IRRIGATION DEVELOPMENT : THE MANAGEMENT AND USE OF IRRIGATION IN THE MOUNTAINS OF NEPAL

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PREFACE

ICIMOD's approach to problem oriented research involves both knowledge reviews and field studies. The focused reviews and field studies conducted by the Mountain Farming Systems Division cover various aspects of agricultural development. Since early 1988, a series of 'state of the art' reviews of agricultural policies and programmes were sponsored by ICIMOD in different countries of the HKH Region. The purpose of these studies and the subsequent National Workshops in different countries was to understand some of the constraints and prospects of Mountain area development. These exercises were also aimed at acquiring comparative perspectives of development approaches and strategies in different countries.

This paper was also a part of this series of studies, commissioned by ICIMOD, and was also presented at the workshop on "Nepalese Experiences in Mountain Agriculture : Policies and Strategies" organised jointly by the Ministry of Agriculture, HMG/N, and ICIMOD. This paper focuses upon the management and use of irrigation in the mountains of Nepal and the responsibility of the content rests with the authors and does not necessarily reflect the views and policy of IIMI or the Water and Energy Commission Secretariat with which IIMI is affiliated in Nepal.

CONTENTS

Review of Irrigation Management

Nepal has a total land area of about 141,000 km. Due to the rugged hill and mountain terrain it is estimated that only 22 per cent of the total area can be cultivated. Although the hill and mountain regions account for over 75 per cent of Nepal's total land area, these contribute to less than 50 per cent of the cultivated area. More than half of the cultivated area is in the lowland plains of the *Terai*, along Nepal's southern border (ADB and HMG/N 1982).

Farmers in Nepal have recognized the value of irrigation in intensifying agricultural production. For centuries they have been constructing irrigation systems for controlling water at their own initiative. In the isolated valleys of the country, irrigation development has been the domain of cultivators for many years.

Historically, irrigation development was initiated either by a religious trust, or by an individual or a community effort. The Government had not played an important role in irrigation development, until recently. The first public sector irrigation system, *"Chandra Nahar"*, was constructed in 1923. Before that time, a number of systems - *"Raj Kulos"*, having state patronage, were constructed using local technologies which were, to a large extent, managed by the beneficiaries.

The tradition of farmers' involvement in the development, operation, and maintenance of irrigation systems has given birth to a multitude of farmer-managed systems scattered all over the country. The local administrative structure and the legal tradition that has evolved over a period of time have permitted Farmer-Managed Irrigation Systems (FMIS) to operate without interference from governmental administration and government irrigation agencies. This practice was confirmed in a 17th century edict issued by King Ram Shah, stating that irrigation and its management were the responsibility of the community and that conflicts relating to irrigation were to be resolved by the community. However, the promotion of irrigated agriculture has been a prime concern of the Government for centuries, and assistance has been provided by the Government to FMIS, especially, when they were damaged due to natural calamities. Land tenure known as *jagir* (land assigned to a government employee) sometimes carried with it the responsibility of repairing and maintaining irrigation systems supplying water to it. Failure to keep the system operating, resulting in inability to cultivate rice, would be punished by dismissal (Regmi 1984).

As Nepal moved into the era of planned development after the 1951 revolution, heavy emphasis was laid on the development of irrigation infrastructure. Since 1951 the accumulated investment in irrigation development by government agencies has been more than Rs. 4320 million. This has improved the irrigation supply or brought irrigation water to new areas of cultivation covering some 350,000 ha. Investment in the public sector irrigation development is increasing both in percentage and total volume. Investment figures for the past 20 years are given in Table 1.

Table 1: Irrigation Development Expenditure

(million Rs.)

Plan	Irrigation Development Expenditure	Per cent of Development Expenditure
Third (1965-70)	61	2.4
Fourth (1970-75)	265	4.9
Fifth (1975-80)	864	9.8
Sixth (1980-85)	3130	14.4

Source : WEC 1981.

