Sustainable Irrigation Turnover

Report on System Infrastructure

KAR Project R7389

Report OD/TN 110
November 2001

DFID Department For International Development

HR Wallingford

Mott MacDonald

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Contract - Research

The report is the initial output from Knowledge and Research Contract R 7389, Toolkit for Sustainable Irrigation Turnover, carried out in Nepal by the International Development Group at HR Wallingford, the Department of Irrigation, HMG Nepal, and Mott MacDonald, on behalf of the UK Department for International Development. Additional work is being carried out in Gujarat, India, with the Aga Khan Rural Support Project and the Development Support Centre, both NGOs with active programmes in the State. The research aims to identify issues which affect how irrigation schemes are maintained after turnover from government to farmers, produce checklists for the turnover process, and develop training materials for maintenance, so as to improve the sustainability of schemes and reduce the need for frequent rehabilitations.

The HRW job number is MDS0534.

Details of the KAR contract are as follows:

Theme:	W5 Improved availability of water for sustainable food production and rural development
Project title:	Toolkit for Sustainable Irrigation Turnover
Project:	R 7389

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Date 14/11/2001

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Executive Summary

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The report describes the first phase of a three year collaborative research project "Toolkit for Sustainable Irrigation Turnover", focused on Nepal and Gujarat State, India. The research aims to identify issues which affect how irrigation schemes are maintained after turnover from government to farmers. In a second phase, checklists for the turnover process, and training materials for maintenance will be developed, so as to improve the sustainability of transferred schemes and reduce the need for subsequent government intervention. The work is funded by the UK Government's Department for International Development through its Knowledge and Research programme. The project team led by HR Wallingford Ltd includes Mott MacDonald Ltd, the Department of Irrigation of His Majesty's Government of Nepal, and two non-governmental organisations in Gujarat: the Aga Khan Rural Support Programme and Development Support Services.

The report describes findings from an extensive literature review and from fieldwork conducted on four irrigation schemes in Nepal, two of them turned over to farmers, as well as from working visits to schemes under Participatory Irrigation Management in Gujarat, India. A separate report, OD/ITM 61 - Study of Water User Associations on four Irrigation Systems in Nepal, Pradhan P (2001) - describes investigation of the functioning and performance of the Water User Associations on the schemes. Detailed results of technical assessments of the infrastructure on the four systems is included in report OD/ITM 62 - System Infrastructure: Report on Field Investigations (2001).

The WUAs had been established with varying objectives. There are clear differences in their states of development and relative success:

- At Khageri (turned over below main canal), Water Users Associations were promoted to jointly manage the system. A Main Committee collaborates successfully with the Irrigation Department. The branch canal committees seem to be actively collecting resources, maintaining the canal and distributing water within their areas. This transfer process has been relatively successful: it was managed incrementally, on a system in good condition where farmers are well-educated.
- At West Gandak, the whole system is turned over to farmers. The system is complex. Political factions are exploiting social differences. The duties of the Water Users Association are too onerous and they are now ineffective, given the demanding nature of operation and maintenance at main system level and the inadequacy of the funding base.
- At Kankai irrigation project, the Main Committee of the water users association is supposed to support the Kankai Irrigation Office. In practice, the latter makes the decisions, the WUA providing communication. WUAs established on the branches are active in basic tasks including maintenance,

but they are potentially fragile. Kankai is still an Agency Managed Irrigation Scheme (AMIS), but a process of partial management transfer is in progress.

- At Tilawe, on the Narayani Zone Irrigation Development Project, the objectives in establishing Water Users Associations were not clearly defined: the associations lapsed as soon as support was withdrawn, as they had little role – in reality they no longer exist. They were not formed as part of a management transfer programme. The scheme is still fully managed by the Department of Irrigation.

Traditional Farmer Managed Irrigation Schemes (FMIS) in Nepal can provide pointers as to how transferred schemes might function over the long term, but they also display significant differences from AMIS, due in part to their different histories, design and scale. There are financial, social and technical constraints to transferring management of irrigation systems from governments to farmers. Traditional irrigation relies on labour (particularly off-season labour at times of limited alternative employment opportunities) and local materials, rather than cash. Modern irrigation continues to be more dependent on cash, which must be collected and managed soundly. FMIS have tended to develop over time: their layout often allows for more independent, localized operation, under which individual canals are operated by individual villages. Many FMIS have the further advantage that water is relatively abundant for the area irrigated.

Few countries have tried to fully turn over the management of main canals to farmers, as at West Gandak. Management of finances, equipment, and labour on the scale required at that level of the system demand technical and organisational skills of farmers that they probably do not, and need not, possess. Many farmers at West Gandak appear to believe that the Department of Irrigation is still responsible for the main canal, not just for assisting the Water Users Association in its management. WUAs do not have sufficient scope for raising the required resources when government budgetary support is limited, although at the time of transfer they may be unaware of the true costs. The prospects for the full turnover of large-scale Agency Managed Irrigation Schemes, including the main canal, are therefore limited. However, there are options for transferring some responsibilities to farmers or for joint management of main systems, as at Khageri, where the strategy appears to be successful. Transfer of branch or secondary canals has proved more successful, and is more likely to be effective if farmers have already been involved in operation and maintenance at that particular level of the system.

Among the many issues which emerged from the surveys in Nepal, farmers frequently commented that they:

- were not clear about their responsibilities for operation and maintenance, nor about the role of the Department of Irrigation (three out of the four schemes). They also choose to believe that the Department will intervene with substantial repairs when systems fail for lack of maintenance.
- require an adequate and reliable water supply before consistently involving themselves in operations and maintenance. Water shortage is a serious concern on most systems.

frequently do not trust Water Users Associations to operate honestly and transparently. The rates of collection of Irrigation Service Fees are generally poor. Procedures for assessing and monitoring collections do not seem to be adequate;

The cost of necessary maintenance on turned-over schemes in Nepal exceeds the Irrigation Service Fee by considerable amounts. For traditional cropping patterns, and the very low crop prices prevailing in recent years, fees set according to practice in other countries are not realistic in Nepal. The relatively low output per unit of water and land in Nepal is a particular problem. A rough estimate suggests that some NRs 500/ha would be required for annual maintenance of the main and the distributary canals once deferred work had been done. Water users on Farmer Managed Irrigation Schemes may contribute up to NRs1000/ha, mostly in the form of labour. It seems unrealistic to expect contributions of this magnitude on turned-over schemes. At present, the Irrigation Service Fees at Khageri, indicative of the four study schemes, is around NRs 120/ha, plus varying amounts collected for maintenance of the secondary system. The rates of collection – a maximum of around 60% (Khageri)- are declining.

Despite fairly optimistic findings in some previous studies, it is far from clear that turnover produces an improvement in maintenance. The outcome will depend on the effectiveness, or otherwise, of the turnover process. Failed turnover leads to a rapid decline in maintenance standards. Successful turnover is likely to lead to better results than under agency management, but requires that farmers can collect required resources.

In Gujarat, Participatory Irrigation Management (PIM) is being promoted both by non-governmental organisations (NGOs) and by Government. There have been a number of successful initiatives, particularly by NGOs. The state has a tradition of effective co-operatives, in particular for milk production. Success of the PIM process is highly dependent in part on the attitude of Irrigation Department staff working with farmers' groups. Although there exist government guidelines for O&M responsibilities on PIM schemes, in practice there often do not seem to be clear-cut boundaries separating government's and farmers' responsibility for maintenance. Societies which have a good working relationship with the Department are more likely to be clear about responsibilities. Irrigation personnel indicated that PIM schemes require more government staff time and resources than when the Department managed them.

Farmers readily see the need for desilting canals, but do not appreciate other real maintenance needs, particularly preventative maintenance, nor the true costs. WUAs do not appear to carry out any form of coherent maintenance planning. The case for planning should be clearly made before transfer, when the resources and the responsibilities need to be defined. Maintenance should be explained as an essential means to safeguard incomes and livelihoods. It is essential to make a realistic assessment of Water Users Associations' capacity to operate, manage, and maintain the different levels of a system before any agreement to transfer. It is evident that farmers in Nepal cannot yet manage, unaided, the more complex infrastructure involved with main canal systems. Joint management of the main system at Khageri provides a hopeful precedent for schemes where Water Users

Associations are keen, allowing their involvement at the highest level of the, system and interaction with operation and maintenance engineers. Otherwise properly established Water Users Associations in Nepal appear able to manage small branches without complex infrastructure, serving command areas in the range 250 ha to 300 ha.

WUAs require a sound basic institutional structure, in order that skills in maintenance identification, planning and execution can be effectively transferred. Training for Water Users Associations should include management, accounting, book-keeping, and better irrigated farming practices. Improved output and incomes are essential, to provide the resources needed for maintenance. Maintenance training should focus on identification, planning, and improved quality of execution of basically simple works. WUAs should be encouraged to appoint maintenance specialists.

Sustainable operation and maintenance require strong support to farmers and water users associations following transfer. Since follow-up assistance is necessarily costly, better management of the system would be a more cogent rationale for turnover, rather than savings in government expenditure

Rehabilitation prior to transfer should focus not only on those parts of the system to be turned over, but also on the main canal, as its role is more crucial and its condition often more critical. An overall plan for rehabilitation and subsequent maintenance should be made. If farmers will commit to agreed maintenance programmes, there could be advantages to transfer without prior rehabilitation as arranged in some other countries, on the understanding that rehabilitation will be carried out by government when it becomes necessary.

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1. INTRODUCTION

The subject of the report, a three year collaborative research project "Toolkit for Sustainable Irrigation Turnover", focused on Nepal and Gujarat State, India, is due to be completed by December 2002. The work is funded by the UK Government's Department for International Development through its Knowledge and Research programme. The project team led by HR Wallingford Ltd includes Mott MacDonald Ltd, the Department of Irrigation of His Majesty's Government of Nepal, and two non-governmental organisations in Gujarat: the Aga Khan Rural Support Programme (AKRSP) and Development Support Centre (DSC).

1.1 Objective and details of the project

The overall objective of this project is to assist governments pursuing policies of turnover to improve the sustainability of irrigation infrastructure. There are two phases:

- An initial research phase to investigate the performance of farmers' organisations in managing, and in particular maintaining, turned over systems;
- During the second phase, guidelines and training material will be developed to aid water users associations, farmers, and government irrigation staff, to focus on the need to adequately maintain system infrastructure.

The outputs of the project are outlined below.

Output 1	Report describing analysis of current operation, production, maintenance effectiveness, constraints and costs on selected turned-over and control schemes.
Output 2	Tools for maintenance and main system management under turnover to help governments identify alternative institutional arrangements for main system operation and maintenance, constraints, likely consequences for infrastructure sustainability and required support.
Output 3	Farmer training materials and guidelines for maintenance developed for community-based water users associations. This will also include implementation of the training material on a pilot scheme.

The report is the first output of the project. It describes findings from a literature review and fieldwork conducted on four irrigation schemes in Nepal, as well as from working visits to schemes in Gujarat, India.

1.2 Structure of the report

The report is structured as follows:

- Chapter 1 includes the objectives of the project and background to turnover policies for irrigation schemes
- Chapter 2 summarises published experience and highlights principal issues in turnover programmes as practised in different parts of the world. It also reviews experience with irrigation management transfer in Nepal, and participatory irrigation management in Gujarat
- Chapter 3 outlines the field investigations carried out in Nepal and India
- Chapter 4 discusses issues arising from the field work and from work elsewhere.
- Conclusions and recommendations are presented in Chapter 5.

Extensive supporting data are included in the Appendices.

1.3 Background to the turnover of irrigation schemes

1.3.1 Definition of turnover

From the 1970s onwards, Governments in many parts of the world have been concerned to turn over management of irrigation schemes from centralized agencies to farmers, with the principal aim of reducing budgetary expenditure. By 1997, over 24 countries had some active involvement in turnover (Vermillion, 1997). The term "turnover" encompasses policies varying from the complete hand-over to farmers of all scheme infrastructure to transfer of certain responsibilities only. Full turnover is unusual on larger schemes, say over 10,000 ha, because of the complexity of the tasks that would need to be undertaken by farmers. Turnover entails:

- Transferring to users, through users' organisations, certain functions that were previously the responsibility of a state agency
- Farmers assuming greater financial and/or organisational responsibilities.

Governments aim to promote the formation of water users associations or groups to take prime responsibility for managing the devolved areas. In some countries including Nepal, a tradition of co-operative management of small schemes by farmers already existed. However, after many decades of government management, farmers on public schemes may be unused to the disciplines needed to assume greater responsibility for water management. Low returns to agriculture, and the need to pay for services that were provided "free" for many years, are also disincentives to greater enterprise. To attract farmers to the process, governments commonly undertake to rehabilitate schemes before turnover.

It should be noted that in the following pages, reference is made to Irrigation Turnover, Irrigation Management Transfer, and Participatory Irrigation Management. The terms are to some extent interchangeable. However, individual nations and organizations have their own terminologies for the processes broadly referred to in the project title as Irrigation Turnover. Nepal has a programme of Irrigation Management Transfer (IMT), whilst Gujarat State, India, uses the term Participatory Irrigation Management for a programme which includes maintenance by farmers, the principal concern of the present project. In general, the reference in the text uses the term most appropriate to the context in which it is used.

In Gujarat, Participatory Irrigation Management (PIM) can be categorised into two broad groups:

- Schemes initiated and supported by Non-Governmental Organisations, in which the farmers manage the system to various degrees
- Schemes where there is a transfer of responsibilities from the Narmada and Water Resources Department to the users.

The first group demonstrates farmers' capability to manage but does not involve transfer of the scheme to them, although it may be transferred to the NGO. The second group may involve transfer of control over only a proportion of the command or over the complete system.

1.3.2 Background to study of the impacts of turnover

Many studies of the impacts of turnover have been carried out, but many have been limited in scope. Despite the clear success of the turnover process in countries like Mexico and Turkey, there are concerns as to the sustainability of turned-over systems where farmers fail to identify any advantage to themselves. There seems to be solid evidence that turnover by itself does not materially increase crop yields or command areas. Where the process is successful, farmers' motivation appears to be linked to better control over water, a primary input to their agricultural system, which allows them greater flexibility in managing their livelihood and income.

The long-term sustainability of turned-over systems requires many factors to be broadly favourable. These factors include the following:

- An assured supply of water
- Farmers must be able to achieve viable livelihoods
- The farming community has mechanisms for resolving disputes
- The farming community must possess appropriate organisational knowledge and skills.

Adequate maintenance is essential to sustain a system. The effort and resources devoted by the community to the maintenance of the irrigation system is an indicator of community management skills. Without due care, deterioration, aggravated by poor initial construction, will proceed unchecked. The familiar cycle leading to partial or complete failure requiring early rehabilitation, will be repeated. If system rehabilitation is undertaken prior to turnover, it is difficult to make meaningful assessments of the sustainability of the infrastructure under management by farmers until a substantial period, at least five years, has elapsed. Farmers will allocate their working time according to perceived priorities. In the immediate aftermath of rehabilitation, and without encouragement and support, water users are unlikely to devote much time to a routine of identifying, planning, and executing maintenance, which is essential to sustaining the infrastructure over the long term. Turnover programmes normally include training for members of water users associations, but in the early months and years after transfer, continuing support may be needed to equip farmers with the technical, financial and organisational skills needed to operate and maintain tuned-over systems.

Little investigation has been made of the state of the irrigation infrastructure, of the extent and effectiveness of farmers' maintenance activities, and of the possible need for continuing "hands-off" support, once systems have been turned over. The programme of research has been formulated to address the need, with the aim of making turned-over systems more sustainable.

2. IRRIGATION AND TURNOVER

A literature review of published experience with turnover and maintenance was carried out. The review highlights principal aspects of turnover programmes that are implemented in different parts of the world. The background to irrigation management transfer (IMT) in Nepal, and to participatory irrigation management (PIM) in Gujarat was also reviewed. The literature review focused on the sustainability of transferred schemes, and discusses particularly those issues that affect the organisation and execution of maintenance. A summary of the main points from the review is included in the sections below. Appendix A provides further details.

2.1 Summary of world-wide experience

In a "Synthesis of Benefits and Second Generation Problems", investigating experience with irrigation management transfer in four countries, the World Bank Institute (Svendsen et al) identified four major "second generation" problems for water users associations. These were:

- Insecure water rights;
- Financial shortfalls;
- The need for rehabilitation;
- Lack of financial and administrative management expertise.

Insecure water rights are an "external" problem that may be difficult for water users associations to resolve without government action. The remaining three "internal" problems are linked to finance and organisation. Poor maintenance is not singled out as a problem, but it often results from both financial problems and lack of business management skills. Inadequate maintenance is also a primary contributor to early need for rehabilitation, and is one of the issues which can contribute to the ultimate breakdown of a scheme.

In Nepal, branch canals may serve 100-1000ha. In programmes of partial turnover, where government retains the management of the headworks and the main system, operational and maintenance issues that occur below that level are not complex, and are well within the capability of farmers to manage. In general, however, farmers initially need help to identify and plan priority maintenance works, and to improve the standards of maintenance execution. Well-planned, organised and funded maintenance depends on the establishment of sound institutions. The achievement of a good financial performance by a water users association is basic to good maintenance.

Natural disasters and emergencies can cause damage that is beyond the financial and technical capacity of water users associations. In many richer nations, some form of insurance often covers the damage caused by natural disasters and accidents. However, in the developing world, it is unrealistic to expect water users associations to accumulate sufficient capital for such eventualities. Governments in countries such as Mexico and the Philippines, as well as Nepal, recognise the need for intervention at such times.

Principal findings from the literature review were:

- Recovery of operation and maintenance costs has improved substantially under some management turnover programmes, but collections are still generally insufficient to cover full costs
- Poor financial management, accounting and bookkeeping are serious problems in water users associations
- It is often recommended that water users associations develop subsidiary enterprises to increase income and resources. Successful water users associations have generally expanded their activities once irrigated agriculture has provided a sound base, but in the initial stages such diversification may prove beyond the capabilities of farmers and distract attention from the fundamentals.

- Governments need to continue to provide effective support to turned-over irrigation schemes for a considerable period post-transfer;
- To date, quantitative impacts of the transfer of management of irrigation schemes to farmers have not been conclusively demonstrated, even in terms of reduced Government expenditure and increased expenditure by farmers on irrigation operation and maintenance
- There is a tendency for water users associations to set low maintenance standards and low tariffs, thereby jeopardising the benefits of the turnover process.

Pradhan (2000) summarizes factors that contribute to effective functioning of water users associations. They include:

- Wide participation by members of the system, including fair representation by head, middle and tail end farmers
- Inter-dependencency of farmers owing to difficulty of water acquisition or resource mobilization;
- Transparency of procedures and functiong of the water users association
- Resource mobilization, cash, labour or in-kind, based on fair contributions by all
- Rules for water distribution agreed by all members. Clear sanctions for non-compliance
- Defined water rights linked to individuals' obligations and contributions
- Executive committee elected by farmers and accountable to a general assembly
- Overall rules and regulations to be established and monitored by a general assembly which meets at regular intervals

Pradhan comments that the functioning of water users associations is affected by the water supply, the water capture and distribution system, the nature of water rights, and relationships with government and other external bodies.

2.2 Experience in Nepal

2.2.1 Introduction

Irrigation has been practised in Nepal for hundreds, if not thousands, of years. Records refer to numerous small systems and several large farmer-managed schemes, some of nearly 10,000 ha. Large scale 'modern' irrigation started with the construction of the Chandra canal in 1928 that supplies some 9000 ha in the plains (Eastern Terai). There has been considerable expansion in the area served by government-managed irrigation schemes since 1950, including the Sunsari-Morang Irrigation Project of 68,000 ha, following agreements between India and Nepal on the Koshi and Narayani river waters.

The Nepali Government constructed several smaller government managed irrigation schemes, mainly fed by rivers in the Terai, for supplementary monsoon irrigation in sparsely populated areas. The Government also provided assistance to farmer-managed irrigation systems, particularly in the hills. The design of early farmer-managed irrigation projects followed the "Indian model" of protective, extensive, irrigation covering large areas with low water duties, rather than the practice on indigenous farmer managed irrigation schemes that often delivers large volumes of water per unit area.

In 1998 the reported area under different types of management was as follows:

- Government managed irrigation schemes: 265,000 ha, of which about 220,000 ha. in 20 schemes
- Transferred irrigation schemes 20,000 ha
- Farmer managed irrigation schemes 500,000 ha

Government policies on irrigation have gone through a number of changes since the first five-year plan (1956 to 1961). The emphasis gradually shifted from large-scale construction to smaller-scale developments with greater participation by beneficiaries. In 1990, the perception of poor performance and

sustainability on large government-managed schemes led to the Irrigation Management Transfer Project and to increasingly focussed attempts to involve beneficiaries in management of large schemes. The Irrigation Master Plan (1990) envisaged that overall government management of large schemes would continue, but recommended turnover of projects smaller than 2,000 ha, even where farmers were reluctant to take responsibility. Latterly, a series of projects providing assistance to farmer-managed irrigation schemes have been undertaken, whilst command area development of larger schemes continues. There is stated to be a large potential for new irrigation and new construction remains a priority. The targets in the ninth five-year plan (1997-2002) include 50,000 ha of new government managed surface irrigation and 90,000 ha of groundwater irrigation subsidised by private development.

Pradhan (2000) comments that the implementation of irrigation management policies has coincided approximately in time with privatization policies in other types of enterprises which were formerly operated by the state. However, few developing countries have even contemplated full privatization of an irrigation service in the manner that has been applied to sectors such as airlines, telecommunications and state banks.

2.2.2 Objectives of the turnover process in Nepal

The overall objectives of irrigation management transfer in Nepal are to:

- Achieve more efficient and sustainable irrigation
- Reduce government involvement in irrigation management by transferring responsibilities to users and effectively reducing government subsidy to agriculture.

The more immediate objectives are:

- A "full transfer of regular operation and maintenance activities from the Department of Irrigation to water users associations"
- A commitment by the Department for Irrigation to deliver water to a certain point.

2.2.3 Nepali policy and regulations relevant to turnover of irrigation schemes

Government policies relevant to the management of irrigation schemes are set out in a number of key documents including:

- Water Resources Act 1992;
- Irrigation Policy of 1992 revised in 1997;
- Irrigation Regulations of 1998.

A summary of the most important aspects of the above documents is included in Appendix A. The following documents also affect irrigation management in Nepal:

- The *Muluki Ain* (national code);
- Local Governance Act 1998.

The First Amendment (1997) of the Irrigation Policy (1992) Part-I refers to "mobilisation of farmers' resources" with the objective of operating and managing new programmes of construction, renovation and improvement. It aims to set out a legal basis for user associations to raise irrigation service charges and to spend revenues. Part II states that "His Majesty's Government shall not realize water fees on transferred surface and groundwater irrigation systems. The concerned water users associations may realize irrigation service charges from the users…..". The first provision appears to preclude the Nepali Government from charging for bulk water supplies on transferred schemes where Department of Irrigation continues to manage the headworks and main canal. This type of management, or joint management of the main canal,

is likely to be the best solution for schemes with technically complex primary supply systems that may be beyond the capacity of water users associations to operate and maintain.

Capital costs are to be shared between water users associations and the Nepali Government. The minimum percentage contributions required of users for surface irrigation schemes are summarised in Table 2.1. Though the contributions required from users are small, except at the quaternary (watercourse) level, the principle is established that beneficiaries of Government-funded irrigation development must bear at least some part of the capital cost. Apart from cost-saving to the Government exchequer, the policy helps to ensure that only worthwhile projects go ahead, since if farmers agree to contribute to costs, they must consider the project is likely to be successful and of tangible benefit.

Water users associations must deposit a sum equivalent to 0.5% of the estimated project cost, in a bank account held jointly by Department of Irrigation and the water users association, as a fund for repair and maintenance which may be drawn upon after the works are completed.

Table 2.1 Minimum Shares of Surface Irrigation Capital Costs to be Borne by Users

Category		Percentage share to be borne by users
Water users association – Operated Schemes		
a) New construction:		
- Tarai		10
- Hills		5 to 7
b) Strengthening (ie. Rehabilitation & improvement)		
- Tarai		15
- Hills		7 to 12
Schemes to be transferred to water users associations		5
Schemes under joint management		
a) New construction:		
- Tarai:	Watercourse up to 10 ha	100
	Tertiary serving 10 to 30 ha	25
	Sub-secondary canal serving 30 to 500 ha	0
	Headworks and main and secondary canals	0
- Hills:		5
b) Strengthening		
- Tarai		12
- Hills		10

Source: First Amendment (1997) of the Irrigation Policy 1992, Annex 1, Table 1.

The division of Irrigation Service Charge collections between water users associations and the Nepali Government on jointly managed schemes is shown in Table 2.2. Water users associations' share of Irrigation Service Charge revenues increases with their involvement in management. Farmers receive a large proportion of the funds, whereas the balance allocated to the Government is much less than the amount required to maintain the main system. If higher levels of the system were transferred to farmers, they would have greater responsibilities without formal access to sufficient funds to discharge them. They would thus seem to have little incentive to participate in main system management.

Farmers often contribute unskilled labour for maintenance at tertiary level, as well as paying an Irrigation Service Charge. The labour contribution to canal clearance often has a greater value than the Irrigation Service Charge. Limited funds will be needed for maintenance at this level, so small collections are likely to be used for administrative purposes. By contrast, the money available for main system maintenance is grossly inadequate.

Table 2.2 Division of Irrigation Service Charge (ISC) Revenues between the Nepali Government and water users associations

Situation	Water users association share (%)	Government share (%)
Water users association management of tertiaries and below, Govmnt. management of the rest of the system	25	75
Water users association management up to block level	50	50
Water users association management up to, but excluding, main canal level	75	25
Water users association management of the whole system except for headworks	90	10

Source: First Amendment (1997) of the Irrigation Policy 1992, Annex 3, Table 3.

On jointly managed schemes, Department of Irrigation and the water users association agree the ISC. If water users associations fail to collect the assessed amount, they receive only part of the share stipulated in Table 2.2. On transferred schemes, they do not appear to need the Department of Irrigation's approval for the Irrigation Service Charges, unlike in Mexico and Turkey.

Under the *Irrigation Regulation, 2055 (1998),* water users associations are empowered to collect Irrigation Service Fees (ISF) or Irrigation Service Charges (ISC) and are required to maintain land records. An Irrigation Service Fee Fixation Committee sitting in each District is required to set appropriate charges based on:

- The area to be irrigated, its topography, the method of irrigation and the quantity of water available
- The crops to be grown
- Anticipated maintenance costs (operation costs are not specifically mentioned)
- Depreciation of scheme assets and structures
- Scheme capital costs. Irrigation Scheme Fees in Nepal normally only cover operation and maintenance cost recovery, not capital cost. It is not clear why this item is included possibly to provide a basis for establishing depreciation costs
- Change in the consumer price index
- The potential for other income generated by "the use of structures of the irrigation system".

