervention Reference Year	Change in Production (MT/HA)		
		Paddy	Maize	Wheat
Chaurasi	1984*	0.25	0.15	0.50
Manechhango & Pangduri	1987	0.55	0.40	0.28
Rangdi Khola	1985	1.2	0.74	0.49
Ghachok	1988	0.18	0.10	0.40
Thuli Besi	1988	0.60	0.17	0.85
Bhalutar	1985	1.29	-0.18	0.06
Rapti-Nawalpur	1986	0.89	0.46	0.30
Majh Kulo Baguwa	1985	1.10	0.10	0.50
Malebagar	1987	0.10	0.14	0
Hyangja	1985	0.75	0.15	0.50
Lahachok	1980	0.25	0.15	0.50
Bhorletar	1978	1.23	0.45	0.95
Handetar	1988**	0.72	0.36	0.45

Note: *=prior to construction of Hyangja by DHM; **=prior to IMP intervention.

Data source: Key informants' interview and Laitos et al. 1987, WECS/HMI 1991, IMC 1989.

Table 8: Irrigable area and cost of improvements to FMIS in Sindhupalchok

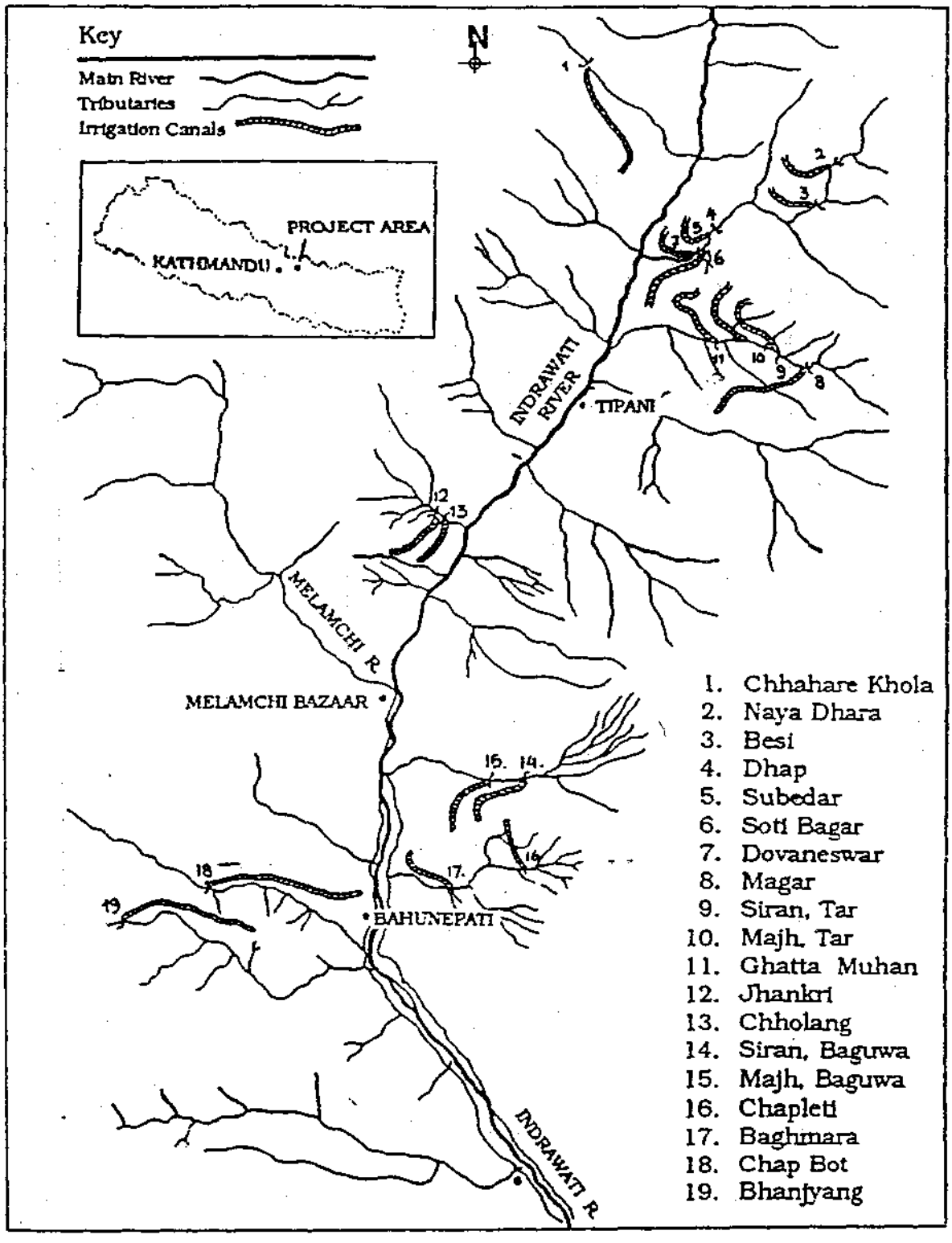
System	Existing command area (ha)	Command area expansion (ha)	Total irrigable area (ha)	Project grant (NRs)	Cost per irrigable hectare (NRs)
Chhahare	126	37	163	126,615	777
Naya Dhara	55	55	110	139,720	1,270
Besi	65	20	85	119,839	1,410
Dhap & Subedar	30	35	65	85,000	1,308
Soti Bagar	19	11	30	150,699	5,023
Dovaneswar	2	10	2	74,807	6,234
Magar	100	43	143	160,805	1,125
Siran Tar	18	6	24	136,789	5,700
Majha Tar	71	16	87	114,321	1,314
Ghatta Muhan	23	10	33	124,321	3,767
Bhanjyang Tar	21	14	35	65,178	1,862
Tallo Jhankri	18	13	31	91,707	2,958
Chholang Khet	23	14	37	116,066	3,137
Chapbot	12	5	17	71,630	4,214
Baghmara	3	6	9	44,433	4,937
Siran Baguwa	18	19	37	57,488	1,554
Majha Baguwa	13	20	33	113,541	3,441
Tallo Chapleti	8	15	23	78,065	3,394
TOTAL	625	349	974	1,871,024	
Average cost/irrigable ha					1,921
Consultant & WECS supervision				1,192,747	
Tools supplied				82,182	
Farmer training				55,000	
Average cost of supervision/ha					1,356
Total cost of improvement/ha					3,286

