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An Institutional Analysis of the Effects of Different Modes of Assistance on the Performance of Farmer-Managed Irrigation Systems in Nepal

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Thousands of irrigation systems in Nepal are managed by farmers themselves. Some of these farmer-managed irrigation systems (FMIS) have been in operation for centuries. It has long been accepted by policy makers and donors that FMIS in Nepal would benefit greatly from the availability of financial capital in order to construct permanent diversion structures to line key parts of a canal, and to undertake other capital intensive work that would improve the technical efficiency of the systems. Consequently, a number of different policy interventions have been undertaken in Nepal that are intended to enhance irrigation performance by improving physical infrastructures of FMIS. Despite the similar objectives of the intervening agencies, however, the consequences of the process of intervention have varied substantially. Given the increasing emphasis on the importance of interventions to improve irrigation performance, it is of great concern to assess why there is a difference in the performance of diverse types of interventions.

In this paper, we first briefly overview the history of irrigation development in Nepal. Then, we describe the institutions involved with the interventions in the irrigation sector development along with the processes of intervention. In the third section, we discuss the rationale of the study and some methodological procedures employed in the study. In the fourth section, we discuss the findings of the study focusing on the factors affecting the performance of irrigation systems in relation to interventions. In the final section, we address the issues that need action by intervening agencies in order to enhance irrigation performance.

Irrigation Development in Nepal

Irrigation development in Nepal appears to be as old as the history of agricultural development in Nepal. Irrigation systems in early times were constructed by local princes, or their officials, as well as by the farmers themselves. Much of the early evidence about irrigation development in the country is found in relation to taxation, land tenure, and customary laws. A feudal system of land ownership prevailed over much of Nepal until 1951. During this era, the country was ruled by the Rana families with fundamental interests in collecting revenue and maintaining law and order. The Rana regime was overthrown following a peoples' revolution, and Nepal began to be transformed from a medieval oriental despotism into a modern nation-state.

Planned modes of irrigation development were initiated in Nepal with the establishment of the Department of Irrigation (DOI) in 1952. Prior to this, irrigation needs in Nepal were largely met by FMIS and a small number of state-supported irrigation projects throughout the country. However, it was only with the implementation of the First Five Year Plan in 1956 that significant efforts toward irrigation development were made by the government. Since then, requisite institutional arrangements from the center to district levels have been provided to the farmers requiring use of natural water resources for irrigation. A series of development plans have been implemented including the ongoing Ninth Plan (1997-2002). A number of policy reforms have been made: Basic Needs -- 1988, Water Resources Act -- 1992, and the Irrigation Policy -- 1992. The irrigation policy of 1992 (revised in 1997) has been instrumental in institutionalizing users' participation in operation and management of irrigation schemes. Two significant action plans that spell out the concept of the Participatory Management program of DOI emerged from the policy; (1) turnover of DOI controlled irrigation schemes to the organization of beneficiaries, and

(2) joint management of large-scale irrigation systems. Implicit in both of these plans is the decentralization of responsibilities that would attract users' participation in operation and management of irrigation systems, thus, reducing the financial burden on the part of the DOI. The DOI, although it has gone through several changes over the years in terms of its nomenclature, is the principal government entity involved in planning, developing, and managing government-owned irrigation schemes in Nepal.

Institutions and the Intervention Process in Farmer-Managed Irrigation Systems

Interventions in the Asian Context

Among the first writings comparing FMIS and AMIS and the processes of intervention and turnover focused on the Philippines (de los Reyes, 1980; Siy, 1982; de los Reyes and Jopillo, 1988; Sengupta, 1991). A major effort to document public intervention in FMIS in the Asian region was made by IIMI by organizing an international conference in Nepal during 1986 (IIMI/WECS, 1987) where the papers addressed research issues related to FMIS and programs to assist them. A common and important theme of the research findings was that "..[b]efore intervening, agencies should understand how the existing farmer-managed systems are organized, the way they carry out irrigation activities, and the environment in which they operate" (Martin and Yoder, 1987:iv). These concerns were reflected from reports on agency intervention programs of the government.

Medagama (1987) described the Department of Agrarian Services' Village Irrigation Rehabilitation Program in Sri Lanka where lack of information and farmer participation in planning inhibited the process of small scale village tank and diversion systems rehabilitation and water management program initiation. Another drawback of the intervention program identified

was that rehabilitation and water management were viewed separately and were undertaken by two different departments which reduced the farmer organization's capacity to manage the system and resulted in greater dependence on the government.

On the other hand, an evaluation of the irrigation component of the Aga Khan Foundation's Rural Support (AKRSP) in Pakistan points out that the program has helped to build effective local institutions that can select and implement development programs (Hussein et al. 1987). They have identified the village organization to be one such institution where members choose the kind of activity they want to be financed. The program strategy included the flexibility where by the members choose the kind of activity they want and are involved at all stages of the program implementation. The policy of paying for local labor as part of the grant and disbursing grants in installments are important features of the intervention approach which according to authors has resulted in an irrigation program that is technically feasible, institutionally sustainable, and economically profitable. The document also consists of papers which deal with interactions between researchers and agency personnel to modify and improve agency intervention programs to assist FMIS. Referring to the earlier focus on Philippines' FMIS and National Irrigation Administration's (NIA) relationship to them, Ben Bagadion (1987) describes how academic research on FMIS influenced Philippines' (NIA) approach to test and modify the intervention process through action research. The important lessons learned from action research on FMIS interventions point to the necessity of farmers' participation in planning and construction, organization development and all stakeholders working together through a learning process approach. Similarly, action research conducted in the northern Thailand has described its importance to increase interaction, communication, and coordination among agency staff, farmer irrigators and researchers (Tan-Kim-Yong, 1987). A series of meetings and workshops involving

these three parties diagnosed problems and suggested solutions. The author proposed using more farmer-to-farmer training and consulting services backed up by a mobile team of professionals.