These considerations provide a sound basis for setting realistic Irrigation Service Fee rates. The recognition of the need to take account of inflation, which has often been given insufficient weight on transferred schemes in Mexico and Turkey, is particularly welcome. According to the *Irrigation Regulation,* water users associations are to collect the ISFs on jointly managed schemes as well as on transferred schemes. They are entitled to retain 25% of the revenue collected, presumably in addition to the shares given in the *First Amendment (1997)* and repeated in Schedule 1 of the *Irrigation Regulation.* Penalties are also to be imposed for non-payment of fees.

Normal maintenance on transferred schemes is the responsibility of the water users association. The Nepali Government will, however, carry out major repairs and rehabilitation resulting from natural disasters where the water users association is not capable of carrying out such works, a sensible and compassionate provision appropriate to conditions in Nepal. Water users associations are required to maintain proper financial accounts, to prepare annual income and expenditure accounts and balance sheets, and to submit them to the relevant Department of Irrigation office and District Water Resources Committee within six months of the end of the financial year.

The Nepali Government retains considerable powers over transferred schemes. The Government may issue and enforce directives concerning the operation and management of transferred schemes; it may

dissolve water users associations or their Executive Committees. Irrigation Inspectors are assigned to inspect transferred schemes.

The *Muluki Ain* includes articles covering water rights, canal construction and repairs, and the Local Governance Act gives some responsibility for natural resource management to the Village Development Committee. Rights to use the infrastructure, and responsibilities for its maintenance, are to be transferred to water users associations, without fee to government. Ownership remains with the government (except in the case of some agency-assisted farmer managed irrigation schemes). The government is required give technical assistance, if needed. Larger projects are to be jointly managed (or, exceptionally, they may be transferred), an Irrigation Service Fee is to be collected by the water users association and shared with the government. However, in practice the amounts which can be collected are too small. WUAs can increase the fees, but they no incentive to increase them to pay more to DOI to care for the headworks. In Khageri scheme, studied under the project, WUAs have refused to pay anything to DOI. A further problem is that the Irrigation Regulations mention a fee of NRs 120/ha. Accordingly, some farmers have successfully gone to court to prevent WUAs from increasing the fee. WUAs on some schemes aim to get round the problem by charging a separate maintenance fee and using the ISF for administrative costs, but farmers resent paying money for staff upkeep, whereas some charge for maintenance is understood.

The regulations provide detailed rules for application of the policy and are a substantial step towards participatory irrigation management. The need to regulate water users associations is widely accepted, but excessive control detrimental to their independence needs to be avoided. For farmer-managed schemes, the fees required to maintain and rehabilitate the system are to be set by a district committee chaired by a government official: the water users associations remain a minority party to the transaction. There does appear to be a possible conflict between the concept of management by water users associations, acting as independent private operators, and their 'ownership' of the management process. Little consideration is given to the obligations and responsibilities of the Government, in terms of providing water and services to the water users associations.

2.2.4 Progress to date

Experience with transfer in Nepal is relatively limited. The International Water Management Institute (IWMI) reviewed progress, concluding that the process has been generally successful, although transfer is still too new and limited in scale to draw firm conclusions, particularly concerning sustainability. In particular, the 1999 IWMI evaluation found little clear evidence that management transfer had yet had an affect on agricultural productivity. A brief review of the Irrigation Management Transfer Project and Joint Management Projects is given below.

Irrigation Management Transfer Project

The Irrigation Management Transfer Project is to cover 70,000 ha in 11 schemes, or about 25% of the planned irrigated area in the country. Only 32,500 ha were actually irrigated prior to the Project. It is an ambitious pilot programme to be implemented in two phases. Some 15,000 ha in four schemes have been transferred, and preparatory works have commenced on the remaining area. The extent of transfer varies, including either the entire system, or the secondary canal network and below. Transfer is sometimes undertaken in several stages.

A very intensive programme of institutional development has been instituted, requiring up to 200 contact days between Department of Irrigation officials or consultants and the water users associations per 1,000 ha. Resources on such a scale are unlikely to be available for the remainder of the project. Schemes were rehabilitated before transfer, although the nature and extent of rehabilitation varied considerably. Activities involved:

- Development of management transfer process including:
  - Preliminary training
  - Water users association formation and administration

  - Participation of members in rehabilitation planning
- Development of Department of Irrigation staff skills and awareness in concepts of management transfer
- Pre-hand-over rehabilitation planning including:
  - Joint walk-throughs
  - Action plans
  - Participation in quality control
- Ensuring good rehabilitation
- Monitoring and evaluation
- Institutionalisation of transfer process
- Sustaining water users associations, participation of women and good linkages with agricultural support services.

Maintenance after hand-over has received less attention. In practice, farmers are unlikely to focus on maintenance whilst rehabilitation is in progress. The establishment of canal management workforces under the Irrigation Management Transfer Project is a useful step forward. No full evaluation of the project has been undertaken yet, nor is it even possible at this early stage. However, there is some indication in the present research that maintenance performance has improved on the schemes where secondary or small main canals have been transferred. Transfer of the large main canal on the scheme at West Gandak has clearly been problematic. No procedure for maintaining the heavily silted main canal is in place, and there are some doubts about the sustainability of farmers' institutions (Prasad et al, 2000). Earlier reports were more favourable, suggesting that management transfer had operational benefits, which now appear not to have been sustained (Prasad et al, 1998).

The Irrigation Management Transfer Project has now developed more systematic procedures for post-turnover support, recognising that technical and financial assistance will still be needed after turnover. Water users associations are required to become independent, economically viable, and sustainable units. However, flexibility in transfer policy and procedures is still needed.

Joint Management Projects

Joint management, the transfer of low level canals and participation by farmers in management of higher level canals, has commenced on several other projects, for example on Sunsari Morang Irrigation Project.

A hierarchy of water users associations has been set up in this scheme, organised as follows:

- Water user groups are responsible for management of watercourses
- Water user committees are responsible for operation and maintenance in tertiary canals serving 50 ha to70 ha, but not for managing flows into them
- Water user Central Committees have some role in supervision of maintenance in secondary canals and may also be directly appointed as maintenance contractors
- The Department of Irrigation is responsible for the main and secondary canal networks.

The Water Users Central Co-ordination Committe is a co-ordination committee at the top level of the system. One level down, the Water Users Central Committee is responsible for irrigation service collection, being mandated to share funds with other tiers of water user organisations, as well as with the Nepali Government. The current Irrigation Service Fee is NRs 200 per year, 50% of which has to be passed to the Government. Ten percent is retained by the Water Users Central Commmittee, amounting to only NRs 20,000 annually for a typical secondary canal serving 1000 ha, assuming 100% collection efficiency. The total would barely cover administrative costs. It is reported that collections are declining and are not always passed on correctly. Some confusion of roles and responsibilities exists. Management is new, and hopefully will improve.

Other projects reviewed
Other reports and documentation from recent projects in Nepal were also analysed. They included the Community Groundwater Irrigation Sector Project Preparation Study; the World Bank Mid-Term Review of the Nepal Sector Irrigation Project (NISP) containing detailed field studies and crop budgeting for schemes on the tarai close to the Kankai, Tilawe and West Gandak schemes; and the Asian Development Bank –funded Irrigation Sector Project Completion Report.

2.3 Participatory irrigation management (PIM) in Gujarat, India

2.3.1 Policies and legislation

The process of participatory irrigation management in Gujarat effectively commenced in 1995 with a Government Memorandum agreeing a policy of Non-Governmental Organisation involvement. The main government policy and legislative instruments are described below.

Memorandum for Non-Governmental Organisation involvement in Participatory irrigation management (May 1995)
Non-Governmental Organisations that function as community organisers must contribute a minimum of 10% of expenditures incurred. The main responsibilities of the community organisers are to:

- Motivate the farmers of the command area to form groups to manage canal irrigation
- Organise the groups in a structured way so that they meet regularly and take decisions collectively. Provide training for facilitating group discussion, keeping records and minutes
- Help groups to prepare necessary documents, apply for registration as Irrigation Co-operatives and follow-up with the relevant department/ agency
- Provide training to the members of the society in maintaining accounts, water distribution, collection of water rates, agronomic practices
- Train the leaders and members of various committees, as well as outlet representatives, to carry out timely repairs and maintenance of the canal system
- Liaise with government officials at district level so as to obtain benefit of various government schemes for societies.

Policy Resolution (June 1995)
In 1972, the Irrigation Commission of the Government of India recommended that water rates on public irrigation schemes be raised to provide a more realistic return on the costs of water delivery. Water rates in Gujarat were found to cover only 8% of the costs of water delivery. It was recommended that rates should be increased to cover annual maintenance, operational charges, and part of the fixed costs of the works. The Gujarat Agriculture Commission approved the recommendations in 1998, and early in 2001 the State Government agreed to raise the rates.

In the meantime, co-operative irrigation societies had been able to raise their water rates to cover operating costs. In 1995, the State Government passed a resolution introducing participatory irrigation management, a partnership between farmers' associations and the Government for administration and cost-effective management of Government water resources. Principal elements are:

- Farmers' associations including at least 50% of farmers can apply for participatory irrigation management. Non-Governmental Organisations are invited to work with farmers
- The government will rehabilitate areas coming under participatory irrigation management, provided the farmers' association contributes 10% of the capital cost
- Farmers' associations must be officially registered under the Co-operative Act, Societies Registration Act, or Indian Companies Act
- The government retains ownership of the infrastructure after participatory irrigation management. The responsibilities of farmers' association are set out in a Memorandum of Understanding

- The government will accord legal rights to registered farmers' associations according to the Bombay Irrigation Act of 1879.

Memorandum of Understanding, November 1995

The Memorandum of Understanding, agreed by the responsible Executive Engineer and the farmers' organisation, spells out the responsibilities of government, Panchayat body and farmers' organisations as follows:

- At the outset, the water rate established by government will be levied on the basis of cropped area. The government will set a standard water charge on a volumetric basis within three years of a society taking over the responsibility for irrigation management;
- The irrigation society will receive a 30% rebate from its water rates to carry out maintenance:
    - Maintenance and desilting of distributaries and minors
    - Keeping the service roads and inspection paths in good condition
    - Removal of weeds, shrubs and trees from the canal site
    - Keeping the structures in good condition
    - Keeping outlets, gate seals etc. in good condition
    - Maintenance of watercourses and troughs
- Any special repairs required for causes beyond the control of the society or resulting from natural disasters to be carried out according to government policy in consultation with the society
- Office bearers and members of the society are required to train in irrigation management
- The society must allocate water to non society members but may charge special rates, provided they are not more than 30% above the rate charged to members
- The irrigation society will receive a 20% rebate from the water rates in order to cover the costs incurred in recovery of water charges, provided 100% of the amount due is received before a stipulated date of payment.

Follow-up actions to policy resolution

- Preference for execution of repairs or rehabilitation works will be, firstly, the concerned farmers' association, secondly, a competent Non-Governmental Organisation, thirdly, the relevant government department. Only in the final resort should the work be done by contractor
- Farmers must be involved in preparing plans of new works or of rehabilitation. For new work, a contribution of 5% will be taken form beneficiary farmers, for repairs / rehabilitation, the contribution will be 10%. Contributions can be in the form of cash, material or labour.

3. FIELD INVESTIGATIONS

3.1 Scope of investigations

Detailed field investigations were carried out on four irrigation schemes in Nepal, and six brief studies were made of schemes in the state of Gujarat in India. The objectives of the field investigations were:

- To assess the state of the physical infrastructure on the schemes
- To obtain information about: farmers' backgrounds, land, cropping, and income, irrigation system management, water users associations, water management and maintenance practices, so as to assess farmers' institutional capability to sustain the system.

On each of the study schemes in Nepal, the following approach was adopted for the investigation:

- Rapid technical asset assessment survey
- Farmer questionnaire survey
- Interviews of farmers' groups
- Key informant interviews.

The agricultural and socio-economic studies focused on the capacity of farmers to meet the full costs of operation and maintenance, including depreciation costs and periodic replacements. The ability of farmers to pay for maintenance is crucial to sustainability. The impact of management transfer on agricultural production could not be assessed because of the relatively recent introduction of the policy.

In Gujarat, owing to technical constraints, and the different approach to turnover processes there, a modified procedure was used. The monsoon rains had failed for the last two years in western India, and as a result, farmers on most irrigation schemes in Gujarat had received little or no irrigation water recently. Short visits were therefore made to the selected schemes in Gujarat to interview groups of farmers and key informants about maintenance and upkeep of the systems.

3.2 Selection of study schemes

Study schemes were selected according to the following criteria:

- The scheme to be between 3,000 ha and 10,000 ha
- Scope exists for improving maintenance at branch/distributary canal level
- The condition and operation of the main system is not at present a serious constraint to proper functioning of the scheme
- Rehabilitation is not in progress or planned in the near-term
- Water users associations exist and are reasonably effective.

Of the four schemes chosen in Nepal, two have been transferred, either fully, or in part, to farmers. Two are still managed by the Department of Irrigation. The schemes are located in Fig 1 and summarised in Table 3.1 below.

Table 3.1 Status of the four irrigation schemes studied in Nepal

Scheme	Gross (ha).	Turnover status
Khageri	3,900	Transfer of branch/secondary canals and below to water users association. Joint management of main system.
West Gandak	8,700	Transfer of main system, branch/secondary canals and below to water users association. Department of Irrigation retains responsibility for intake.
Kankai	7,000	Department of Irrigation responsible for main and branch/secondary system. Five of eighteen secondary canals transferred to water users association.
Tilawe	5,600	Department of Irrigation responsible for main and secondary system.

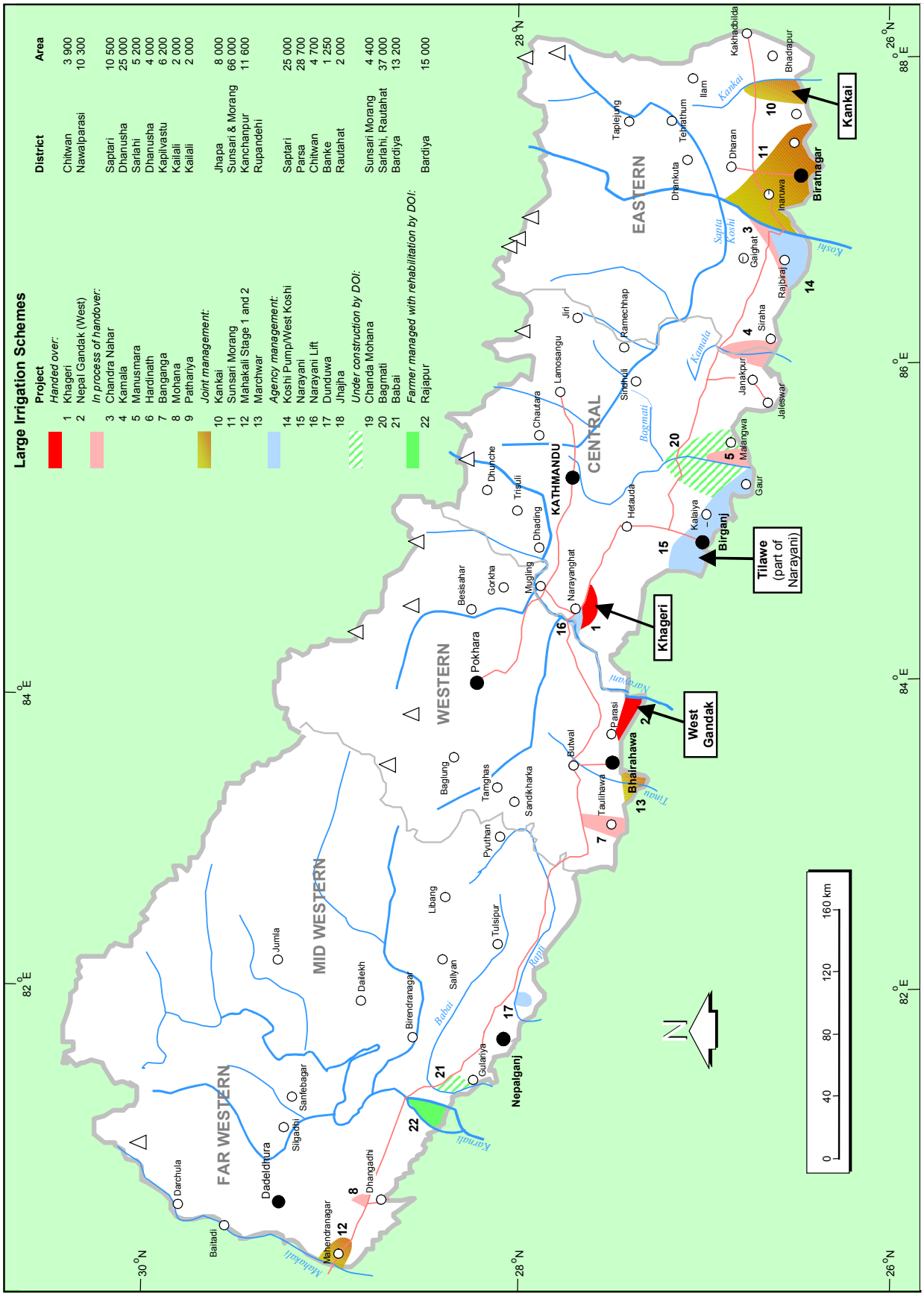

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Figure 1 Study sites, Nepal

Reliable estimates of the net cultivable areas or irrigated areas are not readily available.

Average annual rainfall varies from 1,400 mm at Tilawe to 2,900 mm at Kankai. The land is favourable for irrigated agriculture. As in most of the tarai, the soils are alluvial and are capable of high levels of productivity. They are relatively uniform, soil texture being the main source of variation; some soils are sandy and permeable, and are thus more drought-prone and require more irrigation water. The climate permits year-round cropping, although the cool winter slows plant growth. Triple cropping is difficult except when short season crops like vegetables are included. The pre-monsoon period (March to June) is suited to irrigated early/spring paddy. Despite high rainfall, dry periods can occur in the monsoon season, especially in the critical period of paddy flowering and grain filling in September and October. Supplementary irrigation at this time can produce major yield benefits in a dry year, but not in a good rainfall year such as 2000. Wheat, oilseed, pulses and other crops can be grown on residual moisture in winter/spring.

The tarai has abundant groundwater resources but aquifer conditions are variable. Not all areas are suitable for low cost shallow tubewell private irrigation. There are numerous private shallow tube wells on the West Gandak scheme but relatively few on Tilawe scheme.

For the four schemes, the critical factor influencing crop productivity and farm incomes is the volume and reliability of surface water deliveries at field level, which varies considerably from scheme to scheme. Based on present evidence, farmers on existing surface irrigation schemes such as the four covered in this study can be expected to continue to rely primarily on canal supplies, in spite of the supply problems, rather than switching over to groundwater supplies. Most shallow tube wells use diesel pumpsets. In the past two years, diesel fuel prices have doubled to about NRs 28/litre (2000), and are now a major constraint to shallow tube well expansion.

Three or four branch/secondary canals at each scheme in Nepal were chosen for detailed study, located in head, middle and tail sections.

In Gujarat, rapid assessments were made of six irrigation schemes. Four are in the southern part of the state, where the Agha Khan Rural Support Programme has been involved in participatory processes. The remaining two are in the north of Gujarat, where another non-governmental organization, the Development Suppport Centre, has been actively assisting farmers. Brief details of the schemes are given in Table 3.2 below.

Table 3.2 Status of the irrigation schemes studied in Gujarat, India

Scheme	Gross area (ha)	Turnover status
Dharoi	58,100	Thirteen pilot plots have been turned over to the farmers to act as 'learning laboratories' equivalent to some 3000 ha. The Development Support Centre (DSC) provides support for the turnover process and the farmers.
Guhai	7,100	DSC provides support for the farmers. There are currently 5800 ha under irrigation.
Pingot	300	The Aga Khan Rural Support Programme (AKRSP) has been working in the Pingot system since 1989, providing support to farmers. It is expected that support will be withdrawn in two years time.
Issar	350	In 1995, AKRSP became the community organiser on request by farmers. It has assisted in the formation of the irrigation co-operative society. The society took charge of water distribution in 1996/7 but is still awaiting confirmation of its status by Memorandum of Understanding with the Government
Lakigam	300	AKRSP has been involved with Lakigam since 1994. Currently an area of some 125 ha is being irrigated.
Chopadvav	1,020	AKRSP has had an involvement with the scheme since 1993. A co-operative society was formed in 1994.

On the larger schemes in Gujarat, group farmer interviews were conducted at three of four villages within the scheme. Only one meeting was held on the smaller schemes. Further details of the schemes are given in Section 4.

3.3 Technical asset survey-Nepal

A walk-through survey of each scheme was made to assess the physical condition of the main canal and selected branch canals, using a standardized rapid asset assessment procedure. Each survey team comprised an engineer, a Department of Irrigation officer and, where possible, a local representative of the farmers' group with knowledge of the operation practices (usually a gatekeeper).

Each structure and reach along the selected canals was examined for possible types of defects pre-identified in the standard forms. Where repair or routine maintenance was required, the cost of the necessary action was estimated. In some cases, it was noted whether the repair could be undertaken by the farmers' group from its own resources. The impact of the defect on water deliveries over time was estimated.

The output of the asset surveys was entered into spreadsheets. Summaries of the state of the infrastructure were prepared and costed priority maintenance activities identified.

3.4 Farmers questionnaire-Nepal

A detailed farmers' questionnaire proforma was prepared, to provide targeted information on the socio-economic and agricultural status of a sample of individuals within each scheme. In practice, it was found that sufficiently large samples, to achieve a high degree of statistical significance, were not feasible. However, the sample size of some 100 farmers on each scheme in Nepal is considered to provide a good indication of conditions affecting maintenance on the schemes.

Land, cropping, farm income, main system management, water users associations, local water management and maintenance practices were investigated. For the purposes of the interviews, farmers were defined as people who actually cultivate the land and are directly affected by the management of the system. Owner-operators, tenants, and sharecroppers were included, but not absentee landowners.

In Nepal, a local non-governmental organisation, Mountain Resources Management Group (MRMG) administered the farmer questionnaires. Three distributaries were selected from each scheme, on each of which 30 to 35 farmers were selected from a list provided by the Water Users Association, to give approximately equal representation from head, middle and tail sections. Two members of the team participated in each interview.

In Gujarat, farmers' group interviews were carried out in collaboration with the Aga Khan Rural Support Programme and the Development Support Centre. Both organisations work with farmers' groups in the role of community organisers and as facilitators in the participatory irrigation management process.

3.5 Farmers' group interviews

A checklist to guide interviews with farmers' groups was based on the broad features of the interviews with individuals. One group of 10 to 12 farmers was interviewed for each distributary studied. The aim was to explore in more detail, and gain consensus on, issues which had arisen in the course of individual interviews.

Interviews were carried out with groups in both Nepal and Gujarat.

3.6 Key informant interviews-Nepal

Key informants identified for each scheme included the following:

- District Irrigation Officer
- District Agriculture Officer
- Official of Agriculture Input Corporation
- Official of Asian Development Bank
- Village Development Committee members of the area
- Local agriculture input suppliers
- Local leaders
- Water Users Association Officials

A checklist of issues was used to guide the interviews.

4. DISCUSSION OF ISSUES

4.1 Introduction

It is widely recognised that whilst irrigation is a vital element of world food production, it is failing to perform to its full potential. In recent years, irrigation management transfer has been identified as a mechanism for improving performance. A number of reasons are cited in support of the policy, including empowerment of communities to manage resources; increased efficiency of management and improved agricultural production; more equitable sharing of the benefits of irrigation; reduced costs to Government.

Management transfer is not necessarily associated with system rehabilitation or with the reduction of subsidies to agriculture, although in practice in many cases, including Nepal and India, the issues have been linked. It is common to view system rehabilitation as an essential precondition for farmers' acceptance of additional responsibilities and reduced Government funding. Governments are widely motivated by the promise of reduction in recurrent expenditure. In practice, there are considerable costs to the state associated with management transfer, estimated at US$28/ha in the Philippines excluding the costs of rehabilitation. Expenditures need to be justified by improved performance and reduced overall costs.

The following sub-sections discuss the findings of the study and the literature review as to the impact of irrigation management transfer on standards of maintenance, on irrigation scheme performance, and on system sustainability. Although the focus is on maintenance, a number of other issues - particularly finance, and the performance of institutions - are also addressed, because they strongly affect the organisation and effectivess of maintenance.

4.2 Management Transfer and Maintenance

4.2.1 Factors affecting Outcome

Transfer of management responsibilities for maintenance, including the burden of cost, administation and execution, can in principle result in:

- No change;
- Improved maintenance, owing to better management after transfer
- Deterioration, due to confused responsibilities or the inability or unwillingness of farmers to take on new tasks.

Clearly, the second response is the desirable outcome. Whether it is achieved may depend on factors, such as:

- The process adopted for transfer; which components of the system are transferred; to whom they are transferred;
- The robustness of the newly-responsible organisation, its skills in building trust and in motivating farmers to participate
- Whether transfer can count on effective system operation, which in turn can encourage farmers to participate in maintenance
- Whether farmers have the required technical skills to carry out maintenance.

If a broad programme of rehabilitation has been undertaken as part of a package of incentives to encourage farmers to take over greater responsibilities on the scheme, it is likely (and desirable) that they will have been involved in the planning. However, it is possible that their assessment of needs would be different if rehabilitation were not part of a package of incentives for turnover. For example, they might focus more on improvement to the main canal, rather than on the lower level canals for which they will take over responsibility.

There are a number of apparently logical reasons why maintenance management should improve under transfer, provided the process is well managed (a significant assumption). These include:

- Farmers possess detailed knowledge of their system, including any local problems and requirements
- They are less bound by government norms, standards or procedures, so they may be able to short-cut processes and adopt pragmatic solutions
- They have a strong incentive to reduce costs by avoiding expensive works, whereas government staff may have the reverse motivation
- They are not constrained by Government budgeting cycles and procedures
- Their livelihoods depend on the system being in good condition.

The logic appears to be supported by a study by Brewer and Sakthivadavel's (1999) in Maharashtra and by Svendsen et al. (2000) in Mexico. However, the evidence for a positive outcome is very limited (Vermilion, 1997). Of 26 studies of operation and maintenance after turnover, he found only ten investigated maintenance; only four showed an improvement. It is not inevitable that anticipated benefits will be achieved in practice. Like many institutional processes, the socio-economic environment must favour change and considerable support may be needed in the transition phase. Section 4.2.2 discusses outcomes on the two transferred schemes in Nepal.

4.2.2 Impact of Management Transfer on Maintenance

The impact of irrigation management transfer on standards of maintenance depends on how it is carried out and followed up. Transfer of responsibilities can also affect different categories of maintenance in different ways. For example, removal of sediment from branch canals might be improved by transfer, whereas tasks involving more sophisticated skills could suffer. Some Government support will be needed after transfer, so transferred schemes could be given preferential treatment initially, for emergency maintenance or for other aspects.