Source: WECS/IIMI (1990: 29).

Table 9. Area growing irrigated crops in winter season immediately before and after assistance (ha) and head and tail end cropping intensities

Name of the System	Potato		Oilseed		Wheat		Vegetables		Head Intensity		Tail Intensity	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Chhahare	0.2	2.5	NA	NA	NA	NA	0.1	1.6	200	167	200	192
Naya Dhara	NA	NA	NA	NA	NA	NA	NA	NA	200	200	200	200
Besi	NA	NA	NA	NA	NA	NA	NA	NA	200	235	200	235
Subedar	0.2	0.4	3.0	12.0	6.0	15.0	0.2	0.4	250	270	250	270
Dhap	0.2	0.4	3.0	12.0	6.0	15.0	0.2	0.4	250	290	250	250
Soti Bagar	0	0.6	0.2	2.5	6.0	15.0	0.2	0.4	150	215	150	215
Dovan Swar	0	0.5	0	0	1.0	2.0	0	0.2	300	200	300	200
Magar	0.5	2.5	0	1.0	NA	NA	0.5	1.3	190	194	190	200
Siran Tar	0.5	0.8	3.5	3.5	NA	NA	0.2	0.5	255	200	255	250
Majha Tar	0.8	3.0	2.5	3.0	3.0	15.0	0.5	1.5	300	230	300	230
Ghatta Muhan	0.3	0.8	0.6	1.3	10.0	10.0	0.5	1.0	271	290	271	270
Bhanjyang Tar	0.4	0.4	0.5	1.5	3.0	6.0	0.5	0.6	260	300	260	220
Tallo Jhankri	NA	NA	NA	NA	NA	NA	NA	NA	200	270	200	270
Chholang Khet	0	4.6	2.0	3.5	63.0	63.0	0	1.5	220	235	220	220
Chapbot	NA	NA	NA	NA	NA	NA	NA	NA	270	300	270	270
Baghmara	NA	NA	NA	NA	NA	NA	NA	NA	300	300	300	300
Siran Baguwa	2.5	5.5	3.5	8.5	10.0	15.0	0.5	1.5	300	295	300	285
Majha Baguwa	0	5.0	0	7.5	0	20	0	2.0	280	300	280	300
Tallo Chapleti	NA	NA	NA	NA	NA	NA	NA	NA	250	300	NA	300

Figure 1. Project area map showing the names and locations of the 19 systems that received assistance.



Source: WECS/IIMI (1990)