Another paper examines why agencies have so often not utilized the results of research in Indonesia and have contrasted the macro and micro policy arenas as well as policy analysis and social learning perspectives of research (Korten, 1987). Korten has argued that most issues related to policy intervention in FMIS fall into a micro policy arena and that the social learning research is more appropriate for addressing these issues. The issue of intervention is also related to the question of handing over an entire system back to farmers without making farmers feel the additional burden of expensive operation and management costs. Bruns and Atmanto (1992) in attempting to answer the question of how to turn over small irrigation systems to farmers in Indonesia suggest that participatory design and construction of improvements prepare farmers and irrigation systems for turnover. Trained agency field staff facilitate local participation in preparation and implementation of turnover. Water users register their associations and these associations receive management authority and ownership rights for the entire irrigation systems including headworks. Questions remain, however, as how to determine the role of government in assisting turned over system.

A separate impact survey in the improvement of the performance of small irrigation systems in West Java and West Nusa Tenggara of Indonesia was carried out to obtain a better understanding of earlier programs designed to help develop more effective FMIS (Bruns et al., 1994). The results of this study showed a general pattern of modest but significant improvements in yields and water distribution. The study also points out that yield increases were higher at stimulant program sites with higher level of farmer investment. The study points out, however, that the

impacts of intervention can be greater if sites are carefully selected and planning of improvements focuses on solving problems and contributing to better performance of small irrigation systems.

Interventions in the Nepalese Context

Nepal's agriculture continues to depend largely on rainfall because of inadequate irrigation facilities. Despite the high priority to irrigation accorded in each development plan, recent trends show that the irrigated area of land continues to decrease since 1993 (NPC, 1997). The farmer-managed irrigation systems continue to contribute significantly to the development of agricultural systems in Nepal. More than 70% of the total irrigated area of the country is served by FMIS alone (Gautam et al., 1992). The size of FMIS varies from less than one ha to as large as 15, 000 ha providing the irrigation needs of individual farmers (Yoder and Upadhyaya, 1987). The FMIS, which have performed typically on a self-help basis in the past, most of them now have an organizational basis for carrying out irrigation operation and management activities such as acquisition, allocation, distribution, resource mobilization, and conflict resolution. Regarding performance, the FMIS have performed relatively better than most of the agency-managed irrigation systems (AMIS) (Lam, Lee, and Ostrom, 1994; Lam, 1998).

Given the agrarian economy of Nepal where more than 90% of the population depends upon agriculture (Gautam et al., 1992), the government has regarded improving irrigation management to be of major importance. While the potential of FMIS is substantial, not every FMIS is operating at the most optimal level. Obviously, in many systems there is still much room for improvement. As a result, the government and some international donor agencies have implemented various programs to assist the FMIS in Nepal over the last several decades.

There exist three categories of irrigation management in Nepal. The first category is governed and managed by nonusers (by a government agency), the second is controlled and managed by

water users (farmers) themselves, and the third is classified as joint management aimed at initiating and promoting shared operation and management of large-scale irrigation systems between DOI and water users. In this paper, we will focus primarily on the second category of management and on diverse programs to assist FMISs.

After years of neglecting FMIS, recent policy developments in Nepal have stressed policies which have the avowed purpose of improving FMIS through various forms of intervention. A variety of different agencies using diverse logics have participated in these programs. A description of these agencies and their processes of intervention is presented below.

District Irrigation Office

The District Irrigation Office (DIO) under the Department of Irrigation is mainly responsible for executing the assistance to the FMIS. DIO has intervened in the operation of FMIS by rehabilitating, extending, improving and constructing a new system either through its own implementing staff or by the farmers under their supervision. The extent of assistance is on the basis of financial resource available. Under this mode of intervention, the farmers are not necessarily consulted, when their system has been identified, for a feasibility study carried out by consultants or DOI technicians. Construction work is generally undertaken by contractors and no attempts are made to form a users' committee. After the completion of construction work, arrangement for operation and management are made with outside contractors.

Ministry of Local Development (MLD)

The Ministry of Local Development (formerly Ministry of Panchayat and Local Development) allocated funds for village level projects through the then District Panchayats (now District Development Committees). The farmers then could request the District Panchayats for approval of projects. Once a project is approved, the district administrative office would ask the farmers to

form a construction committee and a formal contract would be signed between the committee and the district administration. After release of initial 50 percent of the estimated cost, construction work would start under the supervision of the district technical office. Additional funds are released based on the progress of the work as certified by the technicians. After the project was completed, the construction committee was dissolved and a users' committee usually formed.

Multi-service Agencies

Besides the above agencies, other agencies were also involved in irrigation development in the country. These included Farm Irrigation and Water Utilization Division (FIWUD) under Department of Agriculture, and several non-governmental organizations such as the International Labor Organization (ILO), United States Agency for International Development (USAID), and the Hill Food Production Project. These agencies undertook projects requested by farmers in a collective manner through village assemblies and those influenced by political lobbying. Usually, the construction work was carried out by forming a construction committee which is converted into users' committee after the project was completed. The completed project was handed over to the user committee for operation and management. Interventions by most of these agencies aimed at overall agricultural development inclusive of irrigation development.

The Irrigation Sector Support Project

There are two major investment projects under the Irrigation Sector Support Project (ISSP): the Irrigation Line of Credit (ILC) and the Irrigation Sector Project (ISP). The Department of Irrigation operates mainly through these projects.