A key question is whether transfer makes the maintenance process more efficient or just changes responsibilities. Changing the responsibility alone could be acceptable if, in the process, necessary maintenance work were done, rather than ignored. However, if maintenance were done to a similar standard at lower cost, the outcome would clearly be better. There are two aspects to improving the processes:

- What should be done before transfer- for example, in terms of promoting an appropriate type and capacity of organisation, improving or simplifying planning for maintenance, and in better selection of rehabilitation works?

  Rehabilitation is often done before turnover as part of a package of incentives to encourage the farmers to take over responsibility. It is likely (and desirable) that farmers will be involved in rehabilitation planning. However, it is possible that their assessment of needs would be different if rehabilitation were not part of the package. For example, they might focus more on the lower level canals, with a view to reducing their future maintenance needs, rather than on the main canal which remained the agency's responsibility. It appears that they might do so, even though the main canal was in worse condition and had greater significance for irrigation performance.

- What factors influence whether proper maintenance is actually done after turnover?

  Better understanding of the importance of maintenance; improved planning, organization and execution of the work; maintenance skills, organisation, and funding are all involved.

Management transfer can take place to different levels of a system. Of the two transfer schemes investigated in Nepal, one (West Gandak) has been fully transferred, and one (Khageri) is partially transferred (joint management of the main canal, full transfer of branch canals). The operation and maintenance performance on the West Gandak system has been unsatisfactory for a number of reasons, including complexity of the system, social and political differences. At Khageri, on the other hand, the

surveys indicated that a main water users association committee collaborates with the Department of Irrigation on maintenance of the headworks and main canal. The Branch Canal Committees are actively collecting resources, maintaining their canals and distributing water in their command areas. One scheme (Panchakanya), which was not investigated under the project, has been successfully fully transferred, but it is small (600ha) and not generally typical of schemes being transferred.

Joint management of the main system and transfer of branch canals appear preferable on schemes larger than 2000 ha, where branch canals typically serve 100 to 500 ha. Smaller schemes are more suited to full transfer, although there may be special problems at the head of the system (as at Panchakanya). Joint management of the main system means that farmers remain dependent on agency management in the main system. They can be involved, as at Khageri, to considerable advantage. However, in many cases, main system management is far more demanding than the operation of branch canals. Policy on irrigation fees mean that in effect the main system is subsidised, but the Department of Irrigation does not sufficient resources for full maintenance and consequently it is not fully carries out.

4.2.3 Comparison of agency schemes with farmer-managed systems

Nepal is justly famous for its indigenous irrigation systems. Some have been in existence for over 100 years and may irrigate up to 10,000 ha. The total area managed by farmers, mostly made up of small schemes, is estimated to be about 800,000 ha. about 70% of Nepal's irrigated area. The Nepali Government has long given some assistance, and many schemes (often named raj kulo) were originally government-built. Interestingly, many of the largest schemes were entirely private – for example Rani/Jamara, Rajapur, Chattis Mauja – and many have received no external assistance.

Intervention on existing Farmer Managed Irrigation Schemes is, however, increasingly common – up to half of the total area has been covered by programmes such as NISP and SISP. Intervention has mostly been on small Farmer Managed Irrigation Schemes, but it is also now being attempted on some of the larger schemes. Some, such as the Marchwar lift project, have been absorbed into 'modern' irrigation schemes (not always entirely satisfactorily). Others have been retained in their basic form but are now supplied from new main systems, a solution that has been proposed, but not yet fully implemented, at Babai irrigation project. Yet others, such as Rajapur or Praganna schemes are being rehabilitated without changing either the layout or the management arrangements.

Questions of transfer of ownership and management inevitably arise when the status of a system changes. New structures are built in farmer-managed canals, by the government and possibly on government land, and at that stage they are legally government property. Farmers have little choice but to manage them subsequently, but do they have ownership or merely the right to use them? Will the Department of Irrigation formally hand over to farmers? There have been indications that farmers might refuse to take over structures if certain demands are not met, although it is not clear whether such an action would have any legal meaning, or create any greater obligation on the Department of Irrigation for its future involvement in maintenance. Instances of farmers taking over small government-managed systems have also occurred, a notable example being at Pithuwa, which was built and managed by the government for a short time (not entirely successfully). It was taken over without any formal programme, and is now well-established as a farmer-managed scheme.

Farmer Managed Irrigation Schemes are commonly self-sustaining, but they are also able to plan for, seek and obtain external assistance as required. Fundamentally, the initiative comes from within the water users association.

Despite some problems, Farmer Managed Irrigation Schemes are one of Nepal's clear agricultural success stories. They are widely regarded as highly successful, providing a model for agency-managed systems after turnover. The comparison is instructive but also misleading, and it is important to highlight some fundamental differences:

- Agency-managed schemes tend to be larger, newer and built to hydrological, rather than social, boundaries (the average Agency Managed Irrigation Scheme is more than 10,000 ha, the average Farmer Managed Irrigation Scheme on the Tarai under the ISP programme is 200 ha)
- The water supply on Agency Managed Irrigation Schemes is often worse, as they are built to command the maximum conceivable area, with optimistic assumptions of irrigation efficiency. Farmer Managed Irrigation Schemes tend to enjoy a more generous supply (6 l/sec/ha on Rajapur FMIS, compared to 1 l/sec/ha on Sunsari-Morang scheme, and even less where a system of *warabandi* operates). Farmer Managed Irrigation Schemes are often gradually enlarged as demand increases.
- The layout of Farmer Managed Irrigation Schemes is commonly well suited to decentralized management of essentially independent units. On the other hand, most Agency Managed Irrigation Schemes were designed for centralized management. Management change may then involve major expenditure. The prospects for the successful full turnover of Agency Managed Irrigation Schemes, including the main canal, are limited if the systems are too large, complex and technically sophisticated for operation by small farmers;
- Management arrangements on Farmer Managed Irrigation Schemes were developed in parallel with the physical system, whereas agencies are now trying to transfer under-performing government systems
- Traditional irrigation relies on labour (particularly off-season labour at times of limited alternative employment opportunities) and local materials, rather than cash. Modern irrigation has a greater dependency on cash, which is more difficult to collect and to manage soundly. This situation is gradually changing on Farmer Managed Irrigation Schemes and is one of the emerging challenges for their management;
- New management or maintenance skills are not needed for Farmer Managed Irrigation Schemes, whereas they need to be introduced and developed on Agency Managed Irrigation Schemes.

Lam (1998) attempted to analyse the relative performance of a large number of Farmer Managed Irrigation Schemes and Agency Managed Irrigation Schemes, and concluded that Farmer Managed Irrigation Schemes are more effective even when differences highlighted above, and other confounding variables, are taken out. This is not a surprising conclusion, although the nature of the data and the simple statistical analysis leave the detailed findings open to considerable debate. Lam did not analyse large schemes (i.e. larger than 5,000 ha), which are the primary targets for irrigation management transfer. It does not necessarily follow that Farmer Managed Irrigation Scheme type governance structures can be set up when transferring management of Agency Managed Irrigation Schemes to farmers, but it may be possible to identify key characteristics, as attempted by Lam (1998) and Ostrom.

A good understanding of Farmer Managed Irrigation Schemes is helpful for developing ways of improving Agency Managed Irrigation Schemes since, despite the differences, Farmer Managed Irrigation Schemes have relevant institutional strengths. These often result from their effective organisational skills, which have been developed internally rather than imposed. They include an ability to mobilise and manage labour resources for Operation and Maintenance. The financial equivalent of labour contributions has been estimated in various studies, including the present, to lie in the range NRs 100 - 1,800 per hectare, with a median of around NRs 600 per ha. This is much higher than is collected on any Agency Managed Irrigation Scheme or transferred scheme, and is an indication of farmers' ability to pay for operation and maintenance if they are confident in the management system. The process is very transparent since labour is contributed when required, without administrative or transaction costs which may be misunderstood or resented. Defaulters are immediately apparent by their absence - strong compliance systems are important features of common property management.

4.3 Schemes investigated in Nepal

4.3.1 Background to schemes

As indicated at the outset, a wide variety of terms are used for the various processes of public participation in irrigation management or transfer of management responsibilities from government agencies to user

organizations. In Nepal and India, it is normal for farmers to be responsible in practice for the lowest levels of the system (e.g. tertiary canals), but the scale and extent of their responsibility varies from scheme to scheme. In Nepal, the current terms are:

- Agency-managed, where the Department of Irrigation is responsible for the whole system
- Joint-managed, where the Department of Irrigation manages the main system with some involvement by a Water Users Association, and Water Users Associations manage lower levels of the system
- Irrigation management transfer (IMT), which denotes the process by which management responsibilities for all or part of the system are formally transferred to users.

The schemes studied in Nepal come into various categories:

- West Gandak – fully transferred to Water Users Associations
- Khageri – jointly managed, with secondary canals turned over to Water Users Associations
- Kankai – agency-managed, with some secondary canals turned over to Water Users Associations and some involvement by the Water Users Associations in system management
- Tilawe – agency-managed, with no Water Users Associations.

Schemes at West Gandak (4.3.3) and Khageri (4.3.2) were both transferred under the Irrigation Management Transfer Project, but to different extents and at different rates. Schemes at Kankai (4.3.4) and Tilawe (4.3.5) remain substantially or wholly the responsibility of the Department of Irrigation.

Key aspects affecting performance after the transfer process are listed below:

- Design of system (reliability of water supply, layout, complexity of operation)
- Conditions of the system before transfer
- Pre-turnover planning for rehabilitation and subsequent maintenance
- Whether rehabilitation was focused on priority needs or was seen as an incentive for turnover
- Extent of, and budget for, rehabilitation
- Costs of transfer - for setting up, training and supporting Water Users Associations
- Strength of Water Users Associations and capacity to organize and manage maintenance

Table 4.1 compares the key aspects on the two transferred projects.

Table 4.1 Comparison of key aspects on turned over schemes in Nepal

Aspect	Khageri	West Gandak
Design of system (layout, complexity of operation etc)	Simple layout, few controls, small branch canals, little problem of sediment, but poor water supply in dry season	Inadequate supply, headworks controlled by India Large branch canals, and also many direct offtakes from main canal Major problem of sediment in main canal
Conditions of the system before transfer	Reasonably good, no major problems	Very poor, much sediment, banks weak / damaged, major problems not addressed in rehabilitation
Pre-turnover planning Rehabilitation Maintenance	WUA participation in rehabilitation planning, little consideration of post-turnover maintenance but since only secondary canals were transferred this was not important	Limited planning for rehabilitation, little or none for future maintenance, no understanding of resources or requirements for maintenance
Appropriateness / extent / cost of rehabilitation	Rehabilitation quite well-focused, although too much lining of secondaries and too little work on main canal. NRs 10,000 per ha	Inadequate, and left major problems unresolved.
Costs of transfer (WUAs)	Not known, but appears to have been greater than West Gandak	Not known, but relatively little training given to WUAs. Insufficient support given to enable them to set up sustainable systems
Strength of WUA	Main WUA strong and well organised, but declining revenue due to reluctance of farmers to pay. Apparently effective in liasing with DOI. Branch WUAs variable, but generally manage secondaries reasonably.	Originally strong, but not sustained, major changes after elections and now highly politicised and not trusted. Now unable to raise funds

Note: WUA = Water Users Association, DOI = Department of Irrigation

4.3.2 Irrigation infrastructure, Khageri Irrigation Scheme, Nepal

Scheme description

Khageri Irrigation System is situated in the western part of Chitwan district of the Narayani Zone, in the Central Development Region of Nepal. The service area is connected to the district headquarters by several village road networks. The system sits in the sub-tropical climate zone. The mean annual rainfall is about 2000 mm of which some 80% falls during the monsoon (June to September).

The system was designed in 1960, by the Department of Irrigation, to provide supplementary irrigation to monsoon paddy in the newly re-settled land of the Chitwan valley[1]. Original plans to develop 6,000 ha of land were abandoned due to shortage of water. The system now irrigates about 3,900 ha of cultivated land, mostly during the period of monsoon paddy cultivation[2].

Until 1992, the Department of Irrigation controlled operation and management of the system. In 1993, the system was put under a joint management programme and in 1994 was adopted under the Irrigation Management Transfer Project (IMTP) of the Department of Irrigation. IMTP is now complete and all the branch canals have been turned over to water user associations. The Khageri River provides the main water source for the scheme. The embankments of the East-West highway cross the river at the headworks, providing flood protection and control. The headworks are in good condition. They consist of a gated barrage with two manually operated bays, each of 11 m span, a reinforced concrete floor with baffle blocks, and loose gabion protection downstream of the barrage. The downstream protection was washed

[1] Government initiated a resettlement program in the Chitwan Valley in the early fifties by clearing the forestland.
[2] The area varies depending upon the intensity and duration of the rainfall. 3900 ha can be brought under irrigation only under the best condition.

away and was recently repaired. The District Irrigation office is involved. The organisation has recently been strengthened by establishment of a unit responsible for Panchakanya, Khageri and Narayani Lift schemes (Panchakanya is fully transferred, and Narayani is not transferred). It is thought the move resulted after complaints from farmers that they lacked support, and is commendable. However, it underlines the fact that the financial savings to Government of turnover are likely to be small.

The main canal is 22.7 km long, the first 1 km of which, partly lined with reinforced concrete, is in fill. The canal then runs unlined through the buffer zone of the Royal Chitwan National Forest for 9 km without offtakes. The right side is unembanked, which allows water from incoming drains to collect in natural reservoirs to supplement the main supply and act as storage for the system. The design discharge of the main canal is 7.24 m^3/s. Once outside the forest, the main canal follows the contour and requires few cross drainage structures. There is little problem with siltation. There are 49 major structures along the main canal, some of which are gated controls. Small branches serve on average 250 ha. They operate without check gates, making the system easy to operate. Tertiary outlets serve 5 ha to 8 ha.

System condition

Minor rehabilitation at transfer cost about NRs 10,000 per hectare, of which 25% was spent on the main canal, mainly on desilting, lining, and some new structures. Rehabilitation was well-planned, involving considerable participation by users. Small changes were made to structures for better operation. Users later complained that excessive desilting was carried out in some canals, the over-enlargement causing extra seepage and reduced command. Their response has been to seek more canal lining. Some farmers have stated that, since various works were excluded from rehabilitation, they are not motivated to maintain the system. Problems in distributary S5 are thought to be related to this issue. The system as a whole is in relatively good condition and has well-established farmers' institutions. Maintenance (by farmers) does not constrain operation at present, and is unlikely to do so for the next few years. The main canal is believed to be the main constraint to performance. The cost of main canal maintenance has been estimated in this study at nearly NRs 400 per hectare, partly the result of a backlog of deferred maintenance. Branch canal maintenance is estimated at NRs 300 to NRs 1100 per ha, mostly for improvement works. As much of the system has been rehabilitated or received attention over the last decade, it is hard to estimate the true maintenance costs, but it is likely to be of the order of NRs 500 per hectare for main and branch canals down to the tertiary outlets. Many canals have been lined, resulting in low maintenance in the early years, but costs will rise rapidly once the lining begins to deteriorate.

Although the government still has responsibility for operation and maintenance of the main canal, users are actively involved in its operation. Department of Irrigation gate operators operate and maintain the headworks, main canal cross-regulators, and secondary canal head regulators. Some of these staff are nominated by the Water Users Associations, who themselves undertake some of the maintenance under payment from the Department of Irrigation. Associations do not contribute Irrigation Service Fees, as required by the Irrigation Policy, but are reported to do more maintenance than they are paid for.

An Irrigation Service Fee of NRs 120 per hectare per rice crop is levied. The collection rate is reported to be around 60%. 25% of the collection is supposed to be paid to the main committee by the branch committees, but very little is actually paid, and it is insufficient even for administrative costs. The collection is declining, partly because farmers do not perceive that it is usefully spent. Farmers contribute an additional maintenance fee, which varies between canals, to cover the cost of labour for secondary canal desilting. In the case of Minor no 1, a fixed annual maintenance fee of NRs 200 per bigha (NRs 300/ha.) was levied in 2001, compared with farmers' estimates of need for NRs 550/ha. for the system as a whole. The canal is well-maintained and the fee has allowed the Association (drawn from a well-motivated ex-army community) to build up a cash surplus in the bank. Other canal associations raise funds as required. The amount is insufficient for operation and maintenance of the system. Despite limited funding, standards of maintenance do not yet limit the performance of the system, though there are some problems, particularly at the tail of the main canal. Other maintenance issues are the poor condition of canal banks, which are weak and liable to breach in places, and some problems with the main canal gates.

Assessment

It is apparent that although this is a relatively successful scheme, the process of turnover is not entirely replicable or sustainable. The pre-turnover rehabilitation was aimed at reducing maintenance in the early post-turnover years to encourage farmers to take over, and does not appear to have brought a commitment by farmers to maintain the system. Rehabilitation left some major problems in the main canal which are still being rectified. There was inadequate planning for post-turnover management, and there is a gap in the annual financing. The system depends on continued subsidy for main system maintenance. Despite these reservations, turnover can be regarded as a success because it has led to improved management of the system, with greater and more effective involvement by farmers, improved co-ordination, and a more efficient role for Department of Irrigation. The effect on maintenance processes has been less clear: the greatest impact seems to be in the jointly managed main system, where the Water Users Association has been able to ensure that the limited resources are targeted appropriately. However, budgeting is still centrally controlled and is not related to needs – the Water Users Associations and the Department of Irrigation have to prioritise a limited budget rather than plan maintenance logically. The design of the system and the extent of turnover are suited to the local capacity for management. Some small improvement in routine branch canal maintenance may have taken place, with better labour mobilisation and some control over bank encroachment. However, it may be due as much to rehabilitation as to improved standards of management, and the true impact will only become apparent in a few years

4.3.3 Irrigation infrastructure, West Gandak Irrigation Scheme, Nepal

Scheme description

West Gandak Irrigation System is located in Nawalparasi District in the western development region of the Nepal Terai. The main command area is south of the East-West highway and continues to the Indian border. The nearest city, Narayanghat, is 60 km to the east. The scheme lies in the sub-tropical region. Mean annual rainfall is 1500 mm, of which some 80% falls during the monsoon period. Rainfall in July averages 400 mm.

The scheme was constructed under a joint Indo-Nepal agreement on the use of the Gandak River. A barrage across the river, completed in 1970 provides irrigation for 8700 ha of land in Nepal (NWGIS) and 100,000 ha of land in India. The main canal and distributaries were constructed by the Indian Government and completed in 1979. Only part of the command received irrigation until the Command Area Development Project (CADP), funded by the Asian Development Bank, was completed in 1989. In 1992, the government introduced the Joint Management Programme encouraging farmers' involvement in all phases of irrigation development and management.

The main water source for the scheme is the Gandak (or Narayani) river. The headworks consist of a barrage with an overflow weir type intake and two manually operated gated openings. Flow entering the main canal directly depends on the barrage level rather than on the incoming river discharge and is highly variable during the monsoon period due to frequent opening of the barrage gates to pass silt-laden floodwater.

System condition

In the head reach of the main canal, where the section is in deep cut, there is frequent slippage of the upper part of the section under rainfall. This fact adds to the problem of sediment carried through the silt ejector, which cannot be properly flushed.

Siltation is the major problem in the main canal. Up to 70% of the canal section was found to be silted during an inspection visit. The embankments are planted with trees, which obstruct the movement of mechanical maintenance plant. Silt is removed by loaders, excavators and dump trucks, but is improperly disposed of on the banks, whence it regularly flows back into the canal. Maintenance of the canal takes place in March/April when the gates on the barrage are opened for maintenance. As a result, it is not possible to grow an early paddy crop on the scheme. Cultivation of sugar cane is also affected. Cross drainage siphons often do not function effectively, probably due to lack of maintenance but possibly also

due to inadequate capacity for the present conditions in the watershed area. As a result, the canal has been breached frequently in recent years. The canal service roads are in good condition, having recently (2000) been gravelled.

Gates on most of the flow regulating structures are not operational, requiring at least greasing and freeing. A few gates are missing. There is some vegetative growth in the canal section towards the tail end of the canal that receives water infrequently. There is an adequate supply at the head but the canal has insufficient conveyance capacity because of siltation. Alternative policies of rotation between four zones or on-demand operation were proposed at the time of transfer to address the problem of scarcity. They seem to be too sophisticated for inexperienced farmers to manage. At present, there are no rules and regulations for water distribution.

After transfer in late 1997, maintenance has been the responsibility of the WUA, with technical assistance and budgetary support from DOI for a period ending in 2001. However, since the WUA hierarchy is effectively not functioning, maintenance has been badly neglected. Apart from siltation in the main canal, in 2000 there were throughout the command area a number of canal breaches which had not been repaired. The largest branch canal, the Bishnu Ganj, designed to irrigate more than 1000 ha, was not operating.

Lack of funds seriously constrains the scope of possible maintenance. Funds provided by Government were supposed to supplement funding from the WUA, principally from ISF. In practice, collection of local funds has severely decreased amidst accusations of misuse.

Assessment

A major strength of the system is the ready availability of water at the head. A large variety of crops are grown in the area; there is great potential for agricultural intensification and further diversification. There are good roadlinks to markets. Canal networks have been developed down to field level.

The system effectively lacks any overall system of management. Control by Department of Irrigation having been removed, there is now a vacuum, unfilled by Water Users Associations - which are presently not competent or coherent enough to take over. Because of its design and situation, the system particularly requires proper maintenance. Technical problems include deposition of large volumes of sediment, both within the system and on the fields, in the latter case principally from natural watercourses. Frequent flooding also affects production. Problems with cross drainage works on the main canal are in fact the responsibility of the Indian Government, but they are not attended to. The southern main canal, serving India, blocks drainage from the Nepalese main canal to the north. The operation of the barrage in the interests of India, and maintenance of low water levels in the Indian canal, cause supply problems in the West Gandak canal. The problem was only partially resolved at Turnover when the offtakes of the Nepalese secondaries were set lower.

A more detailed assessment of the performance of Water Users Associations and possible remedial actions are included in later sections. Action is needed to check the decline of the system.

4.3.4 Irrigation infrastructure, Kankai Irrigation Scheme, Nepal

Scheme description

Kankai Irrigation System is located in Jhapa District in the Eastern Development Region of Nepal. The main command area is located to the south of the East-West highway, approximately 5 km from the village of Dudhe. The nearest city, Biratnagar, is 75 km to the west. Kankai sits in the sub-tropical climate belt. Mean annual rainfall is 2858 mm, of which some 80% falls during the monsoon (June to September). Rainfall in July averages 835 mm.

The project was constructed in two stages. The first, commanding 5,000 ha, was completed in 1979 and the second, covering an extension area of 2,000 ha, was completed in 1990. The extension area is not developed to the same standard as the original area. A further 1,000 ha is yet to be developed. There are a

total of eighteen branch canals each serving between 120 ha and 800 ha. The Department of Irrigation manages the main system, however, four secondary canals commanding 1,200 ha were handed over to Water Users Associations in 1996. Some rehabilitation and institutional development was carried out on four secondaries prior to turnover, when a main Water Users Association together with Water Users Associations for each secondary canal were formed. A fifth secondary, S5, had only just been handed over in 2001. Until 2000, Kankai was managed centrally by the Department of Irrigation. Since then, responsibility for the scheme has been handed over to the local district irrigation office. Further changes are currently under consideration by DOI, as a result of which the office may be returned to Kankai.

The main source of water is the Kankai River, which is perennial. The headworks consists of a diversion weir with intake on the right bank. The concrete-lined head reach of the main canal leads to a sluiced settling basin. The design capacity of the main canal is 10.6 m^3/s, but it is reported that the maximum flow which can be passed is just over 6 m^3/s, owing to operational limitations at the headworks and rapid deposition of gravel in the intake channel. The scheme is laid out for centralized management, so limited responsibility can be devolved to farmers.

The main canal is just less than 17 km in length. The upper 11.5 km. is lined with concrete slabs or concrete blocks. There is little siltation since the bed slope is 1 in 1000. In some places, gabion mattresses have replaced the damaged lining. The lower section of the main canal is unlined. Sections of the canal are in fill, particularly at the tail. There are a total of 82 structures along the main canal. Small, unlined, branch/secondary canals serve on average 300 ha, and there are a number of direct tertiary offtakes. The canals are easy to maintain, though maintenance tends to follow the occurrence of problems, rather than anticipate them.

System condition

The headworks suffers from serious problems of erosion of the concrete, piping under the weir and downstream scour, requiring urgent maintenance/rehabilitation at a cost of NRs 25 milllion (equivalent to NRs 3500 per ha). The lined section of the main canal is mostly in good condition but some problems are emerging, particularly with cross-drainage works. The unlined section (5.4 km) is in much poorer condition, affected by damage to the banks, weed growth and sedimentation, and urgently requires maintenance. NRs 3.7 million is required for maintenance of the whole main canal (Rs 500 per ha). Much of the work results from a backlog of deferred maintenance, but it can be estimated that about NRs 150 per ha will be required annually, with occasional requirements for larger sums. Branch/secondary canals are in relatively good condition.

The costs of structural maintenance have been estimated at NRs 250 per hectare, the greater part for rehabilitation of gates and measurement structures, which are not used in practice. Excluding these items, the cost of maintenance of secondary canals comes to NRs 75 (canals) plus NRs 25 (structures), in addition to expenditure on routine annual sediment clearance and weed cutting. The figures probably allow for a backlog of deferred maintenance. Costs of canal operation staff, estimated at NRs 150 per ha by Royds (D B Thapa p8, 1999), miscellaneous costs for routine maintenance, and unskilled labour for desilting and weed clearance in secondary canals need to be added. The various cost are summarised in Table 4.2 below.

Table 4.2 Component costs for the Kankai irrigation scheme

Component	Cost
Headworks	NRs 250 (including deferred maintenance averaged over 20 years)
Main canal	NRs 200
Secondary canals	NRs 100
Desilting of secondaries (labour)	NRs 50
Operation and maintenance staff	NRs 150
Sub-total	NRs 750 per ha

The figures exclude labour contributions to maintenance of field channels and tertiaries. They are indicative only, since it is difficult to separate the backlog of deferred maintenance from normal requirements, but they are very similar to those derived independently by Royds (1999). It is apparent that most of the maintenance effort for Kankai scheme is required on the main canal. Of the four secondary canals studied at Kankai, one (S9) had been turned over, and one (S5) is in the process of hand-over. A fairly informal process of transfer has been followed, but some work has been done in setting up water user associations and in training. Pre-turnover rehabilitation was confined to the secondary canals, and has been aimed at improving the system (for example, by provision of culverts) or reducing short-term maintenance needs (by canal lining). There was little planning of future maintenance needs or resources. There appears to be little difference in condition or performance of these canals that can be attributed to turnover. Associations either, collect an Irrigation Service Fee and use it for maintenance, or they pay ISF and receive a small maintenance grant. In both cases, Irrigation Service Fee collection rates are low, and little maintenance is required or done in practice, apart from some unskilled works. If cash is available it is often used for improvement or new works rather than on maintenance.