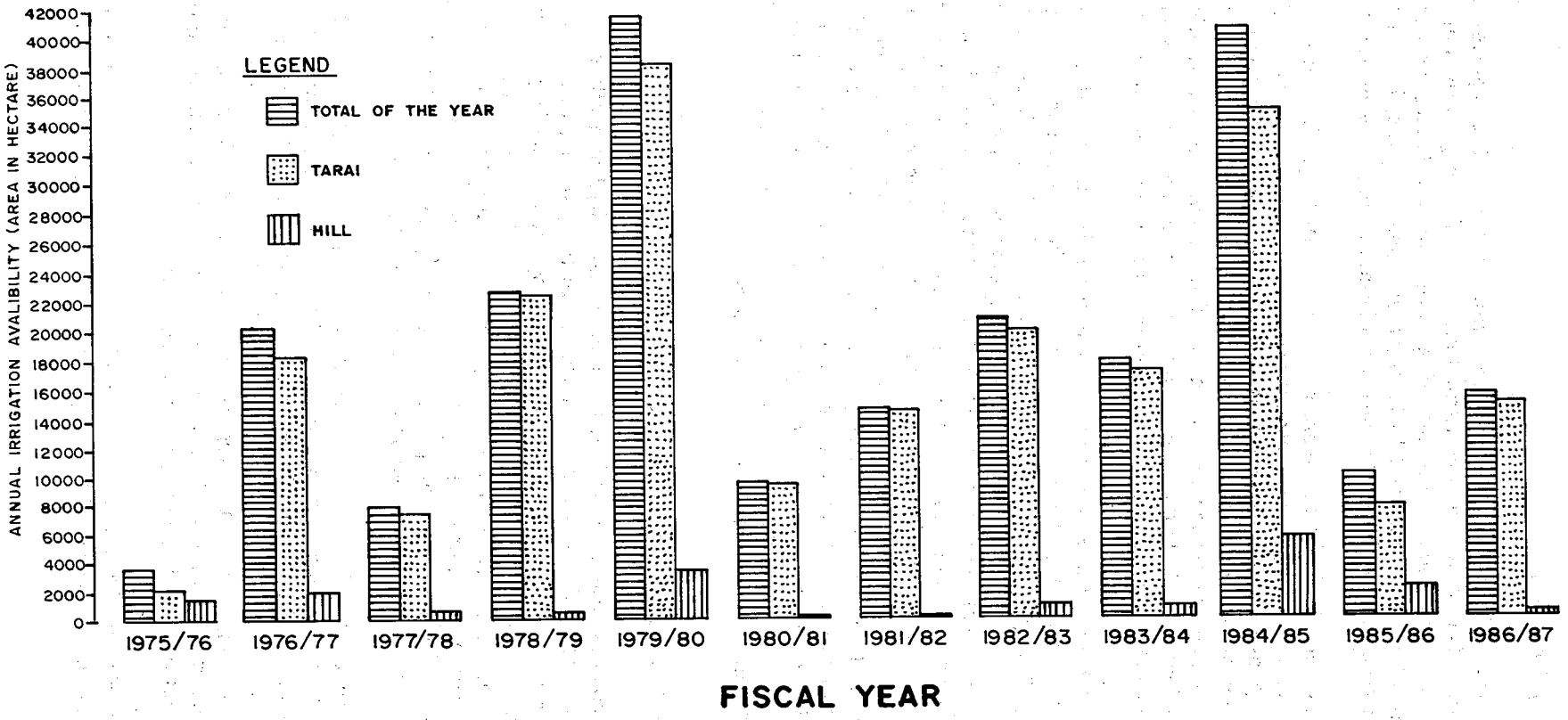
Note : Sixth Plan data are budget figures and the rest represent expenditures.