The Irrigation Line of Credit (ILC) program, launched in 1989, received technical assistance from the United Nations Development Program, and loan assistance from the World Bank in 34 districts of the Western Development Region, which utilizes water exclusively from rivers and

streams. The Irrigation Sector Program (ISP) was started in 1989 to facilitate the government's efforts in terms of investment in irrigation development in a sectoral approach. The program was initiated with loan assistance from the Asian Development Bank. The program aims to provide irrigation facilities in 35 districts of the Eastern and Central Development Regions of Nepal.

The ISSP runs mainly three categories of programs: (1) support of farmer-managed irrigation systems in the private sector, (2) turnover of government-managed irrigation schemes to an association of beneficiaries in the private sector, and (3) participatory or joint management of large-irrigation schemes.

In the private sector, the ISSP program provides irrigation assistance in a 'demand-driven development' concept for field implementation. This means that the program entertains only those projects that are initiated and requested by water users. For this, a formal request from an organized group duly signed by more than 66% of the potential beneficiaries, forms the main basis upon which the agency initiates activities to implement a project. This concept is practically followed both in the ILC and ISP projects. The projects are approved after carrying out a preliminary feasibility survey by a team of technicians from District Irrigation Office (DIO) and the beneficiaries. The projects that are approved are implemented with the involvement of DIO. Such projects are implemented with the concept of participation of the organized water users. The water users are involved in all stages of irrigation development, from project selection to design and construction activities including disbursement of funds for field operations. In terms of cost sharing, water users are required to bear 1 to 5% cash plus contribute labor equivalent to 6 to 20% of the total cost. The balance of the cost is met by the ISSP. One of the basic tenets is that the implementing agency ensures at least 20% of the executive members of the organized beneficiaries are females from the community. Upon the completion of the projects, the irrigation

systems are formally handed over to the organization of water users for operation and maintenance. It is the effectiveness of operation and maintenance by organized water users that determines the long-term sustainability of irrigation systems, rather than the amount of the initial investment of the government.

The program's activities include rehabilitation and improvement of farmer-managed irrigation systems in the command area, construction of new small and medium-scale gravity flow irrigation schemes that serve irrigation needs of a significantly large proportion of the irrigated areas in the country. The program also includes strengthening the institutional capacities of DIOs and Regional Irrigation Directorates to support and institutionalize the participatory irrigation development and management programs under ISSP.

Water and Energy Commission Secretariat and the International Irrigation Management Institute[1]

The Water and Energy Commission Secretariat (WECS) of Nepal, with assistance from the Ford Foundation and the International Irrigation Management Institute (IIMI), initiated an action research project in 1985 in the Indrawati watershed basin in the Sindhupalchok district. The project objectives were to establish low-cost procedures for identifying the needs of farmers in a larger area, and to develop and test methods for delivering assistance that improved the capacity of FMIS in Nepal (WECS/IIMI, 1990:12). Researchers associated with IIMI identified 23 irrigation systems in the watershed where expansion of the system was feasible, and existing users of the system were initially willing to allow expansion and to accept additional farmers as members of a water users' Organization (Lam and Shivakoti, 1992). The farmers in these systems

[1]Since November 1997, IIMI has changed its name to the "International Water Management Institute (IWMI)".

were involved in all aspects of the planning and operation of the project. After extensive discussions the farmers from 19 systems agreed to participate. The farmers knew from the beginning that the budget to be used to help support expansion would be modest, and that the farmers themselves would need to do most of the construction themselves. The farmers were asked to list improvements that they desired and to make a rank order priority of them. The improvements that were most necessary for the expansion of the system, but difficult for farmers to do without financial assistance, were to be given highest priority. The farmers were then assigned a firm budget for the project and were told, that if they could save money on the first priority work, they could use it for the second or even the third priority work. The intention was to create a positive incentive for the farmers to use project funds with the greatest of care.

Another important aspect of this project was "farmer-to-farmer" training. Groups of farmers from the 19 systems were taken to farmer-managed systems that were known to be very efficient and well organized (Yoder, 1991). The host farmers from the effective systems described the ways they had dealt with core organization issues such as labor mobilization for routine or emergency maintenance, water allocation and distribution, conflict management, and the structure of their organizations (N. Pradhan, 1987). The trainee farmers also were shown the constitution and the minutes and attendance records taken at meetings and at sessions where labor was mobilized to maintain or repair the systems. Thus, in addition to this intervention being demand driven, the WECS/IIMI intervention paid very serious attention to developing incentives that would involve the farmers in making very good long-term investments in their own systems, and providing them with the kind of training they needed to improve their own organizational structure and operating procedures.

Agricultural Development Bank of Nepal

Various donor agencies have also implemented intervention programs. Among these programs, the Agricultural Development Bank of Nepal (ADB/N) has demonstrated the possibility of supporting institutional development through credit and subsidy programs for the development of small-scale irrigation facilities. The ADB/N has also collaborated with CARE/Nepal to provide a subsidy in the form of material support to several irrigation systems. According to P. Pradhan, (1989:2), ADB/N has supported the development of about 106,000 hectares; these systems are mostly users controlled. The ADB/N's program includes surface irrigation, shallow and artisan tube wells, installation of a low-cost manual lift, and mechanical irrigation pumps. ADB/N started the Community Surface Irrigation Project (CSIP) as a regular program on the basis of community participation since 1983/84. As of 1993/94, the CSIP covered 14,834 ha of land under 288 surface irrigation schemes in 30 districts in the hills and 17 districts in the *Terai*, respectively. Presently, like in the case of government-sponsored irrigation programs, the ADB/N's irrigation program also operates fully on a demand driven mode. In addition to the formal request, the beneficiaries are also required to submit land title certificates as collateral against the loan to be advanced to them.