The main canal remains the responsibility of Department of Irrigation, and although there is a central water users association its involvement in main system management is small. The central Water Users Association has an annual budget of about NRs 20,000 (NRs 3/ ha), which limits its functioning to purely administrative and co-ordination tasks. The total Irrigation Service Fee collected is much less than actual expenditure on the main system, which in turn is much less than the required amount. In accordance with normal practice in the 1970s, the system was designed with a large number of gated structures. Most are in poor condition, and it is unlikely that they would be used in the present situation, even if they were rehabilitated. The lack of effective control causes some problems in water management. Modification to a less flexible system might be more appropriate, but the cost could be prohibitive.

Assessment

The scheme offers substantial value to farmers, allowing the cultivation of spring paddy rice in alternate years. Monsoon paddy also benefits from irrigation, although the need varies from year to year according to the reliability of the monsoon. Potatoes and vegetables benefit most from irrigation, but the scope for these crops is limited. The cost of operation and maintenance is fairly high, equivalent to 10% or more of the net benefit, largely because of the weir and main system. The willingness of farmers to pay will depend on the water delivery performance being improved, a function which will largely remain the responsibility of Department of Irrigation even after turnover of secondary canals. The central water users association could in theory help with allocations, but an effective approach to financing the operations and maintenance costs of the main system still needs to be devised.

The condition of structures at present does not affect their safety or ability to pass the required flow, but there are problems with control and measurement. Scour damage downstream of structures and poor condition of earthworks are the principal problems in the main canal. Maintenance of canal earthworks is also the main need in the secondary canals. The work is not complex: lack of motivation rather than limited technical skills or resources appears to be the key constraint. Even routine desilting and weed clearance is often done inadequately.

4.3.5 Irrigation infrastructure, Tilawe Irrigation Scheme, Nepal

Scheme description

Tilawe Irrigation Scheme is located in Parsa District in the Central Development Region. The irrigated area is about 10 km west of Birgunj city and is connected by gravel road. The scheme is in the sub-tropical zone with an average annual rainfall of about 1400 mm. Monthly rainfall varies from 4 mm in November to 470 mm in July of which some 83% falls in the monsoon period.

The project started in the late 1950s. During the 1960s, the Indian Government assisted Nepal to construct the Nepal Eastern Canal (NEC) for irrigation of 28,800 ha on the Narayani Irrigation System. The

command area of Tilawe falls entirely within the command area of the NEC. The World Bank assisted in developing the NEC command area, including blocks 5 and 6 that are served by the left and right bank canals of Tilawe. After 1994, the Department of Irrigation maintained the system through the Narayani Irrigation Development Board (NIDB), until 1999, when responsibility was handed to the local district irrigation office in Birgunj. Since then, employees of NIDB have been on general strike, and farmers have operated the scheme on an ad hoc basis.

The main source of water is the Tilawe River, which is perennial. The headworks consist of a barrage, two under-sluices and two intakes. An additional intake has been constructed on the NEC to provide a supplementary supply to Tilawe. The left bank main canal is 12 km in length. The design discharge is 3.3 m^3/s, intended to irrigate 2,789 ha. There are five branch secondary canals with a total length of 22.5 km, six sub-secondary canals, and approximately 7 km of tertiary canals. All canals are unlined except for short sections of secondaries and sub-secondaries. There are at least 82 canal structures. Control structures were previously provided with gates but they were not replaced during rehabilitation. A number of gates remain but they no longer function.

System Condition

Operation and maintenance staff considered the headworks to be in good condition, though some downstream protection work is needed. The gates on the barrage were repaired in 1999/2000. This study concentrated on the left bank system. The channels of the main and secondary canals were felt to be in fair condition, but structures are in poor repair. Designed to be ungated, the crests of many structures have been broken. Work on maintaining the structures has been deferred. Farmers at the head of the system receive all the water they want, whilst farmers at the tail face frequent shortages. According to the agency, most of the tertiary canals have been abandoned. Effectively, all the channels need to be reconstructed. Participation by farmers in maintaining the system is negligible, but during the strike of the Department of Irrigation staff they have operated the system in their own fashion. Normally, about NRs 150,000 is needed to pay operating staff. The cost of necessary maintenance work on the main and secondary canals is now estimated to be above Nrs 1,000 /ha, owing to neglect, the highest figure of the four schemes investigated.

In the 1999/2000 year, some NRs 1,140,000 was spent on maintenance for the Block 6, left bank main area, or NRs 409/ha calculated on the basis of the nominal command area. A substantial amount of the total was spent on lining a sub-secondary canal, arguably an improvement work not to be included under maintenance. In the same year, some NRs 1,000,000 was spent on Block 5, right bank main canal. At present only the highest priority works, identified according to the judgement of the operation and maintenance engineer, are undertaken. Much work is deferred.

Assessment

The general condition of the system is poor, its situation exacerbated by shortage of water and of funding, indifference of farmers and the long-running strike by technical and administrative staff.

The majority of farmers interviewed claimed that maintenance work actually carried out on the system is poor, and that its condition is worse now than five years ago. Given that neither agency technical staff nor farmers are currently involved, its condition can only worsen further. Nearly 70% of farmers claimed not to know who is responsible for maintenance of field channels, which suggests that that they have no feeling of ownership in the system. There are a large number of informal offtakes from the main and secondary canals. Many of the canal bank service roads are impassable during the monsoon. Water Users Associations are non-existent or non-functional.

4.3.6 Summary of infrastructure condition (Nepal)

Tables 4.3 to 4.8 summarise system condition and maintenance on the four schemes. Appendix B provides more detailed information.

Table 4.3 Summary of infrastructure condition (from asset survey)

Scheme/system level		Percentage of structures defective	Percentage of structures requiring maintenance	Percentage of structures requiring improvement	Percentage of canal length defective [1]
Kankai	Main	41%	41%	0%	19%
	Branches [1]	36%	20%	16%	17%
Khageri	Main	23%	21%	2%	13%
	Branches	14%	11%	3%	23%
Tilawe	Main	34%	17%	17%	50%
	Branches	30%	20%	10%	34%
West Gandak	Main	36%	16%	20%	52%
	Branches	40%	23%	17%	54%

Note 1. Estimate of canal length affected by a problem. Asset surveys identified condition of left and right banks and channel section separately.

Table 4.4 Capacity of farmers to carry out repairs/maintenance

Scheme/system level		Percentage repairs within farmers' technical capability
Kankai	Main canal	51%
	Branches [1]	100%
Khageri	Main canal	57%
	Branches	100%
Tilawe	Main canal	63%
	Branches	100%
West Gandak	Main canal	12%
	Branches	72%

Table 4.5 Farmers' perceptions of system condition

Assessment of condition	Kankai	Khageri	Tilawe	West Gandak
Condition of canals. Percentage of farmers considering current condition to be "good" or "reasonable"				
Main	59%	69%	50%	28%
Branch/secondaries	63%	88%	37%	26%
Field channels	68%	78%	42%	38%
Condition compared with five years ago. Percentage considering current condition "better":				
Main	4%	7%	4%	0%
Branch/secondaries	6%	14%	3%	0%
Field channels	3%	9%	4%	0%
Condition compared with five years ago. Percentage considering current condition "same":				
Main	44%	62%	26%	24%
Branch/secondaries	47%	72%	15%	19%
Field channels	54%	68%	32%	30%
Condition compared with five years ago. Percentage considering current condition "worse":				
Main	43%	25%	69%	76%
Branch/secondaries	45%	8%	78%	81%
Field channels	36%	7%	46%	52%
Maintenance: Percentage considering that maintenance work is not well done	69%	50%	70%	81%
Maintenance: Percentage considering that work done now is "better" or "same" as five years ago	16%	44%	7%	34%
Maintenance: Percentage considering that work done now is "worse" than five years ago	42%	50%	82%	65%

Table 4.6 Farmers' perceptions of water supply and system operation

Item	Kankai	Khageri	Tilawe	West Gandak
Percentage judging supply to be adequate during:	94%	48%	65%	55%
Monsoon	34%	8%	49%	30%
Winter	16%	15%	3%	0%
Spring				
Percentage judging distribution to be fair:	43%	66%	33%	13%
Between branches	50%	60%	41%	18%
Along branches				
Main constraint in different seasons:	Operations	Water-short	Operations	Operations
Monsoon	Operations	Water-short	Operations	Operations
Winter	Water-short	Water-short	Operations	Operations
Spring				
Percentage judging supply/operation of main system to be:				
Acceptable	61%	83%	46%	21%
Poor	34%	10%	50%	74%
Percentage judging supply/operation to be "better" compared with five years ago	7%	10%	10%	5%
Percentage judging supply/operation to be "same" compared with five years ago	45%	68%	20%	21%
% judging supply/operation to be "worse" compared with five years ago	44%	15%	69%	74%

Table 4.7 Farmers reporting a contribution to maintenance

Contribution to Maintenance	Kankai	Khageri	Tilawe	W Gandak
Percentage of farmers who help to desilt:				
Main	15%	45%	17%	11%
Branch/secondaries	85%	75%	46%	59%
Field channels	86%	67%	52%	64%
Percentage who claim to help with other maintenance	49%	29%	17%	16%
Avge. Number of days/yr worked on maintenance	3.9	2.8	2.5	3.1
Percentage who think maintenance adequate last year	36%	39%	12%	9%

Table 4.8 Farmers' views on responsibility for canal maintenance

Level of system	Responsible	Kankai	Khageri	Tilawe	West Gandak
Main canal	DOI	84	40	98	65
	WUA	9	32	0	17
	Don't know/other	7	28	2	18
Branch/secondaries	DOI	20	2	57	11
	WUA	73	81	13	54
	Don't know/other	7	15	31	35
Field channels	DOI	1	1	20	0
	WUA	88	75	12	43
	Don't know/other	11	24	68	57

Note: DOI = the Department of Irrigation WUA = Water Users Associations

Table 4.3 summarises the responses of farmers to questions about the state of their systems. They were required to comment on the condition of the main canal, on branches/secondaries and tertiaries separately. In fact, though there were differences between schemes as to perceptions of system condition, both currently and compared with the past, schemes were judged similarly to the asset survey.

The responses for the transferred schemes, Khageri and West Gandak, generally confirm the assessments made by other methods. Rather few farmers consider conditions at Khageri better than five years ago, despite the improvements that have been made over the years. However, there are also rather few that consider conditions to be worse. It is consistent with the judgement of a majority of the farmers surveyed that the water supply operations and distribution at Khageri are acceptable (Table 4.6), and with the outcome of the asset survey that characterized the condition of the system as generally *"good"* or *"reasonable"*. Water shortage is a problem at most times of year.

On the other hand, the majority of farmers at West Gandak clearly believe the system has deteriorated over the last five years and that supply/operations have worsened in parallel. The asset survey showed that the canals and many of the structures at West Gandak were in poor condition.

A majority of farmers interviewed at Kankai consider that the scheme is currently in *"good"* or *"reasonable"* condition. However, there appears to be a gradual deterioration in the system, since substantial numbers believe its condition was better five years ago. Judgements on water supply/operations and system condition are very closely linked: very similar numbers report a deterioration. The asset survey shows that a considerable number of structures, particularly on the main canal, need maintenance. Numbers of structures on the branches are beginning to need improvement.

At Tilawe, around 50% of respondents felt the scheme was not in good condition. A large proportion felt that it had deteriorated noticeably over the last five years, again comparable to the numbers who reported supply/operations to have worsened over the same period. The asset survey shows that most of the canals need work and that deferred maintenance on structures means that improvements will be needed to a substantial proportion of those identified as defective.

Despite deterioration, the asset survey indicated that most of the necessary work on branch/secondary canals was within the capacity of farmers to execute. Apart from West Gandak, a substantial amount of the necessary work on main canals could also be done by Water Users Associations. In practice, except at Khageri (Table 4.6), farmers are not normally involved with main canal maintenance. Most claim to work on desilting canals at secondary/branch level. If that is the case, the surveys show that the time and resources devoted to the task are inadequate. Table 4.8 summarizes farmers' understanding of the

institutional arrangements for maintenance at different levels of the system. It is clear that at Khageri, people understand that the Department of Irrigation and Water Users Associations share the responsibility for main canal maintenance. However, at West Gandak, despite the transfer of the whole system to Water Users Associations, large numbers believe that the Department of Irrigation is responsible for the main canal, and in fact the Department retains control over maintenance plant. Under the agreement, DOI is supposed to support Water Users Associations in their work. It is perhaps an expression of the fact that Water Users Associations are not competent to manage a work of that scale and complexity. It is also worth noting that very large numbers of farmers at both Tilawe and West Gandak either claim not to know who, or claim some third party, is responsible for maintenance of the tertiary system, traditionally an area where farmers or their organisations have sole responsibility for maintenance. It may commonly mean that if any maintenance is done, it is by individuals without any involvement of Water Users Associations.

4.4 Schemes investigated in Gujarat

4.4.1 Introduction

Six schemes supported by AKRSP or DSC were visited to understand issues associated with maintenance under PIM.

The northwestern part of the state is dry, with less than 500 mm rain a year. In the southern part of Gujarat, rainfall averages 2000 mm a year. In winter temperature average between 12° and 27° C, although freezing levels have been recorded in the state. In the summer temperatures average between 25° and 43° C and have been known to reach as high as 48° C.

A wide variety of crops are grown on the schemes. Kharif crops include some or all of the following, depending on location: paddy rice, maize, pulses, cotton, groundnut, castor, millet/sorghum. In rabi, wheat, mustard, cummin, sorghum, sugar cane, castor, vegetables are grown. Summer crops are: pulses, groundnut, fodder, HY cotton and maize.

Average yields for each crop vary widely. Selection of crops and success in growth is dependent on factors such as water availability, local market conditions and existence and leadership of water users association.

4.4.2 Dharoi Irrigation Scheme

Background

Dharoi Irrigation Scheme is located in Mehsana District in the North East of the state of Gujarat. The nearest city and District Headquarters, Mehsana is located 15 km south-west of the scheme. Visnagar, the Taluka headquarters, is located centrally within the scheme.

The Sabarmati River provides the main source of water. A dam across the river was completed in 1978, providing gross reservoir storage capacity of some 900 Mm^3. The main canal serves three secondary canals. Although the right bank canal system was designed to irrigate 45,550 ha, a maximum of 40,000 has been achieved so far. The main canal currently serves Kheralu, Vijapur, Visnagar, Mehsana and Siddhpur Talukas, but plans for a significantly extended command area are under way.

In 1994 the government of Gujarat selected 13 pilot projects as learning laboratories for Participatory Irrigation Management in different agro-climatic regions of the state. Thalota irrigation co-operative society was such a pilot project. Irrigation turnover is now taking place on a village-by-village basis, as other farmers are encouraged to form a society like that in Thalota. Out of a total of 120 villages, five water users associations have been formed, with a further 20 currently in the process of turnover.

All the water users associations visited in Dharoi scheme get support from DSC.

Operation and maintenance

The Government operates the main canal, dam and headworks. Operation of lower order canals depends on the stage of turnover. Four villages were visited, in varying stages of turnover:

Rangpur – Middle / tail end
Rangpur village is in the process of turnover. Irrigation takes place in the winter and summer seasons only and not in Kharif. Farmers submit individual requests for irrigation to the society, according to crop grown and area. The society may limit the area according to water availability. The society has had no need to carry out any maintenance to date, owing to the fact that rehabilitation is ongoing and there has been no water for the last two years.

Thalota - Middle / tail end
The PIM process is complete in Thalota. The irrigation schedule is drawn up by the society, based on the request for water by society members, balanced against the availability of water advised by the government. The government supplies the water on the basis of area cropped. Four to five gatekeepers are employed to operate the schedule according to the timetable. A flume is used to measure actual volumes of water and the farmers agree with the approximate values calculated. The society has a disciplinary committee to deal with abusers of the system. If a farmer is found to be at fault then the water supply is stopped and a fine imposed. Before PIM there were an estimated 21 illegal offtakes along one of the minors. There are now only five official offtakes. The system is not totally equitable owing to the fact that head end farmers take too much water. The capacity of the canal also limits flow to downstream users.

The 20% rebate on water fees received for collection and administration is deemed to be insufficient. The society therefore plans to raise extra money from additional water fees. It presently receives a 30% maintenance rebate and has collected Rs 14,000 in a separate account. Rs 3000 per year has been spent in each of the last 2 years on labour to carry out de-silting water courses and outlets, grass cutting (canal banks), and weed clearance. In view of the high cost of external labour, the society has tried to encourage members to clean field channels but found them reluctant to contribute labour. Farmers would rather pay, even to clean field channels. It is thought that the government will provide funds for emergency maintenance, although the division of responsibility is not clear.

Kiyadar - Middle
The village is irrigated by two minors fed from branch canal number 2. Minor M8R1 branches off minor M8R at the head. During rehabilitation, the society demanded connection of one of the two minors M8R1 directly to the main canal. The society manages a 12 day rotation proceeding from tail to head. It employs two watchmen to operate and manage the system. The outlets have been fitted with lockable gates as part of the rehabilitation. As yet, there has been no experience of conflict, but the locks are set as a precautionary measure. The society collects all the farmers' water requests and present them to the government.

Before PIM, the allocation of maintenance budget from the government was on the basis of area irrigated. Since there was little or no irrigation, there was also no maintenance. The society now has only Rs 5000 in reserve for emergency maintenance. After they begin to irrigate, following completion of the rehabilitation, they society plans to increase fees to maintain Rp 1 lakh in reserve.

Dedeshan – Head end
The PIM process has just begun in the village of Dedeshan. The government is currently in charge of all operations. The village has had a limited supply of irrigation water since construction of the scheme, owing to a problem with canal levels at the offtake from the main canal compounded by seepage from the minor due to poor brick and tile lining.

The government repairs the minor canals, but farmers have been responsible for maintenance of sub-minors and field channels. There are some problems with the outlets and seepage in the sub-minor canals.

4.4.3 Guhai Irrigation Scheme

Background

Guhai Reservoir Project is situated in Sabarkantha District of Gujarat. The nearest city and district headquarters, Himatnagar is located to the east of the scheme. The mean annual rainfall is 931mm.

Irrigation commenced in 1993. The system was designed to irrigate a command of 7100 ha but currently achieves a total of 5800ha over one year. A number of minor canals are in the process of PIM since about 1997, but the main system and remaining minors are still under government control.

The headworks consist of a 800 m long earthen dam constructed across the Guhai river. The reservoir behind the dam has a live storage of 57 mcm. There is an 88 m long spillway and six gates to pass flood water. The right bank main canal serving the area has a capacity of some 5 m^3/s. The first 17km of the main canal is a lined, contour canal and the last 21 km is unlined. Due to the steeply sloping command area, underground pipes supply the water at the tertiary level. Black cotton soil has tended to move and lift pipes and lining across the scheme, leading to heavy seepage and waterlogged areas.

Operation and maintenance

Hapa canal– Middle / tail end

Before PIM, the government managed water distribution so that water flowed continuously by proportional division into all 5 water courses. After PIM, the society decided to switch to On Demand supply, and added gates and broad crested weirs to the water course outlets. They can now control flow so that each water course is supplied in turn, and the amount of water is measured. This ensures a more efficient water supply, especially when there isn't enough water in the main canal for proportional division to work. The society have been able to manage this system of water delivery but doubt whether it would have been quite as successful if the government had tried something similar before PIM.

Water distribution in the area is compounded by the existence of about 100 pumps lifting water for irrigation from the main canal. The practice was illegal at first, but the government has since given permission. The society is in the process of switching over to volumetric charging from a fee based on crop and area in the past. It used to collect Rps110 / ha / season for wheat, compared with Rps 7000 / ha / season charged for tubewell water in places outside the irrigation command.

Parabada canal

Parabada farmers were dissatisfied with the original water deliveries and therefore requested PIM. Since participatory management, the water delivery is reported to have improved, although there has been a drought for two years so the rehabilitated system has not been fully tested.

Parabada society is in charge of 1 minor canal, 5 water courses and 35 turnouts off distributary branch canal, D4 on the Guhai Reservoir Project. The canal is owned by the government and managed by the farmers.

There are 106 irrigators within the Parabada command, of which 70 are society members. A significant proportion of the 36 non-members are from another village. As part of the participatory irrigation management process, the society demanded that the field channels were lined before turnover. The society agreed a 50% contribution and are trying to negotiate 50% matching funds from the government. The cost of this work is Rps 1500 / ha.

The society takes charge of maintenance and describes it as an improvement over the work under government management. Recent activities include de-silting of canal structures and re-joining pipes. Farmers are asked to contribute to maintenance costs with cash. Those who can't afford to pay can give a labour contribution. If there is no labour contribution, then the society will pay for materials and attempt to get skilled labour from outside.

The society is of the opinion that the amount they receive at present for maintenance is insufficient. They feel that the collection of Rps 12,000 would need to be doubled, at least. At present, everyone is reported to pay water fees and there is no need for sanctions.

No emergency maintenance has been required so far. The society aims to do such work itself but might ask the government for a contribution. If a major structure such as a bridge were to collapse, then the government would have to repair it.

4.4.4 Pingot Irrigation Scheme (Left Bank Canal)

Background

Pingot Irrigation Scheme is a medium-sized project located in South East Gujarat in Baruch.

The system was completed in 1989 and irrigation commenced in 1990. The main source of water is the river Tokri. The headworks, completed in 1983, consist of a 1.3km earthen dam with an overflow weir and two head regulators serving left and right bank canals. The dam has a live storage of 7.27 mcm. The Left Bank Canal is 6km in length, and the Right Bank Canal is 4.5km. long. The left bank design command area includes 808ha and four villages

In 1995, a co-operative society was formed with assistance from AKRSP. The society includes all four villages in the command area, and is responsible for operation and maintenance of the system from the main canal down. The dam and headworks remain the responsibility of the Government

Operation and maintenance

No water was received in the left bank canal before PIM and the accompanying rehabilitation works. The Department of Irrigation releases water from the dam, for management by the society, irrigating from head to tail. The Department of Irrigation could only provide two waterings in 2001. The society realised that this was too little to be of use, and wrote to the Department to request that the water be kept back solely for drinking and cattle watering.

The society employs 4 gatekeepers. Before PIM, the government employed 10-15 gatekeepers. The scheme was originally designed to irrigate areas of 40ha for each outlet. During rehabilitation, it was converted to irrigate 8ha units through the construction of extra pipe outlets. The aim was to make the scheme easier to manage by involving fewer farmers per outlet. The system was reported to have reduced the amount of water wasted and reduced the maintenance cost.

Head-end farmers take too much water, leaving a shortage at the tail. This is in part due to scheme design and the fact that head farmers have to block the main canal, "heading up" to direct flow to minor canals.

The Department of Irrigation is responsible for the maintenance of the main canal and the society is responsible for the minors. Department of Irrigation have carried out de-silting once, otherwise the farmers have done it themselves. Maintenance work on minors is carried out by the farmers themselves and paid for by the society. There is very little voluntary labour contribution. The society has received no maintenance training but agreed that it would be useful. To date, the society has carried out canal breach repair, de-silting, erosion repair. The erosion is due to cattle and people owing to the lack of canal crossings. AKRSP have provided technical supervision, in particular for a repair carried out last year. The society receives the maintenance rebate of 30% from the Department of Irrigation but state that it is not enough for the tasks that need doing.

The Department of Irrigation has carried out de-silting, jungle cutting and fixing of pipe joints on the main canal. The siphons and pipelines are susceptible to cracking caused by crabs which get into the joints and open them up. According to the Department of Irrigation engineer, the society lets the government clean the siphons as this job is considered "dirty work" and the farmers are not prepared to it.

Some illegal offtakes from a watercourse have damaged the watercourse lining. The society stated that the farmer responsible would be fined during a watering but not when they were not irrigating, even though clear damage had been done.

Emergency maintenance has been carried out by the society when the main canal suffered a breach. The society paid a sum of Rs 10,000 to get the repairs done immediately. The Department of Irrigation agreed to pay for the works but it took three months to pass through the bureaucracy of the system to produce Rs 8,000. The Department of Irrigation also failed to provide any construction advice or support at the time of the repairs.

4.4.5 Issar Irrigation Scheme

Background

The Issar scheme is situated in Mandvi block of Surat district, 15km from the block headquarters, Mandvi.

An earth dam was constructed in 1977 but an irrigated area of only 50ha was possible until rehabilitation. In 1995 AKRSP(I) became community organisers after requests by farmers. It is currently overseeing rehabilitation of the scheme and assisting the irrigation co-operative society. The society took charge of water distribution in 1996-7 but is still awaiting confirmation of its status under a Memorandum of Understanding with Government. The society has now achieved an irrigable area of 164ha out of possible maximum of 354ha which it hopes to improve on as rehabilitation proceeds.

Operation and maintenance

Since participatory irrigation management the society have decided to alter the operation of the scheme in an attempt to best utilise the amount of water supplied and take into account the irregularity of supply. The society employs 2 watchmen to manage the irrigation. There are three minor canals which are supplied with water in rotation. Each minor receives water for 15 days in turn. Irrigation along the minor takes place from the head to the tail. Two outlets, supplying 12 to 15 farmers are open at a time. There are an average of 6 farmers per field channel and no water courses.

The gate at the intake does not shut properly at present so there is difficulty in enforcing water rotation. Farmers in the head reach of the main canal pay the society to lift water from the canal with diesel pumps. The irrigation department supplied the pumps free of charge in 1998 following a request from the society. There is one pump for per group of 9 to 10 farmers. The farmers pay 50% of the society's water charge for this pumped water and the society allocates pumping time and duration. These head end farmers were the only group currently irrigating with scheme water as they are able to make use of the dam leakage water.

Allocation of water is carried out efficiently. Farmers fill in water demand forms based on crop choice, area and number of waterings. The society provides a summary to Department of Irrigation as a request for water from the dam. A copy of the forms is given to the gate operators who can then control supply according to allocation. If there is insufficient water, then certain crops such as groundnut are not permitted. Any further deficit must be made up by the farmers themselves from other sources. In order to ensure that farmers grow what they have stated, the society visits each farm, at the end of each season. The society has found that there is rarely any deviation from the water allocation forms.

In the past, the society has carried out repair of siphons and outlets with large crack or broken joints. A 10% contribution was paid to the society based on the number of beneficiaries downstream of the affected structure or reach.

The Department of Irrigation carries out desilting and grass cutting once per year. Gate greasing and maintenance of the field channels are the responsibility of the society. The Department of Irrigation refused to let the society carry out maintenance tasks until the MOU had been signed. The society prefers to do the maintenance itself because it can employ society members to do the tasks, the tasks are more likely to be carried out in time and it can supervise more easily and ensure quality construction.

