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FARMER-MANABED AND GOVERNMENT-MANAGED IRRIGATION SYSTEMS IN NEPAL

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1. Introduction

The irrigation investment has been recognized as one of the most important factor for agricultural development in Nepal. In 1992, the irrigated area was 1, 091 thousand hectares and accounted for about 50 per cent of the total cultivated land. The latest estimate of irrigable land area is 2,178 thousand hectares.

Farmers have played an important role in the investment of irrigation infrastructure through their religious trust, individual initiatives or community's efforts. Table 1 shows that the irrigation area developed and managed by farmers is 492 thousand hectares. It accounts for 45 percent of the total irrigated area. Agency-assisted and farmer-managed area in GMIS is 332 thousand hectares. The total farmer-managed area consists of three quaters of total irrigated area. The proportion of farmer-managed irrigation area is much higher in mountainous and hilly areas. It was not common that government herself invested or subsidized in irrigation infrastructure. The bureaucracy for the irrigation development was established in 1952. Although the government has given high priority to the public investment for irrigation facilities since the First Five-Year Plan(1956-1961), the public irrigation investment actually increased rapidly during the Fifth Five-Year Plan (1975-1980), which emphasized that agriculture should be the leading sector of the whole economy.

Table 2 shows the extension of additional irrigation facilities by government and quasi-government projects and others during 1974-1991. The facilitated area fluctuated year by year. Annual average increase of irrigated area is about 24 thousand hectares. Most of the irrigated area is located in Terai, the alluvial low land shown in Figure 1, which accounts for 65 percent of total extension area in this period.

The actual irrigated area is much less than the planned target area in public

Table 1. Present Situation of Irrigation Development and Water Use

(thousand hectare)

Region	Mountains	Hills	Terai	Total
Geographical area[1]	5,170	6,140	3,410	14,720
Cultivated area in 1980[2]	227	1,054	1,359	2,640
Irrigated area in 1992	52	264	775	1,091
Classified by management system				
1) GMIS	11	63	525	599
a. Agency[3] managed	1	15	251	267
b. Agency assisted & farmer managed	10	48	274	332
2) FMIS				
Farmer developed & managed	41	190	281	492
Irrigable area	61	374	1,743	2,178

Source : Master Plan for Irrigation Development and DOI Documents, 1993
Note : 1) Including forest land in geogragraphical area.
2) Agricultural Census in 1980
3) Agency is Department of Irigation (DOI)

Table 2. Extension of Additional Irrigation Facilities in Nepal

(Area in hectare)

Year	Topography				Total
	Hills	Terai	(Sub-total)	Not classified	
1974	120	6,600	6,720		6,720
1975	1,541	2,080	3,621		3,621
1976	1,833	18,260	20,093		20,093
1977	500	7,340	7,840		7,840
1978	305	22,292	22,597		22,597
1979	3,314	37,960	41,274		41,274
1980	100	9,275	9,375		9,375
1981	88	11,300	11,388		11,388
1982	525	13,500	14,025		14,025
1983	590	17,125	17,715		17,715
1984	5,522	34,955	40,477		40,477
1985	2,335	7,800	10,135	17,096	27,231
1986	540	15,140	15,680	20,892	36,572
1987	2,085	5,135	7,220	27,382	34,602
1988	17,502	32,527	50,029	3,275	53,304
1989	2,373	11,070	13,443	12,223	25,666
1990	6,418	15,839	22,257	31	22,288
1991	6,977	9,705	16,682	17,151	33,833

Note : In Fiscal Year
Source : Economic Survey, Fiscal Year 1992-1993, His Majesty's Goverment Ministry of Finance 1991