As a process, ADB/N intervention starts with project identification through a Small Farmer Development Project Baseline Survey. The perceived needs of the farmers are then prioritized. When irrigation gets top priority, ADB/N conducts a feasibility study and, if feasible, an irrigation group is formed or identified if it already exists. The group is expected to contribute 10% of the cost as labor, 60% is funded as a government grant, and ADB/N provides 30% as a loan to the group. Technical assistance is provided by ADB/N and construction is usually carried out by the farmers, or if there is no local expertise, small-scale contractors are used. On completion, ADB/N

hands the project over to the irrigation group, but continues to provide technical services, if needed.

Rationale and Methodology

As described in the previous section, there have been a wide variety of differently designed interventions implemented by diverse programs within government and other agencies frequently supported by donor agencies. All of these programs have the intention of increasing agricultural productivity by developing and improving existing farmer-managed irrigation systems. However, the efforts of the government of Nepal to assist FMIS have not been uniformly successful. While some interventions have enabled farmers to maintain their irrigation systems at a lower cost and increase their overall efficiency, others had a damaging effect. The organizational effectiveness of some irrigation institutions has declined; farmers who used to maintain their systems regularly no longer do so; disputes over water rights have increased; and, in some instances, the total land irrigated and the yields obtained have decreased after interventions that were intended to increase them (Shivakoti et al., 1992).

The above variance in results is a puzzle that needs to be resolved. It is important to learn from past successes as well as failures so as to improve future policies. It is thus important to analyze and understand how various modes of intervention intended to improve the performance of farmer-managed irrigation systems could result in varying levels of performance. What could be the physical and institutional factors that affect the performance of irrigation systems? Are there systematic differences in how diverse intervention strategies are initiated and planned? In general, what lessons can be learned to increase the probability of successful future interventions? These are some of the questions we have addressed in this paper.

We have identified six broad sets of interventions that have had more than a few instances in recent history in Nepal. These six are: District Irrigation Office, Ministry of Local Development, Irrigation Sector Support Project (ILC and ISP), Water and Energy Commission Secretariat, Agricultural Development Bank of Nepal and Multi-service Agencies. These interventions vary substantially in regard to the extent of farmer participation in their design and implementation.

We speculate that there is a difference in the success of interventions that are initiated by the water users themselves as contrasted with those interventions that are carried out without fundamental consultation with the farmers. Among the types of interventions discussed above, the program that involved the farmers to the greatest extent was the one that was undertaken by WECS/IIMI. Most of the interventions organized by the Agricultural Bank of Nepal with CARE funding and the ISSP program also relied heavily on farmer involvement in the initial planning and implementation of the intervention. On the other hand, many of the DIO, MLD and multi-service programs are strongly "supply driven". Thus, we would categorize these six types of interventions into three broad groupings: (1) interventions which were primarily demand-driven approach with a high level of farmers' participation, and (2) interventions which were primarily demand-driven but with a moderate level of farmers' involvement, and (3) interventions which were primarily supply-driven by the agency undertaking and/or with a low level of farmers' involvement in the effort to improve irrigation system. In the first group we would place the WECS/IIMI project. In the second group, we would place ADB/N and ISSP. In the third group we would place DIO, MLD and Multi-service agencies. We would expect to see that the more demand driven programs to be somewhat more successful than the supply driven intervention programs.

We have examined how various physical, social and institutional variables affected the performance of different types of FMIS depending upon the type of intervention they have received, as well as FMIS that have never received an intervention. We have used the information in the Nepal Irrigation Institutions and Systems (NIIS) database that has been developed by colleagues associated with the Irrigation Management Systems Study Group at the Institute of Agriculture and Animal Science, Tribhuvan University, Nepal in collaboration with colleagues at the Workshop in Political Theory and Policy Analysis, Indiana University.

The Nepal Irrigation Institutions and Systems (NIIS) database has been developed over a substantial period of time. The first systems coded in this system included all of the case studies written about individual irrigation systems in Nepal that could be found by scholars at the Workshop in Political Theory and Policy Analysis. We located 130 case studies that had substantial information about the physical structures and social organization of irrigation systems and coded as many variables as possible for 127 of these from written records. Three cases turned out to have insufficient data for final coding (see Ostrom and Benjamin, 1991). Because of the problems associated with missing variables, we asked the Ford Foundation to support an effort to visit many of these systems to complete the missing information and to check on the information contained in the original coding. At the end of this process, we had identified 150 systems. An initial analysis was conducted by Wai Fung Lam which showed that FMIS in Nepal performed at a substantially higher level than AMIS (see Lam, 1998). We were urged to add to the original NIIS database so as to address several competing hypotheses related to the age and size of the systems. With the additional systems added, the original findings were sustained (see Appendix C in Lam, 1994).

During the years since 1993-1997, colleagues at IAAS in Rampur have added 86 additional systems. One group of systems was located in the Chitwan district and an effort was made to collect information about these systems before they received help and assistance from the East Rapti Irrigation Project.

Consequently, we now have information about 231 systems spread out across 29 districts of the 75 district in Nepal. For 24 of these systems, we have information collected at two different time periods[2] In this analysis we have utilized the data collected at the second time period. The irrigation systems coded in the NIIS database is not a "random sample" of the irrigation systems in Nepal. No one knows how many irrigation systems there are and no one has any kind of list that could be used as an initial sampling frame. To our knowledge, however, this is the largest collection of information about irrigation systems in one country that exists anywhere in the world. We initiated this project with the hope that we could learn a great deal from any effort to do a quantitative, rather than a strictly qualitative, analysis of the factors affecting irrigation system performance. If it were to become logistically and financially feasible to draw a random sample of irrigation systems in Nepal (or elsewhere), we would be the first to support such an effort.