4.4.6 Lakigam Irrigation Scheme

Background

The Lakigam Irrigation Scheme is located in the Surat District in the south of Gujarat State. It is 45km from the block headquarters at Mandvi.

The scheme was completed in 1982, but due an incomplete distribution system until 1993 it was only possible to irrigate 25-30ha with water leaking from the dam from the dam. After rehabilitation 125ha are irrigable out of a total command of 350ha. Leakage of the earth dam is still a problem

In 1994 an irrigation society was formed with AKRSP(I) involved as community organisers. Irrigation serves four villages.

The main water source for the scheme is the Dhakni river. The reservoir is formed by an earth dam with a short concrete spillway. Leakage is thought to occur around the walls of the spillway.

The distribution system comprises 6.2km Left Bank Main Canal with five minors of total length 4.66km.

Operation and maintenance

The irrigation department is now responsible for releasing water into the main canal. The society then manages the operation from this point. Since water is short, the society has chosen to open the minor canals in rotation, opening two minors at a time for three days each. There are a total of 5 minor canals four of which receive irrigation though the 4th minor generally receives less water. There are three to four outlets per minor canal each serving 4 to 5 farmers. In addition, there are extra outlets directly off the main canal. A total of 125 ha is being irrigated since the advent of participatory irrigation management. The greater part of the irrigated area is at the head of the first two minors. Minor 1 serves 30%, and Minor 2 some 20%, of the area currently irrigated.

The Department of Irrigation has agreed to supply irrigation water up to the 15 March as the dam was designed for irrigating kharif and rabi crops only. The society would like greater flexibility. At present there are no irrigation request forms for the farmers. Water demand is agreed informally with the society, up to a maximum of 5 waterings. The society does not have any idea of crops grown per area irrigated. It reports equitable distribution of water except for head end farmers who receive one extra irrigation at the end of a season, when reservoir levels are low.

The right bank scheme is the same size as the left bank. There is more irrigated land on the right bank, since most of the water leaking from the dam is collected by the right bank canal.

The main canal is in good condition, showing minor leakage at a few of the structures. The main canal and all the minors are lined. The minors are also in good condition. The major problem is continuing leakage through the earth dam around the spillway wall. Some grouting has been carried out in the past with little effect. The society has commissioned its own study. A value of Rs 17 lakh was put on the repair cost.

A Memorandum of Understanding with Government has been signed but the society does not yet receive the 30% rebate for maintenance. Government carries out repairs on the main canal and the society is responsible for everything at and below minor canal level. The society organised de-silting and cutting activities one year, having raised money for the maintenance itself. Farmers did the work themselves but were paid by the society. Maintenance of the minor canals has been carried out using paid labour. During the rehabilitation work, the farmers kept half of their wage and gave the other half to the society.

Emergency maintenance has been carried out by the society on one occasion. Following a breach in the main canal, the society opted to raise Rs 30,000 and carry out repairs themselves, rather than inform the Department of Irrigation and wait for action. The society described an informal system, where the Department of Irrigation is informed of a problem and the society then waits to see if there is likely to be

any action. If the Department of Irrigation refuses to carry out the work or will take too long before starting work then the society will assume responsibility.

Smaller canals are also breached but are repaired immediately by the farmers affected.

4.4.7 Chopadvav Irrigation Scheme

Background

Chopadvav Irrigation Scheme is located in the Sagbara Taluka of Baruch District. It is 50km from the town of Netrang.

The main water source for the scheme is the river Doman. The headworks consist of an earthen dam, spillway and intake. The dam was completed in 1986 but the rest of the canal work was not completed until rehabilitation under participatory irrigation management in 1994. A small number of head end farmers were able to irrigate with leakage water up until then. Participatory irrigation management began in 1993 when AKRSP(I) assisted with the formation of a co-operative society forming.

There are 7.89km of mostly unlined main canal and 38kms of distributaries.

Operation and maintenance

The scheme consists of a main canal, feeding 10 minors. The Department of Irrigation controls the dam and headworks, and releases water into the main canal. The society employs 2 watchmen to operate the main canal. Half the minors receive water at one time for five days, followed by the remaining minors. There is then no irrigation for 10 days before the cycle is repeated. Those minors at the tail of the scheme may get 7 days "on" followed by 3 days "off".

Each minor canal has a committee, and some outlets have farmer groups. Every farmer requests water by filling in a water allocation form. The leaders of the minor committees agree water distribution with the main society, AKRSP(I) and the Department of Irrigation. The leaders oversee the release of water into their minor with a watchman from the main canal. Co-operation between the minor committees in different villages is said to be good. If farmers on one minor have finished irrigating within the allocated time, they will close their outlet and pass the water on to the next minor committee.

Each minor committee decides on its own system of operation. Small minors tend to operate on a head to tail basis, whilst larger minors operate tail to head. Outlets serve 4-5 farmers and are gated.

The society has developed a disciplinary system and has imposed and collected fines of Rs1000 for tampering with the minor gates and Rs 100 for damaging the canal.

Farmers are responsible for the maintenance of field channels and small repairs, including greasing gate mechanisms, on the minor canals. Government carries out large repairs on the minor canals for which farmers contribute labour. Since1999, the society has carried out de-silting of minors at a total cost of Rs 115,000, significantly more than the 30% maintenance rebate of Rs 20,000 given to societies by Government. Funds accumulated by the society were used to make up the difference.

Government is responsible for all maintenance on the main canal. De-silting of the main canal is carried out once per year and is often a bit late.

In farmers' opinion, the system is deteriorating under the current level of maintenance. They attribute problems to:

- Unlined canals and leaking gates
- Erosion under rainfall on the hilly terrain
- Structures not correctly set to level, leading to water ponding
- Canal bank erosion due to lack of crossings.

The society has therefore prepared an action plan listing specific problems. It has submitted the plan to the Department of Irrigation, without response.

For emergency maintenance, farmers estimate a cost and submit it to Government.

4.5 Water Users Associations - performance, capacity and sustainability

4.5.1 Khageri, Nepal

There is a hierarchy of committees at Khageri. The main committee has three officials and 12 members; each branch committee has three officials and four members. There is a general assembly made up of 85 members representing the land – one per 50 ha – and one for each distributary canal. Elections for the main committee used to be held every two years but they are now held every three years.

The main committee decides on the water distribution system and co-ordinates with distributary committees and Department of Irrigation. It collaborates with annual maintenance of the main canal and head regulator. The main committee had a substantial bank balance at the end of rehabilitation, but this has gradually declined due to the small income (about NRs 15,000 from ISF, which is much less than projected and does not even cover administrative expenditure). There is some emerging dissatisfaction with the committee that is perceived to be unproductive and expensive, despite the fact that most reports on the system indicate that turnover has been beneficial. Dissatisfaction is reflected in the declining Irrigation Service Fee collection rate.

The branch committees organize branch canal maintenance. In the case of Minor 1, a fee is levied and used to pay for maintenance. Uniquely, for the systems studied, this fee exceeds expenditure and the Water User Association has built up a balance in the bank. Other branches collect and spend as required. The amount is only sufficient for annual canal clearance, and they rely on Department of Department for all other items. In the case of Branch 5, no money had been collected and annual maintenance had still not been done by July in 2001. There is thus a risk that these Water Users Associations will not be sustainable unless they can be financed in a more effective manner by improving Irrigation Service Fee collection.

Maintenance and improvement works are widely confused in the minds of Water User Associations. Although maintenance is recognised as being under-funded, lack of additional works - canal lining, extra water sources, new structures (usually culverts or cross drainage structures)- is seen to be the major need. Where maintenance is done, it is usually rectification of a problem, rather than prevention of a problem – repairing a canal breach, rather than strengthening a weak canal bank. It appears that additional resources would be devoted to providing additional structures rather than to preventative maintenance. Table 4.9 outlines Khageri Water Users Association activities in maintenance.

Table 4.9 Khageri Water User Associations - Resources and Maintenance

Item	Main canal	B1	B5	M1
Irrigation Service Fee	50% due from each branch (5% actually received)	Rate increased from NRs 60/ha/crop to NRs 120/ha/crop, collection dropped from 88% to 60%	Rate increased from NRs 60/ha/crop to NRs 120/ha/crop, collection 35% (1999), 50% (2000) to 0% (2001)	Rate increased from NRs 60/ha/crop to NRs 120/ha/crop, collection 25% (2000)
	25% due to the Government (0% paid, but make labour contributions to main canal maint-enance)		50% due to Main WUA (including 25% for the Government), but not paid as committee inactive	50% due to Main WUA (including 25% for the Government)
Maintenance fee	0	Labour as required	0	NRs 150/ha (2000), NRs 200/ha (2001)
Other sources	NRs 4,00,000 (NRs 100 per ha) maintenance budget from DOI in 2000/1			
Maintenance needs	*WUA priority* Main C. in forest, Weak section near Rampur, Desilting/reshaping	Weeds and sediment (much new lining, needs little maintenance)	Weeds and sediment (much new lining, needs little maintenance	Weeds and sediment (much new lining, needs little maintenance)
	Other needs Maintenance to structures and protection. Damage to lining, regulator gates	Maintenance to structures and protection works	Maintenance to structures and protection works	Maintenance to structures and protection works
Maintenance activities	Some repairs jointly planned by DOI and WUA, WUA involved in implementation (85% paid by DOI)	Weeds and sediment	Weeds and sediment (2000). None yet planned in 2001 (July), but needed	Weeds and sediment due for clearance in 2001 before irrigation

Note: WUA= Water Users Association DOI = Department of Irrigation

Key issues include an inadequate resource base, and a poor understanding of what these resources should be used for. Rehabilitation has meant that little maintenance was needed in the early years, but now revenue is declining as needs are increasing. There is a perception that money is wasted on unnecessary administration, which the users feel could be better spent on improving the system. The main maintenance problems are in the main system, whereas the transferred elements just require manual desilting and repair. The short-term requirements are for:

- The central Water Users Associations to convince users that it is having a beneficial impact on main system management – it should be demonstrated by better maintenance of the canals, not by provision

of additional structures. This will be a prerequisite for continued funding by users, via the branch Water Users Associations.

- Branch Water Users Associations need to convince users that to support improved management of the main system, they need to do routine maintenance on time, otherwise insufficient water will reach the tail of canals. They should make the (very low) contributions that they are required to make, in order to avoid deterioration of the system, and should not rely on periodic grants for lining of badly-maintained canals. Technical skills are less important than an appreciation of the importance of undertaking simple maintenance, and an acceptance that it is now their responsibility.

In accordance with the Irrigation Policy, Water Users Associations should pass 25% of Irrigation Service Fee payments to the Nepali Government for operation and maintenance of the main system under joint management arrangements; this would be equivalent to about NRs 30 per hectare. In fact, no payments are made by the Water Users Associations, whilst the Department of Irrigation paid NRs 400,000 or NRs100 per hectare. The Water Users Association stated that they provided much of the labour for maintenance by Department of Irrigation, including extra labour to the value of 15% of the Department of Irrigation contribution. However, even if paid in full, this would represent less than half of their dues to the Nepali Government. These issues need urgent attention if the Water Users Associations are to be sustainable and effective. It is likely that they will require support from Department of Irrigation to achieve targets.

Most of farmers' comments in the group interviews focus on water management, rather than on maintenance:

- Farmers at the head, and also the tail, get more water than before transfer, making it easier to grow paddy;
- Operational procedures have changed for the better. There are now people in the villages responsible for better water management. Less water is wasted;
- At the head end, outlet pipes have been relocated for better distribution. Bank-cutting is better controlled;
- The Main Committee is considered disorganized and weak.

Farmers clearly recognize that they are responsible for operations, and have organized for that responsibility. The fact that maintenance is not at present a focus of their attention is not necessarily of great concern, as strong organisations will manage problems as they occur in due course. However, within the remainder of the present project, farmers' thoughts now need to be increasingly directed to sustaining the system.

4.5.2 West Gandak, Nepal

In 1992, a joint management programme between farmers and the Department of Irrigation was undertaken to improve management of the system and ensure participation of farmers. In 1993, an elected executive committee and Water Users Association were formed and the Water Users Association was registered. In 1997 the system was fully turned over after rehabilitation.

The Water Users Association is a four-tier organization consisting of a Main, Branch, *Toli* and *Upatoli* Committees. An amendment to the constitution created a Board of Directors of around forty members, including an executive committee of five members. The Board of Directors created a Water Management Task Force. The Executive Committee, in particular, appears unnecessary and bureaucratic. According to Department of Irrigation, district office, Nawalparasi, the Water Users Association are not functioning. Joint management of the system would have been a better option. Working procedures have not been established so decisions are ad hoc. There is no proper accounting system and no records of, for example, sale of timber from the banks of the canal. Irrigation Service Fee collection has declined over time, principally due to inertia and incompetence by branch canal committees.

Government provides about NRs 900,000 annually for desilting and maintaining the (main) canal. Heavy equipment is in poor condition – it has not been handed over to the Water Users Association. Table 4.10 gives an estimate produced by the Water Users Association office for 1999/2000 showed costs of work planned for maintenance.

Table 4.10 Cost of maintenance work planned by the Water Users Association for West Gandak

Item	Total cost (NRs)	Contribution of WUA	Contribution of DOI
Canal maintenance, protection of structures	1,121,000	141,818 (13%)	1,040,000 (87%)
Service road maintenance, Canal protection works	389,409	38,286 (10%)	351,123 (90%)
River training, drain and canal protection	568,181	68,182 (12%)	499,999 (88%)
Contingency	26,298		
Total	2,104,888	248,286 (11%)	1,891,122 (89%)

Statements of income and expenditure for the Central Committee in the 1996 to 1997 and 1997-98 years were obtained.

Head-end farmers claimed:

- Water Users Associations are not functioning. Committees to deal with different reaches were not formed.
- There is no planning for operation and maintenance;
- They have no confidence in those committees which exist
- There is misuse of funds
- Fees are not paid for lack of confidence and transparency
- Maintenance of branch canals is poor or non-existent
- Local politicians have taken over the Main Water Users Association

The Germi Minor at the tail of the system seems to be effectively non-functional. Farmers appear to be practising rain-fed farming.

On the Manjharia Branch canal, towards the upper end of the system, officers of the Water Users Association said:

- Their water supply is poor. Farmers use groundwater.
- The Branch Committee consists of 29 members.
- Meetings are supposed to occur once a month but attendance is sporadic.
- Irrigation Service Fees have not been collected for the last two years.
- 60% of collections are supposed to go on maintenance, 20% to the Central Committee, and the balance to the fee collector;
- There are no plans for cleaning the canal.

Clearly, radical changes are needed to improve the functioning of the system. In the first instance, joint management of the main system will help to relieve farmers of a major burden. The hierarchy of committees should be critically examined to reduce bureaucracy and improve effectiveness and

transparency. At that stage, maintenance issues should be reintroduced once the reformed Water Users Associations have a better understanding of their responsibilities.

4.5.3 Kankai, Nepal

The Central Water Users Association Committee, elected by farmers, includes representatives of the secondary canals. It operates under a written constitution, defining rules and regulations for canal protection and use of water, collaborating with Kankai project on operation and maintenance, budgeting at secondary canal level, and on water distribution. The Central Committee is funded by10% of the total Irrigation Service Fee collected by five transferred branch/secondaries, too small an amount to have any effective functional role.

Project officials assert that transferred canals perform better than average. The committees are apparently active in water allocation and distribution, fee collection, maintenance, and record keeping.

Department of Irrigation maintenance of secondary canals is done in consultation with the Water Users Association Main Committee. A total of some NRs 200,000 is assigned by Department of Irrigation to maintenance of 12 secondary canals. Construction work is done by contractor and desilting of canals is carried outby users. Water fees for the Department of Irrigation-managed secondaries, collected by Village Development Committees, are sent to the Treasury. There is thus little transparency in the process. Department of Irrigation overseers and ditch tenders control water allocations, in consultation with Water Users Associations.

The Main Committee claimed:

- Farmers are becoming more aware of their responsibility for management of the system
- There are problems of indiscipline. Water is piped illegally from the secondary canals
- Pumping from the head end causes water shortage in the middle and tail of the main canal
- Conflicts have decreased
- Users request water from secondary committees. A dhalpa (ditch tender) is instructed to distribute water.
- The Committee has little regular contact with Kankai Irrigation System Office. Committee members have difficulty travelling to the irrigation office in Chandragadhi after the transfer of Kankai irrigation system management to District Irrigation Office, Jhapa District.

Farmers are concerned that funds passed by the Central Committee for maintenance of secondary canals are assigned to the appropriate canal member on the Committee. They feel there is a lack of transparency in the process. On some canals, only a minority of households contributes money for desilting. On canal S7 (not transferred), one person from each household is expected to contribute labour for maintenance, regard less of the size of the landholding. There are some complaints that the policy is unfair to smaller landholders. Representatives of a Ward Committee also said there was mistrust in the community about the process of allocating and using funds Canal S9 was taken as representative of transferred canals. Features of the process were:

- Structures and canal rehabilitated prior to transfer;
- Partial canal lining;
- Strengthening of secondary level Water Users Associations and office established;
- Records updated;
- Bank account opened;
- Water Users Associations authorized to collect water fee for use on Operation and Maintenance;
- No annual support as supplied to other secondaries, branch canals which are not transferred are still dependent on the annual budget allocation by Kankai Irrigation project. Only transferred canals do not get government budget allocation for maintenance

Water fees from this transferred canal (S9), at NRs 100/ha/crop, are divided as follows: 50% to the Treasury via the Kankai Project Office; 10% to the Main Committee; 40% for maintenance of the canal. The bank account is operated by joint signatures from the central committee representative for S9 and the S9 Water User Association chairman. The Water Users Association is making regular deposits in its account. The secretary is paid according to the water charge collection-5% of current fees and 10% of overdues. Records are kept but they could be improved for easy access.

The transferred canals provide a basis for further devolved management but at present they are special cases. They will need continuing support to improve and formalize procedures.

4.5.4 Tilawe (Narayani Zone Irrigation Development Project, NZIDP), Nepal

In 1994/95 efforts were made, with World Bank support, to form Water User Groups in Blocks 5 and 6. However, there is nowadays little outcome or memory of that activity. Technical activities on the system are carried out by NZIDP. Main canal, branches and even sub-secondaries are maintained by contractors on behalf of the project. With a change in status from construction to Operation and Maintenance there has been considerable labour unrest amongst the Department of Irrigation employees, causing disruption to operation and maintenance on the NZIDP system.

Farmers said they do not contribute to maintenance of the system. Influential people in the villages constitute the remnants of the Water User Groups. They expect continuing government intervention and support. In the absence for a considerable period of NZIDP gate operators and ditch tenders, owing to unrest, farmers at the top end of the system (BSC1, Ghurmi) took informal charge of operations on the system. Resistance by officials meant that farmers had to organize themselves to resist intimidation. Many buffalo are kept. They represent a particular problem for maintenance of the canals, but there appears to be no control over owners' use of the system.

4.5.5 Summary of the characteristics and performance of Water Users Associations in Nepal

A summary of the performance and characteristics of Water Users Associations in Nepal is given in Tables 4.11 and 4.12 respectively.

Table 4.11 Characteristics of Water Users Associations in Nepal

Functioning of WUA	Irrigation system			
	Khageri	West Gandak	Kankai	Narayani Block 6 (Tilawe)
Participation of members	Participation in Branch level meetings		Branch committee members participate in meetings	Branch committees inactive, no participation
Mutual dependency between head and tail (water scarcity)	Spring season: water available in 3 Secs at head. Monsoon: all secs supplied	No inter-dependency	Water distribution: spring season in rotation, monsoon continuous	No interdependence, even between reaches within branch
Transparency of irrigation activities	Transparency maintained. Records open to members, Branch canal committees are open	No transparency. Records not open to the members. Management controlled by 4-5 people	Transparency in 3 transferred branches. Kankai office decides for other canals	No activity, no transparency
Accountability of WUA members	Accountability at central level not clear, branch level accountable to the users	Small management group formed, not accountable to anybody	Not clear	WUA do not exist
Resource mobilization for operations and maintenance	Main canal and head work by DOI, branch canal by cash collection	Resource mobilization from other non-water sectors , no contribution from farmers. DOI subsidy for O&M	Cash collected on transferred branches but Kankai Project allocates budget for other branches	Does not apply
Water distribution by collective decision	Water distrib. Schedule prepared by M/committee. Supervision committee implements	No water distribution schedule. Water released after desilting	At farmers' request dhalpa (ditch tender) distributes water	Does not apply
Punishment for non-compliance	Implemented at branch canal level	Provisions exist but not enforced	Provisions exist but not enforced	No provision
Water right definition	Water shares defined	Water shares defined	Water shares defined	Water shares not defined
Formation of Executive Committee of WUA	Committees exist at main and branch levels	Committees exist but inactive	Committees for main canal and branch canals	No committee
Role and responsibility of General Assembly	General policy for system management	To oversee system management, establish and monitor rules & regulations	General policy for system management, but DOI local office decides many issues	Does not apply
Partcipates in activities at branch canal level	Active in O&M and water distribution	Not functioning	Yes, limited	Does not apply
Status of Transfer	Joint mgt main and headworks, farmers manage branch canal	Fully transferred to WUAs	3 branches handed over to users in a form of informal joint management	Status not clear

Table 4.12 Summary performance of Water Users Associations in Nepal

Indicator of success	System			
	Khageri	West Gandak	Kankai	Block 6 NZIDP, Tilawe
WUAs choose their own objectives	Branches set their own objectives	Objectives ill-defined	Guided by the agency	No objectives
Select their own leaders	Elections at Main and branch levels	Politicized election based on political parties	Election process	No elections
Make and amend their own rules	Yes	Yes	Yes	No rules
Collect and spend their own fund	Fund collection at branch level	Declining fund collection at branch level	M/Committee depends on funding from branches which depend on DOI except for transferred branches	No fund collection
Compliance With rules	Branch canals follow their own rules	Anarchic	Very weak	No rules
Subsidy by the DOI	Subsidy for headworks and main canal	90% cost of maintenance funded by DOI	Transferred canals collect ISF but other branches subsidised.	DOI-funded

The following general observations are made:

- Farmers are generally not clear about their responsibilities, or about the role of the Department of Irrigation.
- They choose to believe that the Department of Irrigation will intervene for substantial repairs/maintenance even if the root cause is inadequate routine maintenance.
- They indicate that their involvement in operation and maintenance is dependent on having an adequate and reliable water supply
- Many expressed concern about lack of transparency in the operations of Water Users Associations
- There is a feeling that the training given prior to transfer was targeted too much at Water Users Association committee members
- It is important that the cost of maintenance required to keep infrastructure in adequate condition is realistically assessed and explained to farmers prior to turnover. There is a lack of appreciation of the real cost of maintenance, especially preventative maintenance.
- There appears to be no coherent maintenance planning. There is a general lack of awareness of maintenance needs other then canal desilting.
- The collection rates of Irrigation Service Fees are poor and the procedures for assessing and monitoring collection do not seem to be adequate
- The transfer of branch/secondary canals is generally effective where farmers have already been involved in operating and maintaining this level of the system

4.6 Agency involvement in post-turnover management

Khageri

The Department of Irrigation gives considerable support to water users associations at Khageri. It includes technical and financial management of the main system, as well as some assistance to Water Users Associations for lower level activities. The Main Water User Association expressed some concern at difficulties of co-ordination with the Department of Irrigation. The situation may have improved with the reinstatement of an office responsible for the three schemes Narayani Lift, Panchakanya and Khageri, which is separate from the District Irrigation Office.

Water Users Associations are entitled to undertake a limited amount of work, by direct, non-competitive appointment as "contractors" to Department of Irrigation. However, the WUA complained that it does not fully understand the procedures involved in payment, leading to long delays. However, the Water Users Association is not contributing its dues to the Nepali Government, or is attempting to do so in unofficial ways. Tasks such as canal clearance, which involve management of mass labour, demanding for Water Users Associations but Water Users Associations could meet an agreed percentage of the total cost for works done by themselves or contractors. There is always scope for abuse in such a system, as there is in percentage contributions for rehabilitation works. Nevertheless, this can be made more transparent.

The Department of Irrigation will need to give support to the Water User Associations to make them more effective and so that they can convince users that they are effective. The Central WUA needs to: be more involved in planning O&M, improve its arrangements for implementation, clarify financial dealings and be more flexible in its working. Branches need to demonstrate that they can improve supply to their members, clarify responsibilities and improve execution. User organisations at this level are not faced with sophisticated technical problems; they need to be well-governed, adequately resourced, and have a clear understanding of their responsibilities.

West Gandak

As indicated in Section 4.3.3, radical changes are needed to improve the functioning of the system. The scale and complexity of the main canal requires agency involvement, particularly in managing plant and equipment. Another important aspect is the need to provide strong representation in negotiations over water supply and operations with the Indian authorities at the barrage. At the present time, farmers feel no responsibility for the main canal. Elements of the institutional model used at Khageri should be drawn upon to try to introduce to farmers a broader and less parochial view of operational needs, particularly in connection with the main canal.

It appears that the tiered structure of Water Users Associations is heavily bureaucratic. Funds are inadequate and have been mismanaged. The organisation lacks proper understanding of its responsibilities and tasks. A radical look at how the institutional structure can be streamlined seems an essential preliminary to any efforts to strengthen Water Users Associations. Maintenance issues would follow, once a more coherent structure has been established. Continuing support will clearly be needed for a considerable period.

Kankai

The five transferred branch/secondaries provide a basis for wider transfer of responsibilities. Problems identified to date need to be addressed. Examples of problems that need to be addressed include:

- Establishment of mechanisms for better and more frequent links with the Project office;
- Greater transparency and oversight in the allocation of maintenance funds from the Central Committee to secondary Water User Associations to retain the confidence of farmers in the transactions;
- The system of labour contributions for maintenance needs to be thoroughly discussed and agreed with farmers;

- More meaningful funding of the central Water Users Committee to allow it to play an active role is necessary, once the base for contributions is extended with greater transfer.

The transferred associations appear to have a focus on maintenance, but need to be convinced of the value of preventative maintenance. They should be supported by training in identifying needs, planning, and quality of work execution. The tasks are not complex, so the WUAs should be able to sustain the process. However, since the responsibilities are not demanding, there may be a risk that the organisations wither, leaving a vacuum in which essential basic tasks do not get done. Simpler organisations might be adequate at this level and scale of canal.

Tilawe
Apart from early assistance with World Bank funding for the establishment of WUAs, DOI has had little involvement with institutional strengthening. The agency manages maintenance on a task basis.

4.7 Maintenance after Turnover

4.7.1 Users organisations

An effective users organisation is a prerequisite for good maintenance after turnover. However, unless the organisation is developed on the understanding that maintenance is one of its high priority duties, it is unlikely to develop the management skills and resources to carry out this function. Informal arrangements can be effective on small canals (tertiaries) and sometimes on larger ones, depending on the strength of leadership (Kolavalli & Brewer), but usually a formal management structure will be required.