Figure 1 shows the annual increase in irrigated area since 1975. The increase in area shown is due to agency investment and does not reflect ongoing farmer activities in expanding irrigated area. Since the *Terai* in Nepal offers the best potential for irrigation development, major emphasis has been focused there. Difficulties and high costs have limited the efforts to construct hill and mountain irrigation systems almost to the extent of neglect. One factor limiting the efforts in hill irrigation development is that the topography mandates small systems, another is that in many cases farmers have already developed their own system to utilise the available water. However, with 50 per cent of the population living in the hills and mountains, more emphasis must be given to expand irrigation to increase food production in this region.

The rush to improve irrigation facilities largely neglected the tremendous efforts made by farmers to develop irrigated agriculture. Nepal's first Five-Year Plan did not recognize the existence of FMIS. The contribution of farmer-managed irrigation systems to the Nepalese economy was first noted in 1981 (WEC 1981). Recent changes (late 1987) in the government's irrigation development policy emphasizes the importance of the irrigation resources developed by farmers, and stresses the provision for appropriate assistance for improving and expanding these systems.

Figure 1

ANNUAL ACHIEVEMENT OF IRRIGATION IN NEPAL



Source: HMG, Ministry of Finance. Economic Survey of Nepal 1987/88. Kathmandu, 1988 P.8

Classification of Irrigation

Irrigation systems in Nepal can be divided into two broad categories by two distinctively different criteria. The most common distinction is to refer to government systems as those that have received some substantial amount of government assistance, as compared to farmer or private systems which have received little or no assistance. Thus, it is the source of financing and technical assistance that forms the basis for distinguishing between the two.

Another criterion that has emerged more recently is to distinguish between groups of systems on the basis of major management responsibility. Systems in which farmers take overall management responsibility on a continuous basis and control the water from source to disposal of excess as drainage are referred to as farmer-managed. These are in contrast to systems in which government personnel are responsible for most of the management activities with varying levels of farmer participation. While the farmers may be responsible for some aspects of operation and maintenance in agency-managed systems, government assistance and presence is ongoing.

The distinction between these two criteria is important in the reporting of irrigated areas and in the resulting influence on management practices. The performance of government irrigation development programmes is often evaluated on the basis of fulfillment of targets relating to the area irrigated. Thus, it is important to report all development assistance on the basis of land area, regardless of future management practices in the particular system. However, in the past when farmer-management was not considered a viable option, there was a tendency for management responsibilities to shift towards the government agency when existing farmer-managed systems were included in the area being developed. Making a clear distinction between the area or system assisted and the management responsibilities is useful in the consideration of irrigation development options that include heavy beneficiary participation in mobilizing resources for the development of the system as well as for ongoing operation and maintenance. This opens the way for turning over an agency-managed system to a farmer-managed one without the responsible agency losing credit for successful irrigation development.

Extent of Area Presently Irrigated

When a new irrigation system is designed, the area that is hydraulically commanded (i.e. to which water from the system of canals can easily flow) can be quite accurately determined. However, frequently there is not enough water to irrigate the whole command even in the monsoon season and it becomes extremely difficult to determine the actual area irrigated by a system. When privately developed systems are improved, it is even more difficult to determine the irrigated area because of complex water rights that have already been established. In addition, there is no reliable estimate of the number of privately developed systems. All of this has led to much confusion over the irrigated areas reported by different agencies.

According to a report by HMG/N, Ministry of Water Resources (1988), approximately 434,000 ha in all of Nepal are commanded by projects that received substantial government and semi-government agency assistance up to the fiscal year 1986/87. Out of this, about 40 per cent (170,000 ha) receive water for monsoon paddy, and less than half of this for year-round irrigation. According to the same report, irrigation systems developed by the private sector, (FMIS) including private tube wells, provide monsoon supplemental irrigation to 509,000 ha and year-round irrigation to 115, 000 ha of cultivated land.