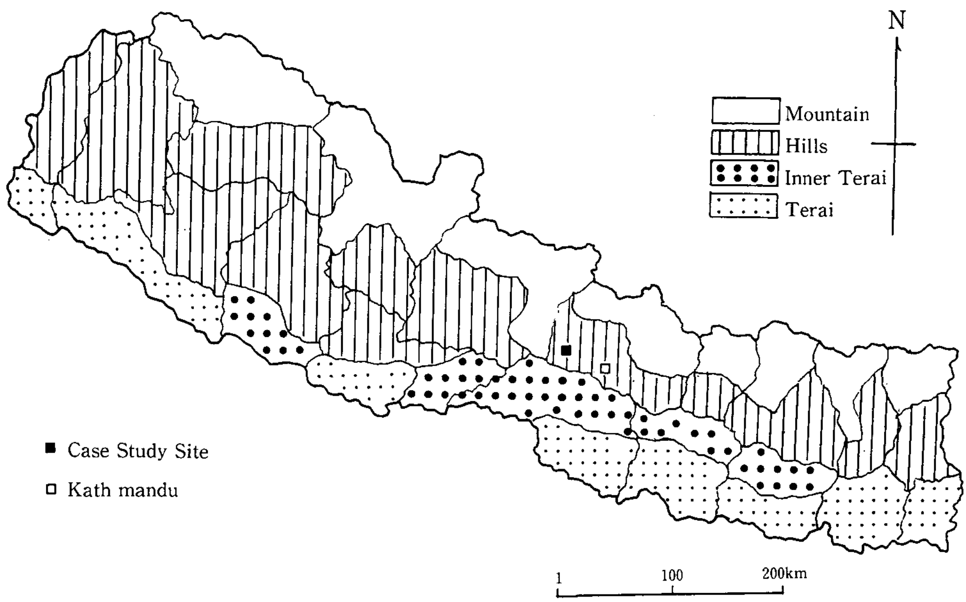

Figure 1. Topographical Region of Nepal

large-size irrigation projects[1], because of the lack of capital, low technology for flood control, lack of funds for maintaining and low level of irrigation management ability to operate irrigation schemes. The management of large scale project does not have enough funds for the maintenance. In some government-managed irrigation systems the water charge covers only 7 percent of the operation and maintenance cost[2]. Even nowadays, the situation has not improved.

Nepal is heterogeneous in its landscape as well as in the sources of water tapped and to be tapped for the irrigation. Therefore, reliance on a single mode of irrigation technique may not be viable from both technical and financial point of view. Because of this fact, economics of different irrigation modes needs to be explored to increase returns and coverage of the area under irrigation. Furthermore, given the topographical constraints and varying degree of water availability, small scale irrigation system has more potential.

The small scale irrigation scheme requires simple technology, low cost and is easy to set up, operate and maintain. Experiences also suggest the greater assurance of people's participation in such projects. From the point of economic return and capital resource used, the scheme has shown better performance than large projects in Nepal. Using ground water, small scale projects have increased rapidly.

Table 3 shows the estimate of irrigated area of small scale projects. The area under the small scale irrigation system is 478 thousand hectares, which accounts for 51 per cent of the total irrigated area. The proportion of small

Table 3. Net Irrigated Area under Small Scale Irrigation Scheme

(thousand ha.)

	Hills	Terai	Total
Surface Irrigation			
Farmer-managed	159.6	206.0	365.6
Government-managed	11.6	13.0	24.6
Ground Water			
Farmer-managed	–	61.0	61.0
Government-managed	–	26.6	26.6
Total	171.2	306.6	477.8

Source : Dhakal, N. P. and Sharma [5]
Note : The Classification of size of irrigation projects by Department of Irrigation in Nepal is different in each topographical regions. The small projects range is up to 50ha in Hills and up to 500 in Terai.

scale irrigation is 77 per cent in the hills and 42 per cent in Terai. The proportion is much higher in Hills than in Terai. About 89 percent of the small irrigation system has been developed by farmers and the remaining 11 per cent by the Government.

Recent research in irrigation investment for agricultural development raised the question on the economic performance of public irrigation investment projects, especially of large size projects. Many researches were carried out from the view point of management efficiency of irrigation projects[3]. The lack of farmers' participation is the main issue. Pradhan[1] and Martin and Yoder[2] make clear the characteristics of farmer-managed irrigation system. Few comparative research surveys have been done to distinguish the difference between farmer-managed and government-managed irrigation system.

The purpose of this paper is to compare the economic performance between farmer-managed and government-managed irrigation systems in small scale projects through farm survey. The strategies for "increasing" economic efficiency of irrigation systems and the role of public sector in small scale irrigation system to alleviate poverty in Nepal are also discussed.