There are a number of important issues involved in creating an appropriate form of organisation able to undertake maintenance efficiently. Some examples noted in the field studies are included in italics below:

- The objectives need to be well-defined and matched with resources.

  The West Gandak Water User Association has an impossible task in maintaining the main canal with the resources it can mobilize from irrigation. Better planning before turnover would have identified the problem and helped develop alternative arrangements. The Khageri Water Users Association has the more realistic task of co-ordinating management of the main canal with the Department of Irrigation, which continues to subsidize maintenance

- The structure of the Water Users Association needs to be well matched to the objectives and tasks, with a realistic arrangement for the general assembly, committees and officers.

  There are some 146 elected committees and sub-committees at Kankai, where Water Users Association have a very limited role in managing small secondary canals

- Local controls on Water Users Associations should not affect their autonomy, but should ensure that they are well governed. There is a need for registration and auditing.

  All Water Users Associations on Agency Managed Irrigation Schemes in Nepal are established to a single format laid down in the Irrigation Policy. A range of different organizations exist on Farmer Managed Irrigation Schemes– for example, each branch canal at Rajapur Irrigation Scheme has a different style of organization to suit individual approaches to a common task

- Water Users Associations must have suitable technical and management skills, with sufficient continuity of staff to ensure that skills are not lost with each election. They will need support to maintain these skills in the early years after transfer.

  Some training is given prior to transfer, but there are usually elections shortly afterwards (in the case of Kankai, about 50% of officials changed) with a loss of skills from the organization. Simple procedures, and possibly a non-elected secretariat, would reduce the problem. The technical skills required for maintenance are simple, except in the case of large control structures, such as head

regulators and intakes, or mechanical plant (as at West Gandak). Planning, management, and quality control are more important deficiencies.

- Organizations with single or multiple functions? A single model will not be appropriate to all situations. Multi-function Water User Associations may get diverted onto other tasks at the expense of irrigation, but single-function organizations just for irrigation management can be too bureaucratic.

  The Water Users Associations at West Gandak became involved in forest management, road tolling, and land rental, and then collapsed amidst accusations of asset stripping, corruption and politicization. At Kankai, the Water Users Association on secondary canal S10 only deals with irrigation, and most of its functions are in practice carried out informally by its members, leaving the formal organization with little to do. It suggests that the organization is over-bureaucratic. On the other hand, it is essential to ensure that basic tasks are not overlooked-there needs to be a balance between the responsibilities and the organizational structure.

- There may need to be a hierarchy or federation of organizations to deal with different levels of canals. This also can be top-heavy, involving numerous committees for limited functions.

  High level committees, with limited roles in co-ordination, seek high status and prestige that is not commensurate with their function or resources. They can become unwilling to carry out even a limited role. The criticism was voiced in all schemes visited.

- There should be an established base of beneficiaries, to mobilize necessary resources.

  In West Gandak, the Water Users Associations could not collect Irrigation Service Fees reliably because it did not know from whom it should be collecting and it could not monitor defaulters systematically.

- Management systems can be simple, to avoid excessive bureaucracy, but must cover key issues like rights and responsibilities of different parties.

- WUAs must be able to enforce contributions and exact penalties from defaulters.

  In all turnover schemes studied, Irrigation Service Fee payments are declining and there is little the Water User Associations can do about it. Procedures exist, but there is no enforcement. There is little connection between payments and service. ISF is mainly used for administration. Cash or labour are contributed separately for routine work, whilst resources for major works are inadequate.

4.7.2 Agency roles and links with users

Turnover does not absolve agencies of responsibilities for irrigation. They will retain certain responsibilities and they will also need to support users organisations. Division of responsibilities should be jointly defined and agreed in advance – a clear understanding of responsibilities by both parties is fundamental, defining the roles required for sustainable management in the longer term.

Tasks retained by the agency may include:

- management of high level components in joint-managed system
- ownership of components for which the rights to manage have been transferred
- emergency repairs to transferred components
- auditing or monitoring performance of user organizations

User organisations are set up, usually in a format prescribed by government, to undertake certain tasks. Thus, both their structure and function are new and impose new demands on communities. They may need support in many aspects for some time, for example to ensure that they continue to plan and implement maintenance, collect and manage finances, work with the agency on joint-managed components, and administer the Water Users Associations soundly. Water Users Associations may also need assistance with broader issues such as agricultural services or diversification of their functions. This is discussed briefly below

Although it is policy for operation and maintenance to be financed by users, it is currently subsidised (as well as under-funded). The situation is likely to continue to a varying degree for some time, but should be linked to genuine contributions and participation by users. Water Users Associations need a good understanding of government financial rules and procedures. These procedures in Nepal already include some provision for Water Users Associations working as 'contractors' in certain circumstances.

4.7.3 Post-turnover support

To a greater or lesser extent Water Users Associations are new, externally imposed organisations; they may be built on indigenous organisations but they are quite distinct from Farmer Managed Irrigation Schemes management systems. Although they will work with the agency during planning and implementation of turnover, this experience is insufficient to cover all the functions required for management in the longer term. Frequent elections mean that committee members trained in the early stages may no longer hold office once the system is handed over, and the new officers may be unfamiliar with much of the process that has gone before. Changes of personnel will be a recurring problem, which can be addressed by limited follow-up training, establishment of a small permanent secretariat and development of manuals and procedures for key tasks. The Water Users Associations will need continued support in a number of specific areas, including:

- Institutional strengthening, to ensure that each organization plays an effective role, understands its responsibilities and can mobilize the necessary resources. The process will be gradual: in most schemes there will be a large number of organizations or sub-groups: some will be well-motivated and skilled, but others may be less active
- Planning and implementing maintenance as needs change and increase in the years after rehabilitation;
- Collecting and managing finances – fee collection often declines once users see that much is consumed in administration. There is a risk of a severe financing deficit when increasing maintenance is required. Support for both financial management and public relations may be appropriate
- Working with the agency on joint-managed components, to ensure that each party understands the other's procedures; and
- In the longer term, possible diversification into other areas, building on successful performance without diverting attention from the core functions.

4.8 Irrigation Service Fees - Farmers' capacity to pay

Water User Associations must balance the incomes that they can reasonably depend on, principally from water fees, with the expenditures they will incur for operation, maintenance and administration. The survey sought social and economic information to provide the information necessary to develop financial analyses. Table 4.13 below sets out basic facts about the farming population in the scheme area.

Table 4.13 Basic facts about the farming populations on the irrigation schemes

	Scheme			
Item	**Kankai**	**Khageri**	**Tilawe**	**W Gandak**
Household head by sex (%):				
- Male	99	97	99	99
- Female	1	3	1	1
Average household size	7	7	9	9
Ethnicity (%):				
1. Tarai peoples:				
- Ahirs	-	-	27	7
- Kurmis	-	-	21	1
- Tharus	-	-	-	33
- Others	9	1	71	43
Total	9		99	84
2. Hill Migrants	91	99	1	16
Percentage of farmers who migrated to the scheme	80	97	-	16
Farmers' tenure status (%):				
- Owner-cultivator	84	97	89	95
- Owner/sharecropper	9	2	4	3
- Owner/tenant	3	1	5	2
- Sharecropper	2	-	-	-
- Tenant	2	-	2	-
Average holding size (ha)	2.1	1.1	1.1	1.8
Farming as primary occupation	100	99	99	99
Importance of off-farm employment	n/a	N/a	High	Medium

Farming is the primary occupation of almost all those interviewed, but off-farm employment of some members is an important source of income for many households. Average agricultural daily wage rates do not appear to differ much between the schemes, varying between NRs 60 and NRs 75 (US$0.81 to US$1.01) when the value of food provided is included. Standards of living are relatively low.

Almost all farmers appear to be primarily owner-cultivators, the proportion of sharecropping and fixed rent tenancy being small. Average holding sizes on the Kankai and West Gandak schemes, at 2.1 ha and 1.8 ha respectively, are much larger than at Khageri and Tilawe (1.1 ha). The maintenance costs set out in Table 4.14 below have been derived from the asset surveys detailed elsewhere in the report.

Table 4.14 Cost of required maintenance (NRs per ha)

Scheme/system level	Cost of required structure maintenance/ha	Cost of required canal maintenance/ha	Total cost of maintenance/ha	Capital cost of required structural improvements/ha
Kankai	270	252	523	3,571
Main	56	54	110	173
Branches			Total 633	Total 3,744
Khageri	85	285	370	5
Main	143	504	647	0
Branches			Total 1,017	Total 5
Tilawe	621	287	908	170
Main	289	245	534	50
Branches			Total 1,442	Total 220
West Gandak	111	148	259	291
Main	228	420	648	272
Branches			Total 907	Total 563

Note 1. The figures are averages derived from the canals and structures surveyed on the four schemes

The differences in the required maintenance costs between the four schemes in the table illustrate the point that on a needs-based assessment, there will be considerable variation between locations. This depends amongst other factors on: scheme age; its design; the extent to which it has, or has not, been maintained to date; the topography (flood/erosion-prone/hilly areas etc); the attitude and habits of users. The design and basic layout of the schemes, although differing in some respects (for example the extent of canal lining, detailed design of structures etc), is in many respects similar. Much greater variation in required basic maintenance cost could be expected, for example, in e.g. smaller schemes; those depending on groundwater; locations in hilly areas. To the costs derived from survey may need to be added permanent staff costs, depending upon the status of the system.

A broad estimate of farmers' capacity to meet increased operation and maintenance costs is required. To date, both the Irrigation Service Fees and the collection efficiency have been very low. For transferred schemes to be sustainable in the long-term, farmers must be able to meet at least the costs of routine and preventive maintenance. Under the Irrigation Policy, the Nepali Government can meet the costs of occasional major and emergency repairs, usually resulting from severe floods and other unusual events.

Irrigation increases winter crop yields and allows the substitution of drought-resistant, but low yielding crops like pulses, by higher yielding crops like wheat. By preventing severe falls in paddy output in poor monsoon years, irrigation can also play a role in food security. The assessment concentrates on the incremental returns to irrigation, considering the effects on farm incomes of varying irrigation operation and maintenance costs.

Appendix C includes the analyses of irrigated and unirrigated net returns based on observed cropping patterns and intensities, crop yields, input and crop market prices, and constraints to the cropping system.

The annual incremental benefits from irrigation per hectare were found to vary from NRs 5,200 at Tilawe to NRs 6,900 at Kankai. In view of the similarity of incomes on the four schemes, an average figure of NRs 6,000/ha per annum has been taken for purposes of the analysis. The maximum percentage of the increment that could reasonably be taken to meet operation and maintenance costs depends on a multitude of factors. Farmers' payment capacity, according to various criteria quoted in the literature (Appendix A):

Criterion for Payment Capacity or ISF Rate	NRs/ha/year
5% of crop gross output (India)	1,800 to 2,000
4-8% of crop gross output (Vietnam)	1,400 to 3,200
5-8% of total crop production costs (M Svendsen et al 2000)	1,200 to 2,100
5% of value added by irrigation (Turkey) (Svendsen & Nott, 2000)	300

Based on the above figures, it might be reasonable to assume a payment capacity of the order of NRs 1,500/ha (as compared to a current typical rate of NRs 120 / ha). However, because of differences between economies, it would be equivalent to some 25% of farmers' estimated net return from irrigation, much higher than the rate adopted in most countries. Furthermore, in years when output prices are depressed, such as in 2000-01, NRs1500 would represent 35% to 50% of farmers' net return, a very high figure, given that even with irrigation, farmers' income may be below the poverty line. An ISF based on the value added by irrigation would be logical, the level being proportionately lower in Nepal than in arid countries which are wholly dependent on irrigation.

Reference can be made to Farmer Managed Irrigation Schemes that are entirely self-financing where fees rarely exceed Rs 1,000 per hectare. The figure is many times greater than the current fees on Government schemes, but it is contributed largely in the form of unskilled off-season labour (which has been valued at Government rates). Costs of operation and maintenance on Farmer Managed Irrigation Schemes and Agency Managed Irrigation Schemes may also be very different; Farmer Managed Irrigation Schemes use large numbers of unskilled labourers and local materials (stone, brushwood etc), whereas Agency Managed Irrigation Schemes require less labour but more specialised materials and skills.

Even though an annual Irrigation Service Fee charge of up to, say, NRs 1,500 / ha may be justified on the grounds given above, smaller farmers may well be unable to afford it (even the labour equivalent is 25-30 days per year). There is no precise definition of the poverty level in Nepal; a per capita daily availability of around 2,200 calories of food is regarded by some as the minimum level below which a person is defined as poor. This is an extremely low figure. ADB quote a figure of NRs 2,833 (US$40) per household per month. By both criteria, farmers on all schemes, except Kankai, are below the poverty line even in a good year. Kankai only just meets the ADB figure at 1999 prices. At 2000 prices, the returns to agriculture in the sample areas are sufficient to reach 25% to50% of the poverty line – on average. The dissatisfaction with agricultural prices in 2000/01 is understandable.

In reality, the figures mean that most families are dependent on off-farm employment, and the value of irrigation must be compared with alternative forms of employment. The returns to irrigated wheat are less than the daily labour rate. Tilawe and Khageri schemes are within daily commuting distances of major towns. There is little prospect of farmers paying a service fee to irrigate wheat. Rice is more profitable, but farmers who are below the subsistence level will be unwilling to pay anything beyond a modest fee. The assessed per hectare maintenance costs, based on the small sample of canals surveyed, vary from NRs 633 at Kankai to NRs 1442 at Tilawe. Cost of improvement works is additional. It is clear that in current conditions it is not feasible to fully cover costs on the schemes in worse condition. In the circumstances, rehabilitation in advance of transfer appears to be a realistic recognition of the facts.

Although the logic of farmers paying a sufficient fee to cover the full costs of operation and maintenance is undisputed, there are clearly practical difficulties in introducing such a system in Nepal in the short term. The problem lies in the poor yields: willingness to pay for irrigation may be much higher if the water supply and other inputs are reliable. In Bangladesh, the millions of farmers who buy water from shallow tubewell and low lift pump owners for the irrigation of the dry season *boro* paddy crop, typically pay the owners 25% of the crop output. This is equivalent to some NRs10,000/ha, but this is only possible if the reliability of water supply and other inputs is such that yields are much higher (typically 4,500 kg/ha in Bangladesh). Whilst improved management should improve production, there is an overall shortage of

water on all four schemes, and there are problems of input supply and quality which are outside the control of farmers.

4.9 Maintenance planning

Failure to adequately maintain necessary infrastructure in the end costs a country dearly when scarce resources have to be diverted to rebuild systems, even allowing for the fact that a major part of the funding may come under soft international loans (Skutsch, 1998).

Fair success has been observed at the early stages of Irrigation Management Transfer. There are some key issues of sustainability, however, which are yet to be resolved. Transfer has usually been combined with rehabilitation, to various degrees, and this has tended to dominate the process – it is difficult to focus sufficiently on management whilst planning physical works. Maintenance needs will depend on what rehabilitation is done and how effective it is, which may not be easy to predict. For example, silt exclusion works can reduce maintenance significantly but they may be less effective than expected, or they may not be used at all, as at West Gandak, (where some farmers who have taken land alongside the escape channel have prevented the use of the sluices).

It is often said that management transfer works well soon after hand-over, when water users associations are recently established and well motivated, but that the associations soon become politicised and the process breaks down. A less common observation is that politicisation is a consequence of breakdown, rather than the cause. Systems jointly or solely managed by water users associations quickly deteriorate if the associations do not have an effective role with adequately defined responsibilities, or do not have the resources, skills or legal mandate to carry out their obligations. Water users associations need a clear understanding of their functions and obligations, which should be well matched with their resources and requirements for expenditure. In the absence of these, the water users association will quickly collapse. Although water users associations will enhance a sense of community responsibility, they need to have more tangible functions if they are to be sustained. They will need support in the future, and the role of Department of Irrigation will remain crucial – for technical assistance, transitional support, emergency repairs.

The technical and financial analyses focused on that maintenance which currently needs to be done in selected canals of 4 systems, to compensate for maintenance deferred in the past. If regular maintenance were carried out, the annual sums needed would be smaller. As an example, estimates made in 2000 for the maintenance of the main canal at Kankai, to compensate for a backlog of deferred work, worked out at some NRs 500/ha on average. With regular maintenance, it was estimated that an annual figure of some NRs 150/ha would have arrested the decline. When it is considered that the consequences of poor maintenance include reduced yields, or even land going over to rainfed agriculture, the economic case for better maintenance is strong.

On the schemes investigated, certain maintenance tasks like desilting and clearance of vegetation can be predicted, and will need to be done at predictable intervals. Such tasks are clear and cannot be ignored without producing an impact on the system water delivery performance in the short- to medium-term. Other tasks, like strengthening deteriorating canal banks and preventing the failure of structures (preventative maintenance), may have no immediate effect in sustaining the performance of the system. However, lack of attention in time will result in sudden failure, entailing financial loss to farmers from partial or complete crop failure and economic loss to the agency and the nation of its infrastructure. Since maintenance budgets, whether contributed by the government or farmers, are invariably too small for necessary tasks, it is necessary to use the funds in the best way possible to address both types of problem. The precarious nature of smallholder farming, means farmers' horizons are often limited to the current cropping season. It is therefore particularly difficult to get them to recognise the need for preventative work in advance of problems. It will be a concern during the remainder of the present project to explore, together with farmers, the risks to their livelihoods of sudden failures of the irrigation infrastructure and the need for pre-emptive responses.

At West Gandak, there was no system for acquiring sufficient resources to maintain the main canal, so the whole rationale of the main committee was undermined. The main committee then degenerated into disagreements over the use of such resources as they had, amidst accusations of corruption and party politics. Benefits of irrigation are often unevenly distributed in the community, so those excluded from irrigation benefits may be resentful and criticise the project in many different ways.
Many water users associations do not believe that they can raise sufficient resources from agriculture to finance operation and maintenance activities. The Irrigation Service Fee is very low, and they rely on alternative sources, such as trees on canal banks, fishing contracts, land rental etc, to cover their costs. Problems with financial management have meant that they are not able to use even their limited resources effectively. Together these problems have serious implications for sustainability. There are exceptions, such as the scheme at Panchakanya, but it is small and in good condition. Maintenance on most projects is effectively financed by the government, apart from direct labour contributions to canal cleaning. Management transfer results in an increase in costs to the farmers, which is politically very difficult to achieve, especially with depressed agricultural prices. There is some scope for increasing direct labour involvement, but other maintenance will remain a problem. *This suggests that hand-over of larger canals and structures will be difficult, or unsustainable, in the short-term and that improvement of performance, rather than financial savings, should be the main motive for transfer.*

It has been suggested (Levine, 1986), that a possible strategy is to limit maintenance expenditure, instead relying on rehabilitation to correct the resulting problems. In practice, by encouraging neglect, such a policy results in frequent and premature rehabilitations, with consequent disruption and continuing loss of production to farmers, all of which have a high financial and economic cost to individuals and the state (Skutsch, 1998). Levine's argument is based on the premise that upgrading will be needed every few years to meet changing requirements, and that the bulk of maintenance could be done at the same time as upgrading. It does not seem applicable to countries such as Nepal, where routine tasks like desilting and deweeding constitute the major part of maintenance work.

It is argued elsewhere in the report that governments do not necessarily save money by transferring systems to farmers, because of the need for continuing support. However, a strong rationale for irrigation transfer is to improve system performance. A continuing tolerance for neglect of maintenance, albeit by farmers, is incompatible with improved performance, even when intermittent upgrading is planned. Given the poor returns to agriculture at present and the difficulty in charging water fees that can cover the full costs of operation and maintenance, it is impractical to expect Water Users Association to achieve substantial savings to set against the costs of rehabilitation, notwithstanding the policy that schemes on the tarai should contribute 15% of rehabilitation cost. It is therefore particularly important that maintenance should be as effective as possible.

Where Water Users Associations assist in management of the main system, they will benefit directly if the Department of Irrigation introduces improved procedures for targeting maintenance to priority items, under a programme of asset management. Procedures for assessing need were introduced in the asset surveys for the present project. Where the responsibilities of Water Users Associations end at operation and maintenance of the branch/secondary system and below, they may need initial assistance in identifying priority works, particularly items requiring preventative maintenance. A simplified procedure might be developed for Water User Associations, based on participation by a Water User Association expressing interest in the process. Adoption of some such formal process and agreement by Water User Associations to participate in training in maintenance planning and execution might be made a condition for continuing the Department of Irrigation support. Any improved methods must be seen to justify the extra work needed to formally identify needs and to keep records of system condition.

Maintenance work which is carried out to a poor standard is a waste of scarce resources, whether of labour or of cash. Particular areas of work where standards of maintenance by farmers can be improved are usually:

- Construction or reconstruction of earthworks; good soil, carefully placed and rammed in layers
- Plugging holes in embankments. Any necessary temporary arrangements to plug leaks to be made good at the season's end by cutting back to sound material , refilling and compacting in layers
- Disposal of silt. Material to be disposed of where it cannot be washed back into the canal during the next rains
- Safeguarding the outer face of embankments against undercutting to gain extra land for cultivation
- Earthen access roads: selection of more granular soils is better than filling ruts with organic soil available to hand
- Protection works: loose stones or individual masonry blocks are usually better than building poor masonry on soft foundations
- Quality of cement/concrete: farmers to be made aware of mix strength and materials, so as to be able to control contractors

Planning and execution of maintenance should be the particular responsibility of a specially –trained individual in the Water User Association, either somebody who is already responsible for water management or otherwise. The responsibilities of each farmer benefiting from the system need to be clearly defined and sanctions-perhaps the loss of right to water for a period – imposed by the Water User Association Committee.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. The strong tradition of Farmer Managed Irrigation in Nepal shows that, with the right incentives, farmers are prepared to commit themselves to the various tasks involved in operating and maintaining an irrigation system. Farmer Managed Irrigation Schemes can provide some pointers as to how transferred schemes might function over time, but they also display significant differences from Agency Managed Irrigation Schemes, due in part to their different histories, design and scale. Although farmers have demonstrated their management skills on several large-scale Farmer Managed Irrigation Schemes, there are financial, social and technical constraints to transferring management of irrigation systems from governments to farmers.

2. Traditional irrigation relies on labour (particularly off-season labour at times of limited alternative employment opportunities) and local materials, rather than cash. The situation is changing, but modern irrigation still has a greater dependency on cash, which is more difficult to collect and to manage soundly.

   Farmer Managed Irrigation Schemes have tended to develop over time and their layout often allows for fairly independent, localized operation with individual canals operated by individual villages. Hydraulic boundaries often developed together with social boundaries, rather than being superimposed at a later stage.

   Many Farmer Managed Irrigation Schemes have a further advantage due to the relative abundance of water available for the irrigated area. For example, the Rajapur Farmer Managed Irrigation Scheme has a water supply of about six times that which might be available on the Agency Managed Irrigation Schemes studied. Many Agency Managed Irrigation Schemes were designed for relatively low water duties over large areas: strong management is needed to avoid conflicts. For these various reasons, many Agency Managed Irrigation Schemes are suited to centralised management. It would be very expensive or impractical to change the layout of a completed scheme, and constraints of water supply are difficult to overcome.

   The prospects for the successful full turnover of large-scale Agency Managed Irrigation Schemes, including the main canal, are limited if the systems require centralized management (because of their layout or design), substantial cash expenditure, or sophisticated technical skills. However, there are options for transferring some responsibilities or for joint management.

3. It is therefore not surprising that few countries have tried to turn over the management of main canals to farmers, as at West Gandak. Management of finances, equipment, and labour on the scale required at that level of the system demand skills of farmers that they may not, and should not need to, possess. It would require them to develop much greater organisational skills than they have had to use in the past. The statements of many farmers at West Gandak, where the Water Users Asssociation is supposed to have charge of the main canal, suggest not only that they feel there are many problems, but that a majority now believes that the Department of Irrigation is responsible for the main canal, not just for assisting the Water Users Association.

   Farmers do not now believe that they should be responsible for financing maintenance of the main canal, and they are apparently supported by the irrigation policy that requires payment of only a very small Irrigation Service Fee to the Department of Irrigation on those schemes where it continues to manage the main system. The budgetary support provided for a limited period by HMG after turnover also undervalued the main system. Water Users Associations do not have sufficient scope for raising the required resources. They did not relate possible income to need when agreeing to the transfer.

Transfer of branch or secondary canals has proved more successful than transfer of main systems. Transfer is most likely to be effective if farmers have already been involved in operating and maintaining at that particular level of the system. Joint management of main systems, as at Khageri, appears to be a more successful strategy.

4. Water user associations in the projects investigated in Nepal were established with varying objectives; there are clear differences in their states of development and relative success:

   - At Khageri, the objective of Water Users Association formation was to promote joint management of the system. A Main Committee collaborates successfully with the Irrigation Department in maintenance of the headworks and main canal. The branch canal committees seem to be actively collecting resources, maintaining the canal and distributing water within their areas. This transfer process has been relatively successful: it has been managed incrementally, on a system in good condition where the farming population is well-educated.
   - At West Gandak, the whole system is turned over to farmers. The Water User Association were required to take over responsibility for Operation and Maintenance, collect resources, manage water distribution, as well as negotiate with Indian officials for regulation of the barrage to release water to the system. The system is complex. Political factions are exploiting social differences within the area. The duties of the Water Users Association are too onerous and they are now ineffective, given the demanding nature of Operation and Maintenance at main system level and the inadequacy of the funding base. Water Users Associations were initially more effective in the euphoria immediately after transfer, but fundamental weaknesses meant that their development not be sustained.
   - At Kankai irrigation project, the Main Committee of the water users association is supposed to support the Kankai Irrigation Office. In practice, the latter makes the decisions, the Water Users Association providing communication rather than direct management. The Water Users Association established on the branches are active in basic tasks, but they are potentially fragile. Kankai is still an Agency Managed Irrigation Scheme, but a partial process of management transfer is in progress.
   - At Tilawe, on the Narayani Zone Irrigation Development Project, the objectives in establishing Water Users Associations were not clearly defined: the associations lapsed as soon as support was withdrawn as they had little role - effectively they no longer exist. These were not set up as part of a management transfer programme and the scheme is still fully managed by the Department of Irrigation.

5. Some general findings from interviewing farmers on the systems in Nepal:

   - Farmers are not clear about their responsibilities for operation and maintenance, or about the role of the Department of Irrigation. They choose to believe that the Department will intervene with substantial repairs/maintenance, even if the root cause of the problem is inadequate routine maintenance. The situation is most favourable at Khageri, where the real test will come as the system ages after recent work. At West Gandak they are dissatisfied with the process of management transfer and feel that all maintenance should be the responsibility of Government.
   - They indicate that their involvement in operation and maintenance is dependent on having an adequate and reliable water supply, which is a serious concern on most systems.
   - A lack of transparency in the operations of Water Users Associations leads to lack of trust. The collection rates of Irrigation Service Fees are generally poor and the procedures for assessing and monitoring collection do not seem to be adequate
   - Some feel that the training given prior to transfer was targeted too much at Water Users Association committee members

- There is a lack of appreciation of the real cost of maintenance, especially preventative maintenance. It is important that the cost of work required to keep infrastructure in adequate condition is realistically assessed and explained to farmers prior to turnover.
- There appears to be no coherent maintenance planning in WUAs. There is a general lack of awareness of maintenance needs other than for desilting canals.