An inventory study of the water resources of the *Terai* districts, initiated by the Water and Energy Commission Secretariat (WECS 1988), reports 5,500 ha of FMIS in the *Terai* alone. Yoder

and Upadhaya (1988) estimate that there are well over 17,000 farmer-managed systems in the mountains covering an area of 300,000 ha. Their estimate was based on extrapolation from a 200 km^2 sample area in the hills where an intensive inventory was made of existing systems. They consider this to be a conservative estimate. Yoder and Upadhaya (1988) also reported that out of the 119 FMIS in the sample area, 25 have received some form of assistance from sources external to their community in the past 25 years. Eleven of the systems have been built (half are still under construction) by the Department of Irrigation, Hydrology, and Meteorology (DIHM).

Table 2 summarizes the information on land area, cultivation area, and irrigable area in Nepal. Out of the 3,100,000 ha that is considered cultivable, 1,900,000 ha is assumed to be irrigable, of which 1,600,000 ha (84.27) are in the *Terai* and 300,000 ha (15.87) in the hills. In total, it is estimated that 1,064,000 ha or approximately 33 per cent of Nepal's cultivable lands are under monsoon irrigation. Approximately 200,000 ha receive a perennial irrigation supply (Ministry of Finance 1988). About one-third of all irrigation is presently under agency-management and two-thirds is managed by farmers. Table 3 summarizes the irrigated area reported by several different sources.

Table 2 : Summary of Land Area and Potential Use.

		(ha)	Per cent of Total
Nepal's Total :	Land area	14,100,000[a]	100
	Cultivable area	3,100,000[a&b]	22
	Irrigable area	1,900,000[b]	13

Source : [a] HMG/N Ministry of Water Resources 1988.
[b] Ministry of Finance 1988.

Table 3 : Summary of Publicly Assisted and Privately Developed Irrigated Areas in Nepal from Different Sources.

	Government & Semi-Gov. Assisted (ha)	Privately Developed (ha)
Command Area	434,000[a]	-
Irrigated Area (Monsoon)	170,000[a]	509,000[a]
	350,000[a]	714,000[b]
		825,500[c+d]
Irrigated Area (Year-round)	85,000[a]	

Source : [a] HMG/N Ministry of Water Resources 1988.
[b] Ministry of Finance 1988.
[c] WECS 1988.
[d] Yoder and Upadhaya 1988.

Beneficiaries were required to form a construction committee and deposit 5 per cent of the total estimated cost in the Agricultural Development Bank. The FIWUD then deposited 70 per cent of the total cost of the project in the Bank and the farmers mobilized the remainder through labour contributions. The FIWUD technicians supervised the construction.

On completion of the project, certification was done by the technician and the construction committee was modified to take responsibility for the operation and maintenance of the completed system.

The Agricultural Development Bank of Nepal (ADB). In the past the Agricultural Development Bank granted loans for three types of irrigation development programmes : 1) FIWUD irrigation schemes, 2) private pump irrigation, and 3) gravity irrigation systems.

The Bank's investment in irrigation started in 1968. In 1981, ADB/N began an intensive loan programme for pump irrigation. Over 11,000 shallow tube-wells were installed under this loan programme making irrigation facilities available to over 45,000 ha. Loans for wells and pumps are to be paid within seven years. The loans are primarily given to individuals. The Government provides labour subsidy for up to Rs 3,000 during the time of installation. Maintenance and operation costs will be borne by the pump-owner.

Besides pump irrigation, ADB/N has financed gravity irrigation systems as well. Irrigation for small farmers has been provided through the Small Farmer Development Project in collaboration with CARE. For such gravity irrigation systems, CARE provides 50 per cent of the cost and farmers have to take 30 per cent as a loan from ADB/N and contribute 20 per cent as labour (S. Pradhan 1985).

Under the reorganisation of irrigation activities in late 1987, the Agricultural Development Bank received an expanded mandate. Through its loan programme ADB/N is responsible for developing 227,000 ha or nearly 25 per cent of the planned irrigation area by the year 2000.