2. Two Categories of Irrigation System and Management Efficiency

Irrigation systems can be broadly categorized into two groups according to the responsibility for their management. One is Farmer-managed Irrigation Systems(FMIS) and the other is Government-managed Irrigation Systems(GMIS), which consists of agency-managed or agency-assisted irrigation system. Farmers are responsible for all management activity in water distribution in the former. Public servant specialized in management takes care of irrigation system with varying levels of farmer participation in GMIS.

There are two different understanding concerning the efficiency of construction and maintenance of irrigation systems. One is that FMIS are more efficient than GMIS. The other is that FMIS are not so efficient in maintenance and that the water control technical level is lower than in GMIS.

The purpose of this case study is to make a comparison between "Intervened" by government agency and "Non-intervened" irrigation schemes. Two sites were selected accordingly[4]. To have a meaningful comparison and to assess the effects of intervention, influences of other casual variables need to be controlled as far as possible. This is especially more important in irrigation. Irrigation systems are complex socio-technical entities and are affected by numerous variables. Indeed, with diverse physical and social contexts, each system tends to be unique. The selection of irrigation sites, therefore, assumes special significance. Such that efforts were to select intervention and non-intervened schemes that are similar in at least the following dimensions: age, size, topography and macro environment (labor supply, market).

A methodology was designed to determine how the intervention scheme differs from the non-intervened scheme in terms of irrigation related socio-economic and organizational dimensions, and to disclose the consequences of the differences on the small farmers. Specifically, the analyses have focused on farm productivity and employment, ownership pattern, farmer participation in irrigation management, social differentiation and marginalization, level of income and income distribution, food consumption and nutritional status.

3. Comparative Case Study

1) System Profile

Both GMIS and FMIS are located in Ward No. 9 at Maidi Village Panchayat in Dhading district of Bagmati zone in Central development region. As a case of GMIS, we selected Pipaltar Irrigation system. It was constructed in 1975 by His Majesty's Government, Department of Irrigation (DOI) with a total cost of Rs 325, 000. The gross command area of the irrigation scheme is 42 ha, owned by 52 households. Net cultivated area within the project is 38.4 ha of land. The irrigation scheme is located at the confluence of the Maidi and Budhi Gandaki rivers with an altitude of 410 meters above the sea level. The irrigation water has been diverted from the Maidi river through a permanent diversion gate and this facilitates year round irrigation. Four water inspectors manage the scheme. They are recruited locally and are paid by the government for their services.

As shown in Figure 2, the FMIS in Majhuwater is located next to the GMIS area. The total gross command area in the FMIS is 21.5 hectares owned by 28 households. Net cultivated area is 18.7 ha. The altitude of the project area is about 395 meters above sea level. The climate of the project area varies from tropical to subtropical throughout the year. The irrigation system has been built in stages with people's participation and contribution in cash and in kind. There