[2]Of these, 5 systems are located in Dang District and were assisted by the ADB/N, and19 systems are located in Sindhu Palchok District and were part of the WECS/IIMI intervention described above. The written case descriptions for these systems were so detailed and accurate that when we visited these systems we coded them as of the second visit rather than confirming the original data. That gave us an opportunity to check out the general validity of the first set of coding and the capacity to compare the structure and performance of these systems before and after the WECS/IIMI intervention (see Lam and Shivakoti, 1992). We plan to visit these systems again in 1999 so as to see how they have developed 12 years after most of the interventions were completed.

Examining the Performance of Diverse Types of Interventions[3]

As discussed above, there are three different types of strategies adopted by agencies involved in the intervention of the114 farmer-managed irrigation systems included in this study. The period of intervention described here dates back to as early as 1957 by the Ministry of Local Development with the most recent ones in 1997. About 21, 40, 28 and 11 % these irrigation systems are located in the hill-river valleys, hills, *Terai*-river valleys and *Terai*, respectively. The area of farmland served by these systems varied from a minimum of 4 to a maximum of 9816 hectares, with the average area of 263.4 hectares. The total canal length of these systems varied from 0.425 to 79.5 kilometers, with 7.1 kilometers as the average length. Most (about 76%) systems lacked access to alternative sources of water supply. In terms of age, there were systems built as early as in the 16th century with recent ones built in the late 1990s. The number of water users varied from 5 in a particular system to 2500 with the average of 207 members. In general, water users were quite heterogeneous in regard to socioeconomic status. Except for the WECS/IIMI, which had projects only in the hills, all other agencies have intervened in irrigation systems located in the hills as well as *Terai*. Each irrigation system has one Water Users Association (WUA) which is entrusted with allocating and distributing of water, conflict resolving and maintaining canals and headworks, and so on. Obviously, given the heterogeneous socio-physical attributes of the irrigation systems included in the study, the management task of the agencies involved in the intervention program will have differed considerably.

Since we do not have before-after data for most of the 114 FMIS which received some external assistance, we compare these systems with the performance achieved by two other types of systems: (1) FMIS which have not received external assistance and (2) AMIS which have been

[3]The discussion on the concept of performance draws heavily upon Lam (1998).

constructed and operated by the Department of Irrigation. These two comparison groups give us different information. The FMIS provide a comparison with a group of irrigation systems which are entirely demand driven. All improvements to these systems have been designed and undertaken by the farmers themselves. The AMIS are entirely supply driven since the DOI determines where they will be constructed, how they will be operated and the level of maintenance supplied.

The discussion of performance of irrigation systems includes three dimensions. These are: the physical condition of irrigation system, water delivery, and agricultural productivity as three coherent parts of irrigation performance. These three dimensions are not additive, nor can any one of them be completely substituted by any of the others. Rather, they are interdependent with one another. An irrigation system cannot be said to perform well if its canals are well-maintained, but its water delivery is unsatisfactory. Similarly, the performance of an irrigation system is problematic if, with effective water delivery, farmers are not able or encouraged to use the water efficiently to increase agricultural productivity.

The comparison among the intervening agencies has been made in relative terms with respect to the performance of irrigation systems that have undergone one or another mode of intervention.

Physical Condition of Irrigation Systems

The physical condition of irrigation systems pertains to whether the system provides a sound technical basis for effective water delivery. This dimension consists of two aspects. The first is the technical efficacy of irrigation infrastructures. Technical efficacy of a system is the capacity of a system to deliver water from headworks to outlets. It is concerned with whether or not the infrastructure is well maintained. A technically efficient system is one which minimizes water loss

in the process of delivery (Sparling, 1990). The technical efficacy of a system is determined by its physical characteristics; such as types of headworks, terrain, canal lining and so on. The second aspect is the economic efficacy of maintaining irrigation systems. The focus in this instance is on the cost-benefit calculus of maintenance. In many rural areas of Nepal, resources are often scarce and the time, effort and money spent on system maintenance could mean a significant investment. The more resources farmers use in maintenance, the less is left over for agricultural activities. This then has a direct bearing on farmers' incomes.

The result from the analysis of the condition of irrigation systems under various interventions is presented in Table 1. This Table shows a substantial degree of variation in the overall condition of irrigation systems. The physical structures of the WECS/IIMI assisted systems outperformed all the systems supported by other agencies. Nearly two-thirds of the systems were rated as in excellent physical condition for the basic construction design of the system. No other interventions came close to this. It must be noted that all the WECS/IIMI assisted systems had temporary (brushwood or sand stone) type of headworks and were partially lined. In contrast, a majority of the FMIS which had received external support with a moderate level of farmers' participation or with a low level of input were in a moderately good or poor condition. Many of these systems did have had permanent type (gabion boxes, concrete weirs, barrages etc.) of headworks.

It is noteworthy that the AMIS, about 83% of which had permanent headworks, had less than one-tenth of the systems that were excellent in terms of physical condition. It is also the case, as well be shown later (Table 5), that the AMIS were less able than other types of irrigation systems to get adequate and predictable water to the tail even though most of them have permanent headworks and are fully lined. Lam (1998) reasons that the existence of permanent headworks

often exacerbates the asymmetries between head-enders and tail-enders, thus leading to low levels of performance of systems. In such an asymmetrical situation, the tail-enders are not likely to take a good care of the physical structures of the systems, nor follow the rules concerning water distribution and allocation.

As shown in Table 2, the technical efficiency of systems, a majority (about 60%) of all of the systems were found to be only moderately efficient. This implies that, given the other constraints the farmers face, in most systems there is a considerable loss of water between the head-end and the tail-end of the system. In terms of economic efficiency too, the performance of most systems was found to be just moderate. An economically efficient irrigation system is one where the cost of operating and maintaining the system is less than the benefits obtained from operation and maintenance.