Farmers' Organisations

Farmer-managed systems range in size from a few hectares to 15,000 ha. Even though farmers face many difficulties in maintaining these systems due to floods and landslides, many systems have been gradually improved each year and only a few have been observed to have fallen into complete disuse. One of the greatest threats to their viability is rapid deforestation. Reduced forest cover contributes to higher silt loads, more destructive floods, and more frequent landslides which force the farmers to work harder to keep their systems operational. Deforestation deprives the farmers of forest products - limbs, branches, and brush - upon which they have traditionally depended for maintaining diversions and repairing breaches in the canals. The impact of deforestation on the ability to maintain such systems needs investigation.

Farmers in each system have developed an organisational structure that fits the needs of their system in its particular environmental setting. The structure has evolved over many years and continues to change. Some organisations are very sophisticated and have a written constitution, well-defined roles, and paid functionaries. In other systems many of the irrigation tasks are carried out on an ad hoc basis.

Many factors contribute to the nature of the organisational structure, including the supply of water relative to the available land area, soil type, nature of land holding, topography of the

command area, area through which the canal must travel, distance from house to field, and social structure. However, the labour requirement for system maintenance has been found to be the most dominant influence. Systems with a high resource mobilization requirement for maintenance usually have the most developed organisation (Martin and Yoder 1988). Patterns of organisation are also associated with the type of physical irrigation system. Hill systems with typically long canals that deliver water to the first field are distinctively different from river valley systems where only a short canal is needed. *Terai* systems tend to be larger, often requiring several tiers of organisation.

Farmer-managed systems do not fall under the jurisdiction of any government agency. Interaction with a government agency takes place only when there is desire to mobilise resources from outside their community.

Reorganisation of Agencies Responsible for Irrigation Development

The Department of Irrigation has been reorganised with the provision of five Deputy Director Generals to look after specific division activities. These divisions are :

- Small Irrigation and Water Utilisation Division,
- Large and Medium Irrigation Division,
- Ground Water Division,
- Planning Management Division, and,
- River Training and Environmental Division.

The irrigation development responsibilities of the FIWUD and the irrigation activity responsibilities of the *Panchayat* and Local Development Ministry are amalgamated in the Department of Irrigation. The Agricultural Development Bank has been given a greater role in irrigation development. Previously ADB/N activities for gravity irrigation development were largely confined to the Bank's Small Farmer Development Project (SFDP). With the reorganisation of the government's irrigation aspects, ADB/N is to undertake irrigation activities throughout the country.

The five Regional Directorates are to be strengthened and should provide technical assistance and supervision to newly established District Offices. District Irrigation Offices (DIO) are to be established in 70 districts. Wherever the Regional Directorate is located, it will function as the District Irrigation Office as well. The DIO has the responsibility of carrying out the principles of the Decentralisation Act. It is responsible for undertaking feasibility studies, construction, and implementation of district-level projects once they have received approval. These projects include all the small, and some medium, irrigation development and river training activities and organisation of beneficiary groups to manage the irrigation systems after completion. The District Irrigation Office also provides assistance for repairing, rehabilitating, and improving farmer-managed irrigation systems. In doing so, the local resources will be mobilized and participation of beneficiaries will be promoted (Gorkhapatra 11 May 1988).

The irrigation sector is going through a transformation process from a construction orientation to a management orientation. However, the transition will take sometime. Evaluation of the Department and its personnel is still based on the amount of project expenditure utilised. Since construction of infrastructure usually costs more and the mechanisms are better defined than

management inputs, there is a compelling reason for the Department to give priority to construction. The 140 per cent increase in the Department's budget for 1988/89 continues to encourage this approach. Nevertheless, if the irrigation sector is going to achieve its growth target and then sustain the operation and maintenance of the expanded irrigated areas, policies and resources must be directed towards encouraging participation of beneficiaries and giving a management orientation to the DOI.