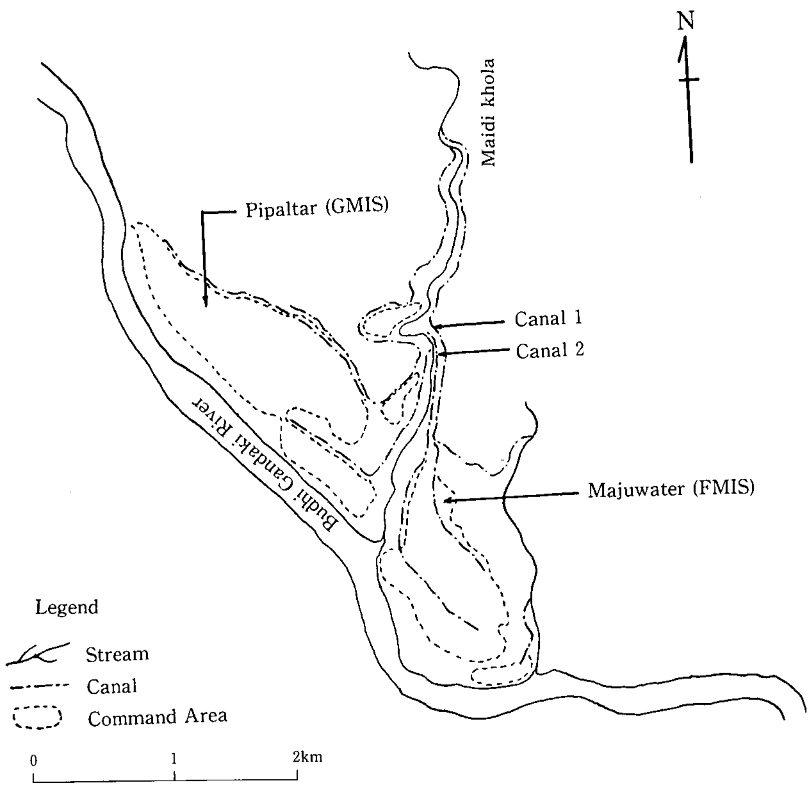

Figure 2. Case Study Area Map

are two irrigation canals in the project area, upper canal (Canal-1) and lower canal (Canal-2). The intakes of both schemes are in separate locations at the Maidi river. A little portion of water is also diverted in the lower canal (Canal -2) from the Hadikhola stream. Although there are two canals constructed by the people themselves, the scheme is considered as one system.

2) Technical Comparison of the Canal Systems

Table 4 shows the technical comparison of the canal system in both systems. GMIS was properly designed and constructed with all necessary permanent structures such as intake structures, crossing structures and lining canal in different places along the canal. The slope and cross-section of the canal have been properly designated providing adequate freeboard and wide canal bank (more than one meter). Since the hired *Aagris* (traditional Canal Cutter) construction, the Farmer-Managed Irrigation System (FMIS) has no structure constructed except HDP pipe siphon near the command area. The FMIS's canal slope is higher than that of the GMIS. The canal cross-section is very narrow and has nominal (less than 10 cm) freeboard. The canal water overflows during

Table 4. Technical Features of Irrigation Systems

	PIPALTAR	MAJHUWATER
Management system	GMIS	FMIS
Command area	42.0ha	21.5ha
Net cultivated area	38.4ha	18.7ha
Intake	Permanent	Temporary
Idle length of canal	1.5km	3.79km (Canal 1, 1.72km) (Canal-2, 2.07km)
Canal gradient	Low	High
Canal size	218 l./sec 1.40sq.m	99 l./sec 0.40sq.m
Canal Density	0.22km/ha	0.37km/ha
Canal lining (Cement boulder)	200m	–
No. of crossing	4	5
No. of Land slides	2	2
Open falls	–	1
Crossing structures	1 super passage	1 HDP pipe system
Structure at land slides	2 gabion boxes	
Other structure	Wall with lined canal, two culverts for trail crossing, one outlet structure at main canal	

Source : Dhakal, N. P. and Sharma [5]

the rainy season. The GMIS has only one water side structure at 1.30 km from the intake. The canal was affected by two landslides caused by canal bank overflow and bed seepage due to both higher discharge from the intake and drainage water flowing from the up-stream hill-slopes direct into the main canal. The main canal has no proper escape structures in different places. The water inspectors do not properly regulate the intake gate.

The canal of FMIS breakes at crossings and weaker portions, because of no structure and narrow canal bank, due to drainage flowing from the hill slope. Beneficiaries of FMIS also close the canal inlet at intake during heavy rainfall while nobody closes the intake gate of GMIS. The canal of FMIS can carry limited flow of water due to its smallness and, therefore, would be less disastrous compared to high discharge carrying canal (higher than design) of GMIS. Proper regulations of intake and installation of water escape structures along the canals would prevent any disastrous effect along the canal and minimize the volume of maintenance works. In GMIS, water has been leaking in some places of the lined canal portion near intake and two landslide portions near the command area. The Irrigation Department has to pay for maintenance of GMIS quite frequently. Lined canal with dry gabion box at landslide portion was installed in 1989 at a cost of about 40,000 rupees. The structure, however, is leaking. No technical reason to maintain at landslide portion is apparent since the problems have been cumulating due to improper use of maintenance fund with poor design and supervision. Other than these, the GMIS is technically sound.