When looked across various categories of intervening agencies, the WECS/IIMI supported systems appeared to be technically and economically much more efficient as compared to others (Table 2 and 3). On the other hand, a higher proportion of the systems with a relatively low levels of farmers' involvement in the irrigation projects appeared to be technically and economically less efficient.

The WECS/IIMI strategy of farmer-to-farmer training programs during the annual general meeting of Water Users Association (WUA) may have contributed to higher level of physical performance shown by the irrigation systems. The training program aimed at improving the capabilities of water users for operation and maintenance of systems, after handing over of the project to the users. In most of the other intervention programs, the training component was lacking or those who did provide training did not organize this program in an effective manner. Keeping a system in good condition requires intensive labor mobilization. In Nepal, manual labor

is extensively utilized in the operation and maintenance of irrigation systems. But in about one-third of the total irrigation systems, the rules and regulations pertaining to labor mobilization was found to be poorly enforced. When the rules are not well enforced, the tendency for water users to avoid contribution of voluntary labor in the operation and maintenance of systems become more prevalent. Similarly, WUAs in about one-third of the total irrigation systems were not strictly enforcing the rules and regulations with regard to monetary sanctions for failing to attend labor days. The mere existence of a rule is futile, if it is not well enforced and followed. Therefore, as Tang (1992) suggests, it is essential that the irrigators discipline themselves to maintain an irrigation system in good condition. The relatively outstanding performance of the WECS/IIMI systems could also be attributed to the effectiveness of the institutional arrangement of the WUAs, as well as to the intervening agency's efforts to improve the organizational structure and operating procedures.

It is interesting to note that a greater proportion of the AMISs operated without farmers' participation were technically as well as economically inefficient as compared to the externally assisted systems with some level of farmers' involvement as well as the systems exclusively managed by the farmers themselves (Tables 2 and 3). This situation can also be viewed as a reflection of the rule-ordered relationships with regard to governance structure and institutional arrangement. Lam (1998) argues that an AMIS might have all kinds of rules to be employed. Yet, these rules are perceived by water users on some AMIS as commands imposed by irrigation officials, which are to be worked around instead of to be worked by. When this happens, such a set of rules is not likely to produce productive working relationships among the water users. On the other hand, in an FMIS the rules are made by the farmers collectively. This can facilitate the development of shared norms that emphasize the importance and viability of self-reliance and

cooperation in dealing with collective action. Lam (1998), in his study, found the involvement of farmers more likely in FMIS, as compared to their counterparts in AMIS, in entrepreneurial activities (such as crafting rules, discussion of issues of common concerns, activities that facilitate the organization of various collective actions concerning irrigation governance and management) in an attempt to achieve coordinated strategies pertaining to operation and maintenance of irrigation systems.

Water Delivery

Water delivery is concerned with appropriation problems of water distribution and allocation. The dimension of water delivery captures not only the adequacy of water delivery, but also such elements as equity and reliability. Water adequacy refers to whether an irrigation system is able to make enough water available to meet the irrigation needs of farmers. Often, farmers have seasonal variations in terms of demand for water. Thus, adequacy should be measured in terms of needs of farmers keeping in view the seasonal variation in the demand for water.

Equity pertains to the allocation of available water in an equitable manner so that farmers who need water to cultivate their land are enabled to do so more effectively. In other words, the allocation of water in such a way that farmers, irrespective of whether they are head-enders or tail-enders, would receive their fair share of water.

Reliability refers to the predictability and timeliness of water delivery to farmers. Predictability implies the knowledge about fluctuation of water flow in advance, and timeliness means that the schedule of water delivery is appropriate in terms of the needs of the farmers.

The data in Table 4 illustrate that only less than half (about 44%) of the total systems seemed to meet the irrigation needs of tail-enders, with sufficient and predictable amounts of water. When viewed by the type of intervention, a big chunk (78.9%) of the WECS/IIMI assisted systems

delivered sufficient amounts of water, even to the tail-enders as per the allocation schedule known to them. The water distribution pattern did not seem to be adequate in almost 70% of the systems that had a low level of farmers' involvement. In 15% of the systems, water was both inadequate and unpredictable. A similar severe problems can be noticed among the AMIS where more than 85% of the systems appeared to deliver insufficient amounts of water to tail-enders (and 36% of the systems deliver both insufficient and unpredictable amounts to the tail enders).

It might be argued that while the lofty objective of the intervening agencies to expand service area has been achieved, the effective water delivery problem which is related to institutional arrangements of irrigation governance and management still remained unsolved. In fact, the seasonal variation in the availability of water also affects the distribution pattern at the head and tail-ends of a canal. In all the systems, somewhat more water was available at head-ends round the year, as compared to tail-ends. We have also observed many irrigation systems where the water users had conflicts among themselves over the issue of water allocation and distribution in the absence of clearly defined organizational rules and regulations related to systematic allocation and distribution of irrigation water. Tang (1992) has pointed out that water allocation is a major source of conflict in irrigation and this problem has to be solved by some form of institutional arrangement.

The information presented in Table 5 reveals a variation in distribution of irrigation water across the systems under all intervening agencies. On the whole, in about 24% of the systems some farmers were either deprived of their fair share of water and/or given a lower priority in the of distribution of water. This problem was more prominent in the AMIS, where about 56% of the systems encountered such situations. In contrast, a minimum of the ADB/N and ISSP assisted systems faced such problems. In this particular instance, only10% systems were in a

disadvantageous position. The situation where farmers were relegated to a disadvantageous position as a consequence of inequitable distribution persisted despite the existence well-defined individual rights to appropriate irrigation water from the resource. The condition of inequality of was more conspicuous in a supply-driven mode of intervention, as compared to demand-driven interventions. This implies an ineffective institutional arrangement on the part of the irrigation governance in the matter of equitable distribution of water. Ii is highly likely that inequality lead to collective inaction owing to lack of enough incentives to cooperate on the part of downstream farmers, while head-end farmers enjoy more benefits.