Comparison of Irrigation Development Cost by Using Different Approaches

In the past, when an irrigation agency built an irrigation system, it took all the responsibility of designing and constructing and played a major role in the operation and maintenance. FIWUD, MPLD, and ADB/N took a modified approach requiring different levels of beneficiary inputs. This resulted in cheaper projects since the beneficiaries did not want to pay high costs and also because there was then the farmers' contribution of labour and cash to the cost of the project. Some figures of irrigation construction costs are given in Table 5.

A recent study of the irrigation sector by the ADB/N (1988) suggests an investment of Rs 60,000/ha for the hills and 30,000/ha for the *Terai* irrigation systems. Both FIWUD and ADB/N have implemented projects at the cost of Rs 5000-15000/ha. In FIWUD systems the farmer's share of the cost is 25 per cent of the total, while in the ADB/N programme it is 50 per cent.

Comparison of Water Management Between Agency Systems and Farmer Systems

While a considerable body of information has been generated about the management and performance of FMIS, there is no comparable information available on agency systems. The Irrigation Management Project under the DOI is addressing this problem with an action rogramme in pilot areas and a series of special field studies.

Table 5 : Capital Cost of Different Types of Irrigation Development.

Agency	Type of Project	Investment Cost ($/ha)
	Run of the River	
DIHM[a]	Extensive Development	1380-1900
ADB/N[b]	Extensive Development	262 (average)
DIHM[a]	Intensive Development	2285-3050
DIHM[a]	Surface water storage	4290-6190
DIHM[a]	Command Area Development	1145-1715
	Ground Water Source	
ADB/N[b]	Shallow tubewells	305-580
DIHM[a]	Deep tubewells	1430-2285

Source : [a] ADB and HMG/N 1982
[b] ADB/N, n.d.

A common feature among beneficiaries of many FMIS is a view of water as a "community resource". This view leads to collective decision-making as well as well-developed organisations, rules, roles, and mechanisms for conflict management. Where this view is lacking, systems are often poorly managed. Well-defined principles for resource mobilisation and water allocation are amongst the most important distinctions between well and poorly-managed systems.

A common complaint of farmers in agency or jointly managed systems is that the water delivery is not reliable. This complaint has not been verified by field measurements, but is heard frequently enough to assume some validity. Since farmers are dependent upon agency staff to deliver water from the source to some point in the system where they can take over, they have no control over water availability. In contrast, in FMIS, the control is entirely in the hands of the farmers who must decide how hard they want to work to acquire water in a timely and reliable fashion. Intensive manpower deployment is often required to make the system work.

In systems where water is sufficient for continuously flowing distribution, less supervision is required than in systems where rotational water delivery must be practiced. The ratio of irrigation related personnel to area in FMIS is one person for 1.5 to 10 ha, which is much higher than in agency-managed systems.

Little is written about decision-making and communication in agency-managed systems, but these processes have been studied in detail in FMIS. In well-managed FMIS, the beneficiaries participate in decision-making called to address specific problems through annual assemblies and meetings of all beneficiaries. The assembly makes decisions on basic issues which makes the organisation strong. Individuals or committees are often appointed or elected to implement the decision made by the assembly.

New Irrigation Development Policy

It was recognized that the past working policy on irrigation development had many weaknesses and was inconsistent, and, therefore, a new policy has been put forward. The new policy provides for a uniform approach by all government and semi-government agencies.

Basic Elements of the New Irrigation Policy

The new irrigation policy states that "the foundation stones of the proposed working policy are as follows:

- Beneficiaries' participation and consent be made compulsory for project identification, selection, design, construction, operation, and maintenance.

- Whatever the executing agency, the government contribution or share for each particular type of project is to be fixed, and ADB/N is to provide loans to the beneficiaries based on a fixed formula".