While FMIS has several technical problems, temporary bond intake structure needs frequent maintenance. There are canal breaches at different crossings and loose soil at canal beds. Few small landslides at the middle of upper and lower canal have been causing problems. A main problem arrises at the gully crossing near command area where the siphon structure has been installed. The gully is becoming deeper and deeper due to high erosion caused by rain water. It is interesting that farmers have been maintaining the HDP pipe siphon, though technically it is very difficult work compared to maintenance of GMIS. Upper canal (Canal-1) has two series of 20 cm diameter and lower canal (Canal-2) has a single of 20 cm discharge during peak seasons. Both systems have no structure at distributor canal and command area. The slope of the distribution canal of GMIS is higher and eroding the beds compared to FMIS. There is any drainage structure, therefore the excess water has naturally drained in both systems.

3) Distinct Technical Features and Maintenance of Both Systems

Both FMIS and GMIS have no water users' committee. Beneficiaries by mutual consensus operate the FMIS. These beneficiaries have been irrigating their land on time rotation basis. The time has been fixed on the basis of landslides and soil conditions. While in the GMIS there is no system for the allocation of irrigation water, however, GMIS has four water inspectors (Dhalpa) appointed by the Irrigation Department for operation and maintenance. Practical use of water recorded in paddy cultivation is 3,285 and 5,970 m^3/ha in GMIS and FMIS respectively which are 34 and 68 per cent of net water requirement.

Water inspectors have maintained main canal during the rainy season in GMIS. Farmers participated only three times in the maintenance work during paddy cultivation. The maintenance work in GMIS by the Department of Irrigation and water inspectors as well as by farmers is inadequate. While in FMIS, farmers themselves actively perform minor and major maintenance work regularly by contributing voluntary labor and cash. Per km water loss along the idle canal in GMIS is 40 per cent compared with 32 per cent in FMIS. The water loss along effective canals (at command area) is almost similar in both schemes.

4) Farmers' Profile

The number of households is 52 in GMIS and 28 in FMIS. The population is 294 and 160 respectively. The family number, sex ratio and dependent ratio (the ratio of population aged below 14 and above 60 to 15 to 59) are similar in both systems. The education level is much higher in FMIS than GMIS in which no female is educated. Total literacy rate is 65 per cent in FMIS and 22 per cent in GMIS. Most of the uneducated people represent Kumales who are unprivileged group in the society. The main occupation in both systems is agriculture. Secondary occupations are service, trade and caste based profession.

The nutritional condition is better in FMIS than in GMIS. The people have traditional dietary habits. The calorie intake per day per capita in FMIS is 2,231 cal. and 2,025 cal. in GMIS. The national average calorie per capita is 2,250. The calorie consumed by most of the farmers in FMIS falls within the national average. However, the calorie intake by most of the farmers in GMIS is lower than the national average.

5) Production Efficiency

The average yields of major crops and the total cultivated area are presented in Table 5. The yield of paddy is 2.75 ton/ha in FMIS and 1.74 in GMIS. The national average yield is 2.37 in 1989. The lower yields in GMIS indicate insufficient use of inputs such as chemical fertilizers, improved seeds[5] and water. Fertilizer input in terms of value in FMIS is more than twice of that in GMIS and manure input is more than three times.

Gross margin analyses are given in Table 5. The gross margin is larger in FMIS mainly because of higher returns of main products in FMIS. In FMIS, labor input per hectare of cultivated land is estimated at 215, 177 and 147 man days for paddy, early paddy and wheat respectively. The labor input in GMIS are 152 and 118 for cultivated land and paddy and wheat respectively. The total labor is 7,429 in GMIS and 6,539 in FMIS. Labor utilization is substantially generated by the better irrigation management in the system.