Agricultural Productivity

The dimension of agricultural productivity connotes the productivity of the farmland served by a particular irrigation system. Agricultural productivity has been assessed in terms of the cropping intensity. This places emphasis on the intimate relationships between the collective action of irrigation governance and management, and the local communities which the irrigation systems are supposed to serve. From the perspective of farmers, a high-performance irrigation system should be one which can increase their agricultural productivity and, hence, improve their livelihood. Although achieving lofty goals such as national economic development might be an important concern for the government it is not likely to be the major concern of farmers when they contemplate undertaking collective action with their peers at the local level.

As revealed by Table 6, the pattern of productivity suggests a substantial variation in the cropping intensities across the systems under different modes of intervention. The cropping intensity varied from a lowest of 100% to a highest of 300% at both head and tail-ends of irrigation systems under various modes of intervention. However, the average cropping intensity at the head-end was a little higher (238.28%) than that of the tail-end (230.23 %). When

compared the cropping intensities among various intervention modes, the WECS/IIMI assisted systems excelled all systems. On the other hand, the AMIS had the lowest performance. The difference in the cropping intensities at two different canal ends might be due the fact that the upstream is generally more likely to have reliable and timely access to water as compared to the downstream. As mentioned earlier, many irrigation systems in this study also faced this sort of situation.

The comparison of externally assisted systems with the AMIS and FMIS showed a relatively higher performance in those systems had at least some degree of farmers' participation. The lower agricultural productivity of the AMIS could be a reflection of the overall poor physical condition of irrigation systems and the pattern of water distribution. As we earlier discussed, a relatively higher proportion of AMIS had a poor overall physical infrastructure as well as faced an inequitable pattern of water distribution, thus hampering the users at the tail-end.

Since many efforts to "assist" irrigation systems attempt to increase the size of the command area, we wanted to examine the impact of the size of command area on cropping intensity. We performed a correlational analysis of 108 agency assisted irrigation systems. The analysis resulted in a negative relationships between the area under irrigation and cropping intensity. More specifically, cropping intensity at head ($r= -.215$, $p=.05$) was significantly but negatively related to the service area covered. This implies that while the agencies are concerned with achieving their target of increasing the command area, they should also pay an equal attention to the equitable distribution of water among water users. This is because lack of symmetries in the water allocation and a distribution pattern may lead to deleterious effects on the agricultural productivity. Further, disadvantaged farmers often show a reluctance to be involved in the regular

operation and maintenance of physical infrastructures of irrigation systems which require extensive manual labor.

Concluding Remarks

The study has shown the diverse types and levels of intervention resulting in the disparity of performances of irrigation systems. This disparity in performance has a bearing on the effectiveness of interventions. While one particular mode of intervention has contributed substantially to the improved performance of irrigation systems, others have a somewhat poorer record. In general, the overall performance of interventions in irrigations systems in a demand-driven mode with a relatively higher level of farmers' involvement in irrigation projects has been better than those assisted in a supply-driven mode with moderate or low level of farmers' participation. In particular, the WECS/IIMI example provides an excellent model of intervention that appeared to have paid equal attention to both physical systems as well as social systems of WUAs.

These examples provide useful information about the potential of externally assisted irrigation schemes implemented in various modes and the factors that affect the performance of irrigation systems. Most intervention projects focus more on the physical infrastructure of irrigation systems ignoring the social infrastructure. It is a fact that in the improvement of any irrigation system the key role of a physical infrastructure cannot be denied. However, the social and institutional aspects have no less important role to play in the irrigation systems that are to be managed collectively on an organizational basis. In the irrigation schemes implemented without consultation of the potential water users, it is very likely that the users tend not to contribute voluntary labor in the operation and maintenance tasks to be performed on a collective action basis. The irrigation systems that require collective action on a regular and organizational basis,

tend to succeed when programs are implemented in a genuinely demand-driven style with the concept of people's participation.

Given the subsistence nature of farming and financial constraints on most farmers in Nepal, 'intervention' as a major strategy adopted by the government to improve the performance of farmer-managed irrigation systems is a necessary condition. However, as indicated by this study, focusing more emphasis on the improvement of physical infrastructures is not sufficient. This necessitates a need for a more comprehensive approach, encompassing the development of both physical capital as well as social capital, that provide complex systems of institutional arrangements and conventions for regulating individual rights to use irrigation water. Therefore, mere improvement of physical systems cannot enhance the performance of irrigation systems. Thus, the task of irrigation development goes far beyond the mere construction or rehabilitation of physical systems. The involvement of potential beneficiaries at all stages of irrigation development is inevitably important in order to manage social conflict and growing perceptions of social inequality in the allocation and distribution of irrigation water. In this regard, Uphoff et al. (1991) insightfully point out that focusing on irrigation management should not be considered only as a socio-technical enterprise but also as an organizational-managerial one. Viewed from this perspective, the organizational effectiveness of WUAs is indispensable to the management of irrigation systems. Therefore, the improvement of physical infrastructures together with the development of social infrastructures should be an area of macro-reform that the national government, including intervening agencies, should take into consideration as a policy. This is because while water users' associations represent a major means of improving irrigation management, by expanding farmer participation and responsibility, they are not always or everywhere effective (Uphoff, 1986).