The new policy further states that :

"All parties feel that the beneficiaries' participation is of utmost importance in identification, design, construction, and O & M of projects. Use of the farmers' knowledge and skill in deciding a particular design, shape and size, is seen as today's necessity. The efforts of government agencies, with their controlled, official procedures and financial rules, cannot alone give a smooth

running project. It is necessary to create a feeling of belongingness towards the project, amongst the farmers. It is today's necessity to include farmers' participation in the construction and running of all types of irrigation projects. If the idea can be developed that the control of irrigation projects is in the farmers' hands, then they should be encouraged to utilise irrigation technology more effectively" (HMG/N, Ministry of Water Resources 1988).

This new policy is a major step in institutionalizing the lessons that have been learnt from the study of FMIS. However, the implementation of the policy will be a long and difficult process.

Considerations in the Implementation of the New Irrigation Policy

Organisation for Management. There are many different patterns of irrigation organisation among the existing FMIS. They have evolved under diverse environmental conditions and it will be prudent to devise a flexible policy for legal recognition, rather than force these institutions to conform to a uniform format. New skills will be required by the DOI to discover the characteristics of each existing organisation and be able to strengthen the weak activities without destroying their good points. Whatever form, registration, and legal recognition the user groups take, it should be flexible enough to accommodate the existing modes of organisation.
The Decentralization Act provides for beneficial management of projects. A user committee is to be formed. The Act also prescribes that the Chairman of the user committee shall be either the ward Chairman or the *Pradhan Pancha* of the Village *Panchayat*. This provision has sometimes created confusion when existing irrigation systems have been improved and a new committee with new leadership installed in the place of the old one. There is the danger of losing the expertise developed by long experience in such a situation.

Recognition of Existing Water Rights. Water allocation or water entitlement among beneficiaries of existing systems must be understood and respected if cooperation is expected in making improvements. To be successful, agreement in terms of water entitlements must be reached by all existing and potential beneficiaries before the implementation of physical improvements. This will help farmers understand their obligations and responsibilities. The design of the distribution system must be made so as to allow successful compliance with the allocation or entitlement of each beneficiary.

Design Consideration for Resource Mobilisation. Studies of FMIS have shown that farmers are able to mobilise as much as Rs 1,000/ha to operate and maintain irrigation systems (Yoder et al.). Since systems with high resource mobilisation requirements have stronger organisations, this should be considered in the designing of systems. Often trade-offs are possible between expensive structures that presumably require less maintenance and simpler structures that require more. Frequently, farmers are not able to maintain expensive structures when problems arise. They could handle such problems, when more labour is required, if the structures were simpler.

Systems with high resource mobilisation requirements also show higher equity in water distribution than systems with low requirements. Interdependence of the 'head and tail farmers' for water acquisition assures equitable delivery. When farmers must pay a substantial part of the capital cost to building or improving a system, they prefer cheaper structures and higher annual maintenance cost. This spreads the burden of payments over a longer period.

Non-physical Improvements in Existing Systems. Requests from farmers are always for construction or improvement of the physical infrastructure. Agency emphasis also is usually on making physical improvements. However, both physical and non-physical (strengthening of the organisation by helping them to establish necessary rules, roles, record keeping, etc.)

improvements are often essential for making a system functional. The activity of making physical improvements is a good opportunity for also working on non-physical improvements.

Irrigation for Non-rice Crops. The major thrust of irrigation development has been for supplemental surface irrigation of the monsoon paddy crop. Since much of the land suitable for paddy cultivation has already been irrigated, it is time to turn some attention to alternative forms of irrigation which might be suitable for fodder, vegetables, and orchards. High altitude pastures are limited and could possibly be improved by irrigation from glacial streams. Some of the hill-slopes along rivers have low quality forests which can possibly be improved through 'sprinkle irrigation' for increasing fodder production.

ADB/N has tried 'sprinkle irrigation' for vegetable farming and 'lift irrigation' for non-rice crops. Both of these endeavours have been successful. More experiments with different technologies, to develop low-cost means for bringing marginal land into better use in the hills and mountains, needs to be done.

Appropriate agencies or organisations must be identified and supported to develop and test appropriate technologies. Dissemination can then be done through existing channels.

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