Table 5. Gross Margin Analysis of Crops Production : FMIS and GMIS

(Rupees per hectare)

Crops	Paddy		Early Paddy	Wheat	
	PIPALTER (FMIS)	MAJHUWATER (GMIS)	PIPALTER (FMIS)	PIPALTER (FMIS)	MAJHUWATER (GMIS)
Yield (ton/ha)	2.75	1.74	2.95	1.20	0.79
Cropped area (ha)	11.2	21.8	2.3	5.9	4.6
Labour Input (man days)	215	152	177	147	118
Costs					
Human labour	2,906	2,257	2,823	1,928	1,584
Bullock Power	828	762	887	736	844
Seeds	503	362	553	487	342
Fertilizers	172	65	–	271	50
Mannures	1,451	428	–	1,435	1,159
Total cost/ha	5,860	3,874	4,263	4,857	3,979
Returns					
Main Products	8,250	5,220	8,850	6,000	3,950
By-products	513	324	550	180	119
Total returns	8,763	5,544	9,400	6,180	4,069
Gross margin	2,903	1,670	5,137	1,323	94

Source : Dhakal, N. P. and Sharma [5]

4. Concluding Remarks

As the comparative survey shows, the performance of the small scale irrigation system is better in FMIS than in GMIS. The better performance of the farmer-managed system is because of the active participation of the farmers. In order to improve government-managed system, greater people's participation is needed in the identification, design, operation and maintenance of such projects[6].

Concerning operation and maintenance, the technology employed has to be within the command of the local community. It means that priority must be given to traditional technology followed by such improved technologies. Their skills can be imparted to the local community with relative ease.

Construction and rehabilitation of small scale irrigation system might be more effective to alleviate poverty in Nepal. In this context, Endo [9] proposes "Operation and Management Mini-project" to construct small scale (200–300 ha) irrigation system with international economic aid[7]. After the construction of this system, fertilizer and chemicals should be given to the farmers in the irrigated region. However, for the maintenance and water utilization, monitoring by the aided government agency is necessary.

Notes

1) Large scale irrigation projects performance is low in terms of actual irrigated area after accomplishment. The accomplishment rate becomes lower, while the scale is increasing.

2) Nathan Associates Inc. [3]

3) This is general concern in other developing countries. Kikuchi [4] explains this process as "stage from investment to management in irrigation investment."

4) This survey was conducted by Dhakal, N.P. and Sharma, M and several research associates under the APROSC research project in 1989. A preliminary inventory of information on irrigation of both kinds was obtained from different sources: Department of Irrigation, Farm Irrigation and Water Utilization Division, Agriculture Development Bank, key researchers, and irrigation studies. Prospective irrigation sites were then identified and field visits were planned. Management Specialist/Economist and Irrigation Engineer visited several irrigation sites in the vicinity of Kathmandu. However, the available sites did not meet the specified requirements. Moreover, urban effects were too dominant in those areas. The next visit examined sites along the Prithivi Highway in the districts of Dhading, Gorkha and Tanabu. There too, suitable sites could not be identified. Only hybrid cases of intervention compared with pure intervention (also in a relative sense) could be found. Finally, the team settled on two adjacent schemes in the Dhading district located at some four hours walk from the main road.

5) The international comparative analysis in Asian perspective have been done by Christina and Otsuka[7]. The relationship among new input factors such as HYV adoption rate, agricultural chemicals and irrigation rate and yield per ha in six main rice growing countries including Nepal were examined. Pokahrel[8] reviewed the economic situation of new inputs such as HYV, agricultural chemicals in Nepal.

6) The following recommendations are made for future construction or rehabilitation of such small scale irrigation systems. Selection of schemes should be based on strict economic and technical evaluations after receiving request from the beneficiaries. Interventions for the rehabilitation or improvement of the farmer's traditional schemes should be limited only in the needy areas not in the whole system after receiving requests from the farmers. Once a scheme is selected, or if possible even prior to making a request for a scheme, a water users group should be formed from the real beneficiaries only. If there is a need to move away from the traditional technology, short term training should be provided to members of the users group and the people employed by them. Such training programs would basically relate to exposing the participants to new ways of doing things, which are totally within their own capability both in terms of management and resources.

There should be a monitoring of the distribution of different development schemes in a district, in a village Panchayat and in different wards. Since irrigation projects have in the past often been assigned to areas with locally elite people, socially backward classes residing in those areas are unable to place their demand at the right time and the right place. So monitoring should be established and the places from where no or few project requests are forthcoming should be identified. The concerned authority should submit a catalyst projects and refer them to the appropriate institution.

7) Endo[9], p. 133.

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