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Table 1 Relationship between Intervention Type and Physical Condition of Irrigation Systems

Types of Intervention	Physical Condition			
	Excellent	Moderately Good	Poor	Total
Intervention with high levels of farmers' involvement (WECS/IIMI)	12 (63.2)	7 (36.8)	0 (0.0)	19 (100.0)
Intervention with moderate levels of farmers' involvement (ADB/N and ISSP)	9 (13.6)	45 (68.2)	12 (18.2)	66 (100.0)
Intervention with low levels of farmers' involvement (DIO, MLD and Multi-service agencies)	6 (22.2)	16 (59.3)	5 (18.5)	27 (100.0)
FMIS without intervention	6 (8.7)	54 (78.3)	9 (13.0)	69 (100.0)
AMIS	4 (8.4)	22 (45.8)	22 (45.8)	48 (100.0)
Total	37 (16.2)	144 (62.9)	48 (20.9)	229 (100.0)

Note: The figures in parentheses indicate percentage.

Table 2 Relationship between Intervention Type and Technical Efficiency of Irrigation Systems

Types of Intervention	Technical Efficiency			
	Highly Efficient	**Moderately Efficient**	**Inefficient**	**Total**
Intervention with high levels of farmers' involvement (WECS/IIMI)	14 (73.7)	5 (26.3)	0 (00.0)	19 (100.)
Intervention with moderate levels of farmers' involvement (ADB/N and ISSP)	23 (35.4)	38 (58.5)	4 (6.2)	65 (100.0)
Intervention with low levels of farmers' involvement (DIO, MLD and Multi-service agencies)	6 (22.2)	19 (70.4)	2 (7.4)	27 (100.0)
FMIS without intervention	9 (13.0)	51 (73.9)	9 (13.0)	69 (100.0)
AMIS	6 (12.5)	24 (50.0)	18 (37.5)	48 (100.0)
Total	58 (25.4)	137 (60.1)	33 (14.5)	228 (100.0)

Note: The figures in parentheses indicate percentage.

Table 3 Relationship between Intervention Type and Economic Efficiency of Irrigation Systems

Types of Intervention	Economic Efficiency			
	Highly Efficient	**Moderately Efficient**	**Inefficient**	**Total**
Intervention with high levels of farmers' involvement (WECS/IIMI)	16 (84.2)	3 (15.8)	0 (00.0)	19 (100.0)
Intervention with moderate levels of farmers' involvement (ADB/N and ISSP)	21 (31.8)	41 (62.1)	4 (6.1)	66 (100.)
Intervention with low levels of farmers' involvement (DIO, MLD and Multi-service agencies)	9 (33.3)	18 (66.7)	0 (00.0)	27 (100.0)
FMIS without intervention	14 (20.3)	53 (76.8)	2 (2.9)	69 (100.0)
AMIS	6 (12.5.)	25 (52.1)	17 (35.4)	48 (100.0)
Total	66 (28.8)	140 (61.1)	23 (10.0)	229 (100.0)

Note: The figures in parentheses indicate percentage.

Table 4 Relationship between Intervention Type and Water Supply at Tail-ends of Irrigation Systems

Types of Intervention	Water Supply at Tail-ends				
	Adequate and Predictable	Adequate and Un-predictable	Inadequate and Predictable	Inadequate and Un-predictable	Total
Intervention with high levels of farmers' involvement (WECS/IIMI)	15 (78.9)	1 (5.3)	2 (10.5)	1 (5.3)	19 (100.0)
Intervention with moderate levels of farmers' involvement (ADB/N and ISSP)	37 (58.7)	4 (6.3)	17 (27.0)	5 (7.9)	63 (100.0)
Intervention with low levels of farmers' involvement (DIO, MLD and Multi-service agencies)	7 (26.9)	1 (3.9)	14 (53.8)	4 (15.4)	26 (100.0)
FMIS without intervention	35 (50.7)	0 (00.0)	26 (37.7)	8 (11.6)	69 (100.0)
AMIS	5 (10.6)	1 (2.1)	24 (51.1)	17 (36.2)	47 (100.0)
Total	99 (44.2)	7 (3.1)	83 (37.1)	35 (15.6)	224 (100.0)

Note: The figures in parentheses indicate percentage.

Table 5 Relationship between Intervention Type and Water Distribution Pattern

Types of Intervention	Irrigation Systems with Disadvantaged Farmers due to Inequitable Distribution of Water		
	Yes	**No**	**Total**
Intervention with high levels of farmers' involvement (WECS/IIMI)	5 (26.3)	14 (73.7)	19 (100.0)
Intervention with moderate levels of farmers' involvement (ADB/N and ISSP)	6 (10.0)	54 (90.0)	60 (100.0)
Intervention with low levels of farmers' involvement (DIO, MLD and Multi-service agencies)	6 (22.2)	21 (77.8)	27 (100.0)
FMIS without intervention	9 (13.8)	56 (86.2)	65 (100.0)
AMIS	27 (56.3)	21 (43.8)	48 (100.0)
Total	53 (24.2)	166 (75.8)	219 (100.0)

Note: The figures in parentheses indicate percentage.

Table 6 Relationship between Intervention Type and Agricultural Productivity of Irrigation Systems

Types of Intervention	Agricultural Productivity	
	Cropping Intensity at Head (%)	Cropping Intensity at Tail (%)
Intervention with high levels of farmers' involvement (WECS/IIMI)	252.42 (N=19)	246.15 (N=19)
Intervention with moderate levels of farmers' involvement (ADB/N and ISSP)	235.89 (N=64)	229.10 (N=65)
Intervention with low levels of farmers' involvement (DIO, MLD and Multi-service agencies)	247.40 (N=25)	233.08 (N=25)
FMIS without intervention	255.75 (N=60)	251.03 (N=57)
AMIS	211.54 (N=46)	196.22 (N=44)
Total	239.03 (N=214)	230.18 (N=210)

Note: The figures in parentheses indicate number irrigation systems.