6. The cost of required maintenance on turned-over schemes in Nepal exceeds the Irrigation Service Fee collection rates by considerable amounts. Analysis showed that for traditional cropping patterns, and the very low crop prices prevailing in recent years, fees set on the basis of practice in other countries are not realistic for Nepal. For example, in India, a fee set at 5% of gross crop output, equivalent to NRs 1,800 to NRs 2000 has been recommended. The relatively low output per unit of water and land in Nepal is a serious problem. Recently, the returns to wheat have been lower than the daily wage rate, so there is little hope of charging an Irrigation Service Fee for that crop when farmers would see employment in adjacent towns as more profitable.

   Maintenance works were distinguished from improvement works on all the schemes. Even so, the effect of deferring maintenance has been to require average maintenance investment of between NRs 660/ha and NRs 1200/ha for main and distributary canals on the sample areas of the four schemes, plus funds needed for structural improvements. A rough estimate suggests that some NRs 500/ha would be required for annual maintenance of the main and the distributaries once deferred work had been done.

   Farmers on Farmer Managed Irrigation Schemes may contribute, mostly in the form of labour, up to NRs1000/ha. It seems unrealistic to expect contributions of this magnitude on turned-over schemes. At present, the Irrigation Service Fees at Khageri, indicative of the four study schemes, is around NRs 120/ha plus varying amounts collected for maintenance of the secondary system. The rates of collection, highest at around 60% at Khageri, are declining.

7. Despite fairly optimistic findings in some previous studies, it is far from clear that turnover produces an improvement in maintenance. The outcome will depend on the effectiveness, or otherwise, of the turnover process. At Khageri, where Water Users Associations were actively participating in maintenance, rehabilitation had recently been carried out and it was too early to predict whether the results were more sustainable than under agency control. Failed turnover leads to a rapid decline in maintenance. Successful turnover is likely to lead to better results than agency management, but requires that farmers can collect the necessary resources.

   Strong post-transfer support to farmers and water users associations is needed to achieve sustainable operation and maintenance. Because of the cost of follow-up assistance, a more cogent rationale for turnover would be to achieve better management, rather than to save government expenditure.

   A sound basic institutional structure for Water Users Associations is needed, to allow skills in maintenance identification, planning and execution to be transferred.

8. Participatory Irrigation Management in Gujarat is being promoted both by NGOs and by Government. There have been a number of successful initiatives, particularly in the non-governmental area. The state has a history and tradition of functional co-operatives, in particular for milk production.

   In practice, there often do not seem to be clear-cut definitions or boundaries of responsibility for maintenance between government and farmers, although government guidelines exist. Responsibilities seem to vary from scheme to scheme, and even from society to society within a scheme.

The success of PIM is highly dependent on the attitude of Irrigation Department staff working with farmers' groups. Schemes where societies have a good working relationship with the Department are more likely to be clear about respective responsibilities. Irrigation personnel indicated that PIM requires more government staff time and resources than when schemes were under Department management. Staff are not rewarded for the extra effort.

PIM seems to be more effective when societies correspond with village units and with the managed command area. Management is simplified and there are fewer opportunities for conflict.

5.2 Recommendations

Maintenance is essential to make turned-over projects sustainable, but WUAs are unlikely to focus on the issues unless they are sound institutions following fair and transparent procedures. Training and support in maintenance therefore needs to complement and follow programmes of institutional support to Water Users Associations which include management, accounting, book-keeping, and better irrigated farming practices for improved output and incomes.

The need for maintenance planning should be clearly presented before transfer, and the resources and responsibilities spelled out. Maintenance should be explained as an essential means to safeguard incomes and livelihoods.

Maintenance training should focus on identification, planning, and improvements in the quality of execution of basically simple works. Complaints in the past from farmers, that training focused too much on the Water Users Associations, should be addressed by encouraging Water Users Associations to nominate respected individuals who will have prime responsibility for directing maintenance. Realistic tasks and responsibilities should be assigned, to avoid the imposition of cumbersome procedures. The same individuals would be expected to transfer improved skills and practices to farmers. Such maintenance specialists might be the same individuals who are charged with responsibility for water management or different ones, provided that close liaison between the two activities is ensured.

A realistic assessment of Water Users Associations' capability to operate, manage, and maintain the different levels of a system is essential, before committing to transfer. It is evident that farmers in Nepal cannot yet cope alone with the management of the more complex infrastructure involved with main canal systems. Joint management of the main system at Khageri provides a hopeful precedent for schemes where Water Users Associations are keen, allowing the Water Users Association involvement at the highest level of their system and interaction with operation and maintenance engineers. The negative experience of Water Users Association management of the main system at West Gandak suggests that the organisational structure should be simplified, the hierarchy reduced, organisations re-established and refocused. If such restructuring appears to show better promise, then joint management of the main system with the Department of Irrigation might be a workable strategy. If not, then the main system will inevitably have to remain in the hands of government. Merely reducing the Water Users Association's responsibility at Gandak will not solve the problem, since farmers clearly consider the organisations ineffective and corrupt.

Ideally, best co-operation between individuals is likely when their numbers are less than 20, which implies tight limitations on block size when landholdings are as small as in Nepal. However, the design of Agency Managed Irrigation Schemes means that good co-ordination between groups is essential. Increasing problems are likely to occur as the hierarchy of Water Users Associations is extended. It appears from the experience at Khageri, and to some extent Kankai, that if properly established, Water Users Associations can reasonably manage small branches not equipped with complex infrastructure, serving command areas in the range 250 ha to 300 ha.

Rehabilitation prior to transfer should focus not only on those parts of the system to be turned over, but also on the main canal, as its role is more crucial and its condition often more critical. An overall plan for rehabilitation and subsequent maintenance should be made. If farmers will commit themselves to agreed maintenance programmes and can accept the idea of assured rehabilitation when it becomes necessary in due course, there could be advantages to transfer without prior rehabilitation, as has been the case in some other countries. Farmers are then better placed to appreciate the value of maintenance, can develop the necessary institutional structure and techniques, without jeopardizing expensive investment in infrastructure.

Crop prices for cereals at present are so low that it will be difficult for Water Users Associations to cover the full costs of operation and maintenance on large schemes in Nepal, even if diversified cropping can be introduced over substantial areas. A continuing subsidy will therefore be necessary from government to avoid the need for early rehabilitation which, even when supported by soft international loans, cost the government scarce funds. The "invisible" losses to farmers due to rehabilitation include declining production and income over a period of years during the deterioration of the system, and lost harvests during the period of rehabilitation.

6. ACKNOWLEDGEMENTS

HR Wallingford acknowledges with thanks the substantial contributions made to this report by its research partners, its survey specialists in Nepal, the Mountain Resource Management group, and its collaborators in Gujarat, Aga Khan Rural Support Programme and Development Support Centre.

In particular, the inputs of Dr Umesh Parajuli and Dr Prachanda Pradhan in Nepal, Simon Howarth and Chris Finney (MacDonalds), were essential. Jon Hide was in charge of the project during the field work.

The support of the Infrastructure and Urban Development Department of DFID is gratefully acknowledged.

Appendices

Appendix A

Review of literature

Appendix A Review of literature

A1 Economic and financial aspects of IMT/Participatory Irrigation Management

A1.1 Summary of Reports reviewed

The following reports on international IMT/participatory irrigation management experience were reviewed for information on economic and financial aspects:

- Case Studies in Participatory Irrigation Management , (eds.D. Groenfeldt, M. Svendsen, World Bank Institute, February 2000). This is an extremely useful review of IMT/participatory irrigation management experience and lessons learned. It comprises a detailed analysis of the process and its results in four countries, Colombia, Mexico, Philippines and Turkey, and concludes with a chapter entitled A Synthesis of Benefits and Second-Generation Problems. Its drawback from the viewpoint of the Toolkit study is that three of these four countries are middle income rather than low income countries, with higher literacy levels and more sophisticated economies than Nepal. What can be achieved by water users associations and irrigation agencies in, say, Mexico and Turkey may be difficult to achieve under the constraints operating in Nepal. They are also countries with much greater dependence on irrigation than Nepal (the production per hectare is estimated to increase by a factor of 7 in Turkey). Despite these caveats, the report contains a number of findings of direct relevance to Nepal. A major advantage is that there is much more accumulated IMT/participatory irrigation management experience in the four countries than in Nepal, because of both the longer period of IMT/participatory irrigation management activity there and its larger scale. In Turkey and Mexico, for example, millions of hectares of former Government irrigation schemes have been handed over to users.

- Irrigation Management Transfer in Asia (Papers from the Expert Consultation on IMT in Asia, held in Thailand under FAO and IWMI auspices in September 1995). IMT Country Papers were produced for 13 Asian countries, including Nepal and the five other countries of South Asia. Though containing an abundance of useful information, the report has relatively little on IMT impacts, except on operation and maintenance costs to irrigation agencies and farmers, or on ISF levels and collection and operation and maintenance funding on transferred schemes.

- Privatisation and Self-management of Irrigation, Phase II (IWMI, March 1998). This excellent report presents the findings of a two year research study into IMT impacts, funded by two German institutions. Detailed field studies were carried out in Colombia, India, Indonesia and Sri Lanka. The main emphasis was on IMT impacts and the implications for future research, but "messages", based on the assessments made, were also presented for national development agencies and irrigation users (water users associations and farmers).

- Transfer of Irrigation Management Services: Guidelines (D.L. Vermillion and JA Sagardoy, FAO, GTZ and IWMI, 1999). These Guidelines discuss cost recovery and financial management, but mainly at the macro and policy level rather than micro (water users associations etc) level. However, page 31 has a useful list of eight detailed measures that can be taken to prevent financial irregularities in water users associations after IMT, and pages 82-83 contain a similar list of measures to improve cost recovery and water users association financial management. In view of the limited other economics and finance-related content of the Guidelines, they are not reviewed further here.

A1.2 Case Studies in Participatory Irrigation Management (World Bank Institute, 2000)

With its depth and scope of analysis of the lessons learned from existing experience, this report is required reading for those concerned with IMT/participatory irrigation management. Its definition of the terms IMT and participatory irrigation management is a useful one:

"Almost all irrigation systems have some involvement by water users in system management. When people speak of introducing participatory irrigation management, they are usually referring to a change in

the level, mode or intensity of user participation that would increase farmer responsibility and authority in management processes.

IMT is a more specialized term that refers to a process of shifting irrigation management functions from a public agency to a private sector entity, a non-government organization (NGO), a local government or a local organization with farmers at its base. The most common form of IMT moves management responsibility from a centralized government irrigation agency to a financially autonomous local non-profit organisation in which water users have a substantial voice in the control process or control the irrigation system altogether".

In Colombia, Mexico and Turkey IMT, rather than participatory irrigation management, has taken place. Scheme management (though not ownership) has been transferred from Government to user organisations, whereas in the Philippines participatory irrigation management has been the norm, with IMT bring confined almost entirely to the Communal Irrigation Systems. These are usually under 1,000 ha. On larger schemes participatory irrigation management rather than IMT has been the preferred option in many developing countries, especially in India.

A brief review of the four country reports in the overall Case Studies report is presented below.

Benefits and Second-Generation Problems of IMT in Mexico (E. Palacios V).

Mexico has had one of the most successful IMT programmes. Starting only 12 years ago, by 1996 2,920,000 ha of the 3,100,000 ha in 82 Irrigation Districts had been transferred to water users associations. Economic and finance-related findings included the following:

- As part of the transfer process, a massive increase in ISF rates (400%) had been made in the immediate pre-transfer period, as part of the IMT process. Even so, the ISF revenues raised by the water users associations are still insufficient to cover the full operation and maintenance costs, let alone make provision for replacement costs and system rehabilitation. Government is subsidising about 15% of total operation and maintenance costs (1993-96 figures), in the form of expenditure on the main systems. Despite the marked improvement in system finances resulting from the IMT programme, therefore, long-term financial viability of the water users associations is not yet assured. Convincing users of the need to raise ISF rates from their previous inadequate levels was not easy. Yet, with an average farm size of 6.8 ha on transferred schemes in 1996 (Consultant's calculation), operation and maintenance payment capacity is much higher than in countries like Nepal.

- Few water users associations ISF tariff systems are based on volumetric charging (charging according to the quantity of water used) which, in a country of water resource constraints in many regions, as is the case in Mexico, is considered to be the most desirable system. There is also little inflation indexing of charges. On the other hand, most users pay in advance of receipt of service (i.e. prior to using the irrigation water).

- Few water users associations have sinking funds or financial reserves. In the past CNA (the National Water Commission) has forced water users associations to maintain amortisation funds. It was not clear from the report what exactly this implied.

- The intention is that water users associations should pay bulk water charges to CNA, which operates and maintains major water storage, diversion and other infrastructure and regulates national and regional water use. Many water users associations have, however, been unable to reach agreement with the CNA for such payments.

- Standards of water users association accounting and book-keeping are generally poor. A nationwide set of standard book-keeping practices is needed for the water users associations, and also annual audits.

- Despite the high degree of management transfer under the Mexican system, the Government, in the shape of the CNA, still plays an important role. In addition to funding 15% of operation and maintenance and providing bulk water supplies, the CNA checks each water users association's proposed annual maintenance programmes and makes corrections and suggestions. Post-turnover support is thus still being provided.

- Despite Government promises, much infrastructure was transferred without rehabilitation. Given most water users associations' lack of financial reserves, and the likely need for rehabilitation at some stage in the future, Government will be involved. ANUR, the National Association of Water Users, has come to an agreement with the CNA for a 50/50 sharing of rehabilitation costs between CNA and the users.

- Eighty percent of those interviewed considered that system maintenance had improved since transfer. Unit costs of maintenance had gone down. Impacts of IMT on agricultural production were unclear, because of the effects of major external factors such as economic liberalization.

IMT in Turkey: Process and Outcomes (M. Svendsen and G. Nott)

Turkey is another example of a highly successful system IMT programme, of even more recent origin than Mexico's. Started only seven years ago, as the Turkish Accelerated Transfer Programme, by 1996 DSI (the General Directorate of State Hydraulic Works) had transferred nearly 1,000,000 ha, 61% of the total public sector irrigated area, to local government institutions or Irrigation Associations (IAs). By 2000 1,500,000 ha is expected to have been transferred. Unlike Mexico and many other countries, Local Government has played a major role in the process, much more than did grassroots farmer organisations. Membership of IAs is drawn from local and central government as well as DSI; water users are represented indirectly through the electoral process for local government. The budget for IAs is approved by the Ministry of the Interior, and DSI is responsible for technical oversight. They are large organisations, typically covering 6,500ha. Economic and finance-related findings included the following:

- IMT led to a substantial improvement in operation and maintenance cost recovery, though somewhat less so than in Mexico. In 1990-93 only 37.2% of collectibles (ISF revenues due) were collected. The World Bank had estimated that only 17% of DSI's operation and maintenance costs were being recovered. In contrast, in 1995 operation and maintenance cost recovery by the 12 IAs studied was 72%, and they were hoping for 90% in the near future. ISF levels were felt to be possibly insufficient to ensure financial viability after DSI support is withdrawn although, at least, most IAs were accumulating financial reserves. Nevertheless, as in Mexico, the long-term financial self-sufficiency of the IAs is not yet assured.

- Actual contributions to maintenance costs by IAs is around US $5 /ha, which is higher than the ISF (about US $1 /ha) in Nepal but less than estimated maintenance costs on AMIS, despite the much lower labour costs in Nepal. 75% of maintenance costs were met by DSI in 1996

- The existing crop-based ISF tariff system does not encourage economic water use, because of the lack of volumetric water charging. A tariff structure comprising a fixed area-based "connection charge", plus a volumetric charge plus an energy surcharge for pumped supplies, was recommended in the report. The practicalities of volumetric charging were not discussed.

- No payments are being made by IAs to DSI for bulk water supplies.

- Central government, in the form of DSI, still has a substantial involvement in the transferred systems, in a very similar way to that in Mexico. DSI maintains a technical oversight of IAs' activities, conducts their annual maintenance reviews, and approves their annual repair and maintenance budgets and ISF rates. In the report the need for continuing financial support (including accounting, budgeting and audit), management support, and technical and operational support was identified.

- Capital cost recovery through the DSI amortisation charge system (this was in place long before IMT) is negligible, because of the effects of inflation. There is a lack of policy on the sharing of rehabilitation costs.

- IMT impacts on operation and maintenance costs and quality of irrigation service could not be ascertained, nor could production impacts with any certainty. Crop yields seemed unlikely to have increased, but there may have been some increase in irrigated crop acreages (cropping intensities). The scope for reducing DSI costs was restricted by strong resistance to DSI staff cutbacks.

- Prior to 1993, there had been a long history, dating back to the early 1960s, of transfer of tertiaries and secondaries to users on DSI schemes, with strong local government involvement. This was found to result in only modest reductions in operation and maintenance costs and DSI staffing, because IMT was confined to only the lower ends of the systems. Clearly, to reap the full public finance benefits of IMT, full rather than partial transfer is necessary, except possibly for headworks and main canal, where these are too large or complex for the users to operate and maintain effectively.

- The theoretical basis for the DSI ISF rates is that these should equal 5% of the value added to crop output by irrigation. In 1993 the World Bank calculated that, in fact, 7.6% of the increase in net farm income (this is broadly similar to the value added) from irrigation would be required for full operation and maintenance cost recovery.

Benefits and Second-Generation Problems of IMT in Colombia (L E Quintero)

Unlike Mexico and Turkey, IMT in Colombia was initiated by the users rather than the central government. No mention is made of local government being significantly involved in the process. Of the relatively limited area of 119,400 ha of public irrigation schemes in Colombia, 90% has now been transferred, only six still being administered by INAT, the Government irrigation agency. The transfer programme is considered to have been relatively successful. Economic and finance-related findings included the following:

- IMT has resulted in a major improvement in operation and maintenance cost recovery, to 70-80% on transferred schemes compared with only 10% on INAT systems. Nevertheless, ISF rates are not keeping up with inflation and there is inadequate accumulation of funds for replacements and rehabilitation. Operation and maintenance cost recovery is highest where users have contributed to capital costs.

- In addition to the threat posed by the still inadequate, though much improved, levels of cost recovery, system sustainability is at risk from the short-sighted cost-cutting policy followed by many water users associations. A "risky" approach to maintenance has been widely adopted, with under-funding of the water users associations and reductions in both technical staff numbers and their quality.

- A more appropriate ISF tariff structure is in operation than in Mexico or Turkey, with a basic fixed fee ("connection charge") per hectare plus a variable usage or volumetric fee. In practice, however, there is little actual volumetric charging (charging by measured water quantities) as yet.

- As in Mexico and Turkey, the irrigation agency still has a significant role with regard to the transferred schemes. INAT checks water users associations' annual operation and maintenance plans and budgets.

- Water users associations' financial management skills are deficient, and there is a need for training to strengthen these.

- IMT impacts on operation and maintenance have been positive, with a reduction in unit costs, better standards of maintenance and more flexibility in the system and in irrigated cropping patterns. Production impacts were not reported. INAT has not re-organised itself in the light of its changed role vis-à-vis the transferred system, so the potential for public sector cost savings has probably been only partially exploited.

Participatory irrigation management in the Philippines National Irrigation Systems (N Raby)

In many ways the Philippines IMT/participatory irrigation management experience is more relevant to Nepal than is experience in the other three countries, because of the smaller differences between the two countries in income and educational levels and other factors affecting the IMT/participatory irrigation management process. IMT progress on the National Irrigation Systems (NIS) has been limited, with only 11,200 ha of the total area of some 600,000 ha having been transferred to Irrigation Associations (IAs) by 1995. participatory irrigation management progress has been much greater. Joint management rather than management transfer is, in fact, reportedly the national goal. In 1995, the areas under the three types of NIA (National Irrigation Administration) user contracts were as follows:

	Area (ha)
Contract type	
Maintenance	144,926
Collection	81,141
Combined (maintenance + collection)	236,088
Total	462,155
Area under IAs	517,760

Local government has not been much involved in the IMT/Participatory Irrigation Management process. The report called for it to be given a greater role.

Economic and finance-related findings included the following:

- Although ISF collection had improved, overall collection efficiency on the NISs was still low, at around 60% on systems with IAs. This was significantly higher than the 43% achieved on systems without IAs. These participatory irrigation management cost recovery benefits were increased where participation was increased by means of NIA-IA contracts. For example, it was 83% and more on systems with irrigation fee collection contracts. Clearly, increased user participation leads to increased cost recovery. ISF revenues are protected against inflation through payments being specified in terms of paddy rather than cash.

- ISF tariff structures differentiate between the various types of primary irrigation supply, with different rates for reservoir-supplied, pumped and gravity diversion systems. A crop-based charging system is followed, without division into fixed and variable elements.

- The National Water Resources Board reportedly charges the NIA for bulk water supplies delivered.

- IA financial management is generally poor, especially regarding accounts and accountability and subsidiary income-generating enterprises. Conversion of IAs to co-operatives, in order to undertake such activities, had not been a positive experience. It had diverted and dissipated IA management efforts and increased opportunities for the misappropriation of funds. Training of IA staff to strengthen financial management is required.

- The costs of forming and developing an IA are substantial, at a reported US$ 28/ha.

- participatory irrigation management impacts on agricultural production and quality of irrigation service were difficult to assess, but participatory irrigation management does seem to have brought down operation and maintenance costs, as the following 1993 figures show:

	Repair and maintenance costs (Pesos/ha)	Personnel costs (Pesos/ha)
With IAS	380	340
Without IAS	540	450

A1.3 Irrigation Management Transfer in Asia: Consultation (1995)

The conclusions from this workshop are drawn together in a useful Summary Report. One clear conclusion was that the principal driving force behind IMT in Asia has been the desire to reduce the cost to Government of irrigation operation and maintenance. Financial problems were seen as a major potential cause for failure of scheme transfer. It was reported that "farmer organizations had to search for additional income opportunities" and that "accounting skills, financial control and auditing is often inadequate in farmer organizations". Concerns were expressed about the possible inability of poor farmers to pay for the incremental costs resulting from the transfer from agency management and operation and maintenance funding. It was "widely reported that farmers willingly pay substantial amounts for irrigation service when the service provided is adequate and reliable".

Some interesting figures on operation and maintenance cost recovery charges as percentages of gross crop output were quoted for India and Vietnam. In India the recommended levels of charge were reported to be 5% for food crops and 12% for cash crops (it was not clear whether this was for total output or just the increment in output over non-irrigated crop levels). In practice, the charge in India usually amounts to no more than 2% of gross output. In Vietnam the public sector Irrigation and Drainage Management Companies charge between 4% and 8% of gross output, which is reportedly "amongst the highest in the world for public gravity irrigation".

A1.4 Report on Privatisation and Self-Management of Irrigation, Phase II (IWMI,1998)

Economic and finance-related findings in this report's General Conclusions (pages 8-10) included the following:

- IMT resulted in a reduction in Government operation and maintenance irrigation expenditure in all cases. Where farmers have been paying for nearly the full cost of routine operation and maintenance before transfer, IMT was found to be likely to reduce farmers' irrigation costs.

- IMT was not found to have resulted in an improved quality of irrigation service, defined in terms of irrigation intensity and adequacy and equity of water distribution. Most farmers reported no change in irrigation adequacy or equity. This finding contradicts that from the Case Studies discussed in Section 2.B.2.

- With respect to achieving more sustainable maintenance of irrigation infrastructure, this was achieved in India and run-of-river schemes in Colombia but not in Sri Lanka, Indonesia or expensive lift schemes in Colombia. In all four countries, however, there was evidence of attempts by farmers to improve cost efficiency in irrigation management, but the time-frame was too short to reduce the cost of irrigation significantly.

- As regards agricultural production, the results were so mixed that it proved impossible to determine whether IMT had raised agricultural production or not. Nevertheless, it was felt that IMT by itself tends to have little direct impact on productivity, this being more influenced by other factors. A more comprehensive study with a much longer time series, of as much as 10-20 years, would be needed in order to draw reliable conclusions on agricultural impacts. The same point applies, though to a lesser degree, to irrigation service quality, maintenance standards and operation and maintenance costs. In most countries IMT is still in its initial stages and its longer-term impacts are difficult to assess at present. It is still early days in the worldwide IMT process.

In its "Messages for NARS and national development agencies", the report states that partial reforms, such as those in Sri Lanka and India produce little, if any, change in performance. This is the situation if the transfer is only nominal with the Government retaining some responsibility, control over budgets, water distribution etc or if there is inadequate legislation or enforcement.

According to the report, views vary on the merits of farmer organisations developing subsidiary enterprises in order to increase their incomes. Some see it as an unnecessary dissipation of management effort, as in the Philippines example in Section 2.B.2(d), whereas others see it as a necessary means to replace lost subsidies and to increase farmer group support for their organisation (assuming the subsidiary enterprises are successful).

A worrying conclusion, which the Case Studies in Section 2.B.2 confirm, is that farmer organisations rarely raise long-term capital replacement funds and tend to emphasise cost containment at the expense of preventive, and sometimes even corrective, maintenance. This tendency is a clear threat to long-term post-IMT scheme sustainability. This is, however, not surprising as it is a continuation of past trends. It is indeed debatable that it is a sensible approach (Levine, 2000). It may be inevitable for as long as transfer is only for management rather than ownership.

A.1.5 Conclusions from the Literature Review of Cost Recovery and Economics

The review and analysis has focused on the sustainability of transferred schemes, and discusses particularly those issues which affect the organisation and execution of maintenance. A summary of principal points is included below, with indications of their relevance to Nepal.

In the "Synthesis of Benefits and Second Generation Problems", investigating experience with IMT in four countries, the World Bank Institute identified four major "second generation" problems for water users associations :

1) insecure water rights
2) financial shortfalls
3) rehabilitation (presumably, the need for)
4) lack of financial and administrative management expertise

Point 1) is an "external" problem, which may be difficult for water users associations to resolve without Government action. The remaining three "internal" problems are linked to finance and organisation. Poor maintenance is not singled out as a problem, but it results from both 2) and 4), is the primary contributor to 3), and is likely to be the issue which causes ultimate breakdown of a scheme.

In programmes of partial turnover, where Government retains the management of the headworks and the main system, operational and maintenance issues which occur below that level are not complex, and are well within the capability of farmers to manage. In general, however, farmers will need help at the outset to identify and plan priority maintenance works, and to improve the standards of maintenance execution. Well-planned, organised and funded maintenance depends on the establishment of sound institutions.

In irrigation, as in farmer-managed water supply schemes, natural disasters can cause damage which is beyond the financial and technical capacity of water users associations to overcome. In the West, the situation might be covered by insurance. In the developing world, it is unrealistic to expect user groups to accumulate sufficient capital for such eventualities. Governments in countries such as Mexico and the Philippines, as well as Nepal, recognise the need for intervention at such times.

The main findings are as follows:

- Recovery of operation and maintenance costs improves substantially under IMT and participatory irrigation management programmes, but collections are still generally insufficient to cover full costs. Irrigation Service Fee (ISF) tariffs are frequently set too low and they are not linked to inflation. The efficiency of the collection process needs to be improved. water users associations make little or no provision for the cost of replacing infrastructure at the end of its working life.

  There is a substantial risk of insufficient funding on IMT schemes in Nepal. Farmers on most Government schemes have become accustomed to minimal charging, leading to negligible operation and maintenance cost recovery. Farm incomes and payment capacity are low. By contrast, on functional Farmer Managed Irrigation Schemes (FMIS), farmers are responsible for funding the costs of operation and maintenance, in exceptional cases collecting up to NRs 1,000 or more per hectare. In common with the experience in many other countries, turnover involves promoting a major change in farmers' attitudes. Considerable training and support will be necessary to help water users associations establish adequate revenue collection processes.

- The World Bank suggests that a two-tier ISF tariff system is appropriate where water shortages occur. A fixed per-hectare charge would cover the costs of running the scheme and a variable (volumetric-based) charge would reflect the cost of using scarce water.

  However, there are strong practical objections to the Bank's proposal in the context of smallholder surface irrigation schemes in Asia. A fixed charge would unfairly discriminate against users at the tail of a system, who frequently receive poor service. On most existing gravity schemes, volumetric measurement is realistically practical only at the headworks and distributary canal heads. The crop-based tariff system adopted on most Government schemes in South Asia is more appropriate for present conditions. It is equitable and easy to administer. ISF charges can be based on each crop's total water use. On IMT/participatory irrigation management schemes in Nepal, therefore, it is realistic to try to refine and improve the present ISF tariff structure and raise fee rates to a more realistic level, rather than to replace it with a two-tier system.

- Poor financial management, accounting and bookkeeping are serious problems in water users associations. Since adequate maintenance requires adequate resources, both financial and human, financial management and accounting will need improvement, as a priority. Considerable institutional strengthening of water users associations in these tasks will be required.

- It is often urged that water users associations develop subsidiary enterprises to increase income and resources. The capacity of water users associations varies considerably, so it not considered appropriate to make prescriptive statements on the issue. However, in the early years after IMT it is advisable that groups concentrate on the irrigation enterprise. The history of successful groups pursuing diversified activities indicates they have generally expanded their activities once irrigated agriculture has provided a sound base.

- The need for rehabilitation of defective irrigation infrastructure is a key issue in IMT. In Nepal, the First Amendment (1997) of the Irrigation Policy (1992), requires farmers on the tarai to contribute 12-15% of the capital costs of rehabilitation. However, in practice it appears that contributions are lower and that it is difficult to achieve such a contributions level.

- It is now recognised that Governments need to continue to provide effective support to IMT schemes for a considerable period post-transfer. Consequently, the savings in overall public sector expenditure will be less than anticipated in the past. Little reference is made in literature to the costs of the IMT/participatory irrigation management process, other than a figure of US$ 28/ha reported for the Philippines. It is clear that associated staff costs are substantial. Many irrigation agencies have yet to re-orientate their organisational structure, staff and activities to perform new roles in the areas of technical assistance, advice and regulation. Nepal has already begun to accommodate to new tasks, but the available resources are limited.

- To date, quantitative impacts of IMT/participatory irrigation management have not been conclusively demonstrated, even in terms of reduced Government expenditure and increased expenditure by farmers on irrigation operation and maintenance. The analysis of published literature suggests that the quality of service has in many cases been improved, and that the unit costs of maintenance have sometimes decreased. The latter observation is not meaningful without analysis of the impact of reduced expenditure on system condition and lifetime.

- The dangers of water users associations setting low maintenance standards and jeopardizing the benefits of IMT/participatory irrigation management by setting low tariffs are illustrated by a study of Colombia. It is emphasized that the responsibilities for maintenance and for support post-turnover need to be clearly defined.

A2 Irrigation Management Transfer- Nepal

The following material was reviewed to assess economic aspects of IMT/participatory irrigation management, cost recovery and water users association financial management:

- Irrigation Service Fees in Nepal (K Prasad, S Sijapata, P Pradhan, K R Sharma and N Riddell, Department of Irrigation and IWMI, September 1998). This provides an excellent overview of the whole irrigation cost recovery situation and possible future improvements. Its findings are summarised in IWMI Brief No. 5, dated June 1999.

- Nepal Irrigation Sector Project (NISP) Irrigation Subsidy Study, Phase II (Report, Royds Consulting Ltd et al, March 2000). This included case studies of seven schemes and areas.

- Irrigation Management Transfer Project Contract Completion (Computer Assisted Development Inc. (CADI) May 1996 – Nov. 1999 and APTEC Consultancy (P) Ltd, January 2000).

- Report of an October 1999 Workshop on the Evaluation of IMT Process and Performance, (Department of Irrigation and IWMI). This was reviewed particularly from the viewpoint of IMT economic impacts. IWMI's Brief No. 7 of May 2000 summarised the results of the main impact assessment presented at the workshop.

- Farmer-Managed Irrigation Systems in Nepal at the Crossroad, (P. Pradhan, June 2000). Here the main interest is current levels of irrigation users' operation and maintenance expenditure per hectare, as an indication of farmers' possible willingness-to-pay (WTP) on IMT and participatory irrigation management schemes.

- IWMI Brief No. 6. Post-Transfer Support to water users associations, from the viewpoint of support for ISF assessment and collection and financial management.

A2.1 Irrigation Service Fees in Nepal (IWMI. Colombo. 1998).

This report highlighted the sorry state of cost recovery on Government irrigation schemes (AMIS (Agency-managed irrigation schemes)) in Nepal and the gulf in cost recovery performance between the AMISs and

the farmer-managed irrigation schemes (FMISs). The main points from the study, as reported in the IWMI Brief No. 5, were as follows:

- Total ISF collections on the AMISs in Nepal meet barely 2% of the operation and maintenance costs incurred and average only about NRs 1.7 million, or some NRs 8/ha. Average operation and maintenance budgets for run-of-river AMISs over the previous three years had been NRs 374/ha. Since 1994/95 the situation has deteriorated markedly. During the 1986/87 to 1993/94 period ISF revenues had covered between 12% and 31% of operation and maintenance costs. Poor AMIS cost recovery is a result of both the low level of fees set (NRs 60/crop ha for most surface schemes, unchanged since 1975, and NRs 400/crop ha for tubewell schemes) and the low collection efficiency.

- Though still inadequate, an upward trend in ISF collection and other resource mobilisation was noted on schemes under partial or full management transfer programmes (note: however, that this conclusion was based on very limited data and this Toolkit Study found this to be only partially the case with the four schemes covered in the study, and the situation has deteriorated on one of the three schemes reported as successful). As noted in Section 2.B, the same was found to be true with public irrigation schemes in Colombia.

- Reasons quoted for the low operation and maintenance cost recovery included lukewarm Government commitment to full ISF collection, shortcomings in scheme performance, institutional weaknesses and farmers' view of ISF as a tax rather than a payment for a service provided. Improved service quality and quantity are essential for full cost recovery.

- In common with other countries in South Asia, ISF revenues go to the central government treasury rather than being retained by Department of Irrigation to help fund operation and maintenance. There is thus no direct linkage between ISF payments made and the level of expenditure made. Incentives for the farmer to meet his ISF obligations or Department of Irrigation staff to collect the revenues due are correspondingly reduced. After scheme transfer to the users, this problem would, of course, disappear.

- An entirely different situation prevails on the 490,000ha of wholly farmer-managed irrigation schemes. By definition, FMISs have to fund their operation and maintenance from their own resources, without subsidies from HMGN (except in the form of occasional assistance with scheme repairs after major natural disasters, or rehabilitation under projects such as SISP or NISP). According to the ISF study, tarai FMISs spent between NRs 47/ha and NRs 860/ha on operation and maintenance in 1986. Although the true valuation of labour costs is a matter of some debate, the costs in current terms are clearly very high and exceed Government ISF rates by an order of magnitude - even for schemes such as Rajapur which only provide monsoon irrigation and a limited supply for part of the dry season.

- FMISs have shown an impressive ability to set up and operate their own cost recovery systems. Those studied had set up operation and maintenance cost recovery rules and regulations and maintained records of landowners and land holdings. Such records are essential for effective cost recovery. water users association incomes and expenditures were transparent to all.

Experience with ISF assessment and collection in Nepal provides both positive and negative pointers for future IMT/participatory irrigation management on Department of Irrigation schemes. On the positive side, experience on the FMISs, which are generally regarded as reasonably successful, shows that, under the right conditions, farmers are willing to contribute as much as NRs 1,000/ha, and possibly more, for the operation and maintenance of schemes which perform satisfactorily, and are able to organise and manage a cost recovery system themselves. On the negative side, on the numerous potential candidate Department of Irrigation schemes for IMT/participatory irrigation management a long tradition has built up of under-payment or non-payment of operation and maintenance costs by irrigation users.

It may prove difficult to break this tradition and develop an attitude of full payment for the irrigation service received. For many decades most large-scale irrigation development in India and Pakistan was based on full cost recovery, sometimes of capital as well as operation and maintenance costs. In recent decades this concept has been allowed to erode, but the tradition is still there. Nepal does not have the advantage of this tradition; it is coming from the opposite direction, with a tradition of negligible AMIS cost recovery.

A2.2 NISP Irrigation Subsidy Study Phase II Report (March 2000)

Since under-recovery of operation and maintenance costs is a major irrigation subsidy, this NISP study covered much of the same ground as the ISF study. A sample of seven projects was taken, three of which (Kankai, Sunsari Morang and Rampurphant) involve surface irrigation and four of which involve groundwater (tubewell) irrigation. Particular points emerging from the study are the following:

- Potentially useful data on irrigated versus non-irrigated crop gross margins were obtained. Average annual gross margins per hectare were reported to be as follows, in NRs:

	Sunsari Morang	Kankai	Rampurphant
Irrigated	18,775	38,448	36,117
Rainfed	6,223	10,779	18,062
Incremental GM from irrigation	12,552	27,669	18,055

- These reportedly high levels of irrigation benefits (the incremental gross margin from irrigation) would indicate a correspondingly high level of farmer payment capacity for irrigation. If farmer returns per hectare are really NRs 12,552-27,669 higher with irrigation, most irrigation users on IMT/participatory irrigation management schemes should be able easily to afford to pay NRs 1,000/ha or more for operation and maintenance. The farmer payment capacity analysis in Section 6, however, suggests that, in fact, the incremental returns from irrigation are generally much less than the figures above indicate.

- Typical operation and maintenance costs for medium and large tarai surface irrigation schemes were reported as being NRs 670/ha and NRs 213/ha respectively. However, these are not based on a rigorous analysis of true costs and include some bold assumptions on desilting requirements. True annual costs are difficult to calculate because of the large backlog of deferred maintenance, or even deferred construction. This raises two further questions, which are not addressed in this study:

  i) how to match annual ISF levels with the normal annual maintenance, and less frequent requirements for intermittent maintenance
  ii) what is the optimal level of maintenance – to keep the system constantly in its original (or some specified poorer condition) or to accept gradual deterioration coupled with periodic major maintenance or rehabilitation
  iii) differing maintenance requirements for different designs – eg. gates requiring a lot of maintenance, as compared to simpler fixed control structures

- It was recommended that the subsidy on surface irrigation schemes should be gradually phased out, the aim being 100% operation and maintenance cost recovery on HMGN schemes. This was considered to be affordable to irrigation users. However, the lack of a rigorous and agreed methodology for determining operation and maintenance requirements and hence their cost might affect people's willingness to pay, particularly given the general levels of distrust and lack of transparency prevalent in local financial management. On the other hand, Recommendations for Surface Irrigation (report page 142) recommends subsidies for small and marginal farmers and for farmers in some remote regions.

A2.3 IMT Project Contract Completion Report (CADI et al, January 2000)

This is the terminal report of the CADI-APTEC technical assistance team which was contracted to assist with the implementation of this Asian Development Bank (ADB)-funded IMT Project. The report provides a wealth of information about the project and its constituent schemes and presents numerous conclusions and recommendations. Aspects relating to IMT impacts, cost recovery and financial management were as follows:

- The need for realistic water users association operation and maintenance budgets and ISF programmes and long-term financial viability and self-sufficiency was emphasised. The ISF reported for the three Phase I schemes (Khageri, Panchakanya and West Gandak) on page 49 appear to be clearly inadequate.

- Considerable training was provided by the TA team during its three year assignment, but little of this apparently concerned cost recovery or financial management. operation and maintenance guidelines and training were developed and water users association members were trained in basic irrigation management (but not financial planning and management) principles. Page xvii of the Executive Summary recognises the need for "a better rationale and better training" in ISF collection. Nevertheless, it could be argued that insufficient emphasis is given to ISF organisation and management and water users association financial management in the list of key recommendations for future IMTP activities on page (xvii). Adequate resource generation at the local level is identified as one of the three key IMT issues which still need to be addressed.

- Another of the three key issues identified was the need for the provision of post-turnover support (PTOS) services to water users associations on transferred schemes, to a much greater degree than originally envisaged. IWMI's Management Transfer Brief No. 6, dated June 1999, also stresses the need for post-transfer support to water users associations. This is now widely recognised as a key requirement and played an important in successful transfer in Turkey and elsewhere, but was not fully appreciated in the planning stages of IMTP since a major requirement then was to reduce Government involvement as much as possible

IMT impacts on scheme performance and productivity were not discussed in detail. A realistic assessment of impacts would not be able to be made until several years had elapsed since transfer.

A2.4 Evaluation of IMT Impacts, October 1999 Workshop (IWMI Brief No. 7, May 2000)

At the October 1999 Workshop ten papers relating to IMT were presented, but only one, by M Samad, C Fraiture and K C Prasad, assessed IMT impacts in detail. Their study covered three minor canals (two transferred, one not transferred) in the West Gandak irrigation scheme and four deep tubewells (two transferred, two not transferred) in the Bhairahawa-Lumbini Groundwater Project (BLGWP). A questionnaire survey of a random sample of farmers was conducted on each scheme. The main findings, which were summarised in the IWMI Nepal brief No. 7, were as follows:

- As would be expected, on transferred schemes the operation and maintenance costs incurred by HMGN had gone down and those incurred by the farmers had gone up. However, it is not clear to what extent maintenance activities are being transferred or simply deferred.

- Farmers considered that the adequacy of irrigation water supply and its timeliness had improved and its distribution had become fairer since transfer. They faced less difficulty in arranging for delivery of irrigation water and in obtaining assistance from the water users associations as compared with the HMGN agency previously. (Note: In view of the currently unsatisfactory state of affairs at West Gandak which was revealed during the Toolkit field studies, these favourable findings may no longer be valid).

- No clear overall differences in crop yields and production between transferred and non-transferred schemes were found. It would have been difficult to discern such differences because the transfers had been effected fairly recently and production increases on transferred schemes could have been due to the pre-IMT scheme rehabilitation which was undertaken, rather than to management transfer. In principle, such rehabilitation benefits could have been obtained with or without transfer.

- In the report, concerns were expressed about the inadequate level of ISF set and of the inadequate ISF collection efficiency, and the implications for scheme sustainability. The Toolkit field studies undertaken on West Gandak in 2000 demonstrate the validity of this concern at present; ISF collection there appears to be at a very low level.

A2.5 FMISs in Nepal at the Crossroad (P Pradhan, June 2000)

Almost 70% of Nepal's irrigated area is under FMISs and, despite some problems, these are one of Nepal's clear agricultural success stories. Nevertheless, they are now facing a number of internal and external challenges. According to Pradhan, these include: increased competition for water from other sectors; increasing rural labour shortages affecting FMIS management and maintenance, which is labour-intensive; increasing shortages of local materials, especially timber, for scheme repairs; a growing "dependency syndrome" in the FMIS sector, due to the provision of HMGN and donor assistance; and institutional and legal problems concerning FMIS water users association registration, the newly formed National Federation of water users associations and the future role of the District Irrigation Offices and Village Development Committees (VDCs) with regard to FMIS management. Interestingly, inadequate resource mobilisation for operation and maintenance is not cited as a problem, in contrast to the transferred former AMISs referred to in Section 2.A.5. However, some concern has been expressed elsewhere for the larger tarai systems – particularly those that may now be affected by the abolition of the kamaiya system (bonded labour) in July 2000.

For the Toolkit economic studies the main item of interest in this FMIS paper was the level of operation and maintenance expenditure (labour inputs, other inputs in kind, and cash), as an indication of what farmers on transferred AMISs might be willing and able to pay for operation and maintenance. At 1996/97 prices the operation and maintenance costs/ha quoted (those were from the ISF study) were as follows:

FMIS type	Median (NRs/ha)	Range (NRs/ha)
Tarai system (6 nr)	572 – 627	100 – 1,808
Hill systems (9 nr)	798 – 1,064	212 – 2,287
River valley systems (7 nr)	133	93 – 478

These are mainly maintenance rather than operation costs. As might be expected, maintenance costs vary enormously from scheme to scheme, depending on local conditions. To some extent, these figures also reflect the methodology in costing labour inputs. Farmers might value their inputs differently, particularly if they are being asked to contribute cash rather than labour.

A.3 Policy and Regulations for IMT in Nepal

The First Amendment (1997) of the Irrigation Policy (1992).

Part-I Section 1.3: Objectives, Clause 1.3.2 refers to "mobilisation of farmers' resources" under the objective of operating and managing new programmes of construction, renovation and improvement. Another objective (Clause 1.3.9) is to formulate legal provision to raise irrigation service charges by user associations and to establish a system of spending the collected revenues.

In Part II, Clause 2.2.2(c) of Section 2.2: Policy Provisions for Irrigation Development, states that "HMG shall not realize water fees on the transferred surface and groundwater irrigation systems. The concerned water users associations may realize irrigation service charges from the users…..". The first provision appears to preclude HMGN charging for bulk water supplies in situations on transferred schemes where

Department of Irrigation continues to manage the headworks and main canal. This is often the best solution for schemes with technically complex primary supply systems which may be beyond the operation and maintenance capacity of water users associations (water users associations).

Section 2.4: Resource Mobilisation, sets out the arrangements for capital cost sharing between users (water users associations/beneficiaries) and HMGN, the users' required minimum contributions for surface irrigation schemes to be as in Table A 1, which summarises the main features.

Even though the percentage contributions required from users are small, except at the quaternary (watercourse) level, this provision does establish the key principle that beneficiaries of HMGN-funded irrigation development must bear at least some part of the capital cost involved. Apart from cost-saving benefits to the Government exchequer, this policy helps to ensure that only worthwhile projects go ahead. Farmers will only agree to contribute to capital costs if they consider the project is likely to be successful and will bring them tangible benefits.

Under Clause 2.4.2, water users associations have to deposit in the joint bank account of the concerned Department of Irrigation office and water users association a sum equivalent to 0.5% of the estimated cost, as a fund for repair and maintenance (R&M). This can then be used for R&M after the works are completed.

Table A1 Minimum Shares of Surface Irrigation Capital Costs to be Borne by Users

Category	Percentage share to be borne by users
Water users association – Operated Schemes	
a) New construction:	
- Tarai	10
- Hills	5-7
b) Strengthening (ie. Rehabilitation & improvement)	
- Tarai	15
- Hills	7-12
	5
Schemes to be transferred to water users associations	
Schemes under joint management	
a) New construction:	
- Tarai: Watercourse up to 10 ha	100
Tertiary serving 10-30 ha	25
Sub-secondary canal serving 30-500 ha	0
Headworks and main and secondary canals	0
- Hills:	5
b) Strengthening	
- Tarai	12
- Hills	10

Source: First Amendment (1997) of the Irrigation Policy 1992, Annex 1, Table 1.

Irrigation service charges (ISCs) are covered in a separate Section 2.6, rather than Section 2.4: Resource Mobilisation. Table A2 shows the stipulated division of collected ISC revenues between water users associations and HMGN.

This apportionment of revenues give the farmers control of a large proportion of the funds, whereas the amount allocated to HMG is therefore much less than the actual requirements for maintenance of the main system. Transferring higher level parts of the system would thus give the farmers greater obligations but with less formal access to sufficient funds required to discharge these and thus little incentive to participate in main system management. The costs of maintenance vary according to the size of the system, but this is

not reflecting in the ISC regime. For example the main canal at Tilawe is comparable to a large branch canal at West Gandak.

Farmers often contribute unskilled labour as well as pay ISC, for clearance of canals at tertiary level. Although they retain 50% of the ISC for maintenance of tertiary canals, they also carry out the maintenance as part of their informal unskilled labour obligations: this labour contribution often has a greater value than the ISC. There is little need for cash for this level of maintenance, and thus the small amount that is collected is not spent, or is only used for administrative purposes. By contrast there is grossly inadequate money available for main system maintenance.

As the degree of water users association management and participation goes up, so does their share of ISC revenues. No mention is made of levels of ISC, but Clause 2.6.2 stipulates that charges should be on a per crop hectare basis. This has advantages in terms of practicability and acceptability. Nevertheless, for the reasons given in Section 2.B, a two tier tariff system, with a fixed charge per hectare of irrigable (scheme) land and a variable charge based on water use, could be the eventual aim. However, the charges would need to be increased to a figure more closely representing the true value of water before variable charging has any significant benefit. The practicality (and cost) of water metering means that this is unlikely to be achieved in the short term.

Table A2 Division of Irrigation Service Charge Revenues between HMGN and water users associations

Situation	Water Users Association share (%)	HMGN Share (%)
Water users association management of only tertiaries and below, HMGN management of the rest	25	75
Water users association management up to block level	50	50
Water users association management up to but excluding main canal level	75	25
Water users association management of the whole system, including main canal, except for headworks	90	10

Source: First Amendment (1997) of the Irrigation Policy 1992, Annex 3, Table 3.

Clause 2.6.4 contains incentives for effective ISC revenue collection by water users associations. If they collect less than 80% of the assessed amount they will receive only half the share stipulated in Table A 2. Department of Irrigation is charged with assisting water users associations with ISC operations. On jointly managed schemes Department of Irrigation and the water users association will fix the ISC rates jointly. For transferred schemes there does not appear to be a requirement for water users associations to prepare and obtain the irrigation agency's (Department of Irrigation's) approval for annual budgets and ISC tariffs, unlike the system for transferred schemes in Mexico and Turkey previously referred to.

Irrigation Regulation, 2055 (1998)

The draft Irrigation Regulation, 2055 (1998) was obtained from IWMI. Some changes were made in the final (2056) regulations, but these are not believed to change the general conclusions given below. Clause 12(1)(c) empowers water users associations to collect irrigation service fees ISFs (ISCs) and Clause 12(1)(d) requires them to maintain the necessary land records. Chapter 5: Provision for Irrigation Service Fee, Section 20 covers the establishment of an ISF Fixation Committee in each District and Section 21 then lists nine factors to be considered in setting the ISFs:

- the area to be irrigated, its topography, the method of irrigation and the quantity of water available.
- the crops to be grown
- anticipated maintenance costs (operation costs are not specifically mentioned)
- depreciation of scheme assets and structures

- scheme capital costs. ISFs in Nepal normally only cover operation and maintenance cost recovery, not capital cost. It is not clear why this item is included – perhaps to provide a basis for the depreciation cost?
- the change in the consumer price index
- other income to be generated by "the use of structures of the irrigation system"

Together, these factors provide a sound basis for setting realistic ISF rates. The recognition of the need to take account of inflation, which has often been given insufficient weight on transferred schemes in Mexico and Turkey is particularly welcome.

HMGN approval is required for ISF rates on jointly managed schemes, but approval for ISF rates on transferred schemes is not mentioned. Clause 21(3) states that different rates may be applied for different crops, in accordance with the Irrigation Policy First Amendment (1997).

In Section 22: Collection of ISF, Clause 22(2) says water users associations will collect the ISFs on jointly managed schemes as well as on transferred schemes (Clause 22(c), and shall be entitled to retain 25% of the revenue collected. This is presumably in addition to the water users association shares given in the First Amendment (1997) and repeated in Schedule-1 of the Irrigation Regulation. Section 23 states that no "royalty" need be paid to HMGN on transferred schemes and Sections 24 and 25 cover the timing of ISF payments and penalties for non-payment (up to 50% of the ISFs due).

With regard to maintenance costs to be covered by water users associations on transferred schemes, normal maintenance is the responsibility of the water users association (Clause 8(1)). HMGN will, however, carry out major repair and rehabilitation work resulting from natural disasters ("huge damages") where the water users association is not capable of carrying out such works (Clause 8(2)). This is a sensible and compassionate provision which recognises the particular conditions prevailing in Nepal.

Sections 13 and 14 require water users associations which operate irrigation systems to maintain proper financial accounts, to prepare annual income and expenditure accounts and balance sheets and to submit these to the relevant Department of Irrigation office and District Water Resources Committee within six months of the end of the financial year.

Under Sections 15 and 16, HMGN retains considerable powers over transferred schemes, in the same way as do the respective agencies in Turkey and Mexico. Clause 15(1) allows HMGN to issue and enforce directives in regard to the operation and management of transferred schemes and to dissolve water users associations or their Executive Committees, and Clause 26 covers the appointment of Irrigation Inspectors for the inspection of transferred schemes. As in other countries, water users associations are authorised to use and manage transferred irrigation systems (Section 4), but without ownership being transferred.

A4 Policy and Regulations, Gujarat State, India

Extending participatory irrigation management projects (September 1996)
The Government of Gujarat, Narmada and Water Resources Department plans to bring 50% of the Command area under participatory irrigation management by the year 2003. Principal guiding instructions are:

- An understanding of the social situation in the villages where the command area farmers live is advised for greater chances of participatory irrigation management success.

- According to the policy resolution, 51% of the farmers in a command area are required to be members. This set of guiding instructions, however, advises the promotion a co-operative only if most of the farmers, not less than 80% are willing to join the proposed society.

- There should be a joint survey of the project to be turned over so that farmers organisation have full involvement in any rehabilitation works.

- If the farmers' society fails to hold to the terms of the MOU after rehabilitation is complete then the water supply will be stopped.

Guidelines for rebate (February 1997)
These guidelines clarify the system of rebate for maintenance and water collection along with the penalty procedure if water charges are late.

- 20% of the gross sum collected is returned as a rebate towards water collection. 30% of the gross sum collected is returned as rebate towards system maintenance.

- If the water charges were received late then an extra 10% of the net remaining sum (after rebate) will be recovered as a penalty charge.

Rehabilitation agreement (May 1997)
A policy was passed to formalise the agreement between the farmers' organisations and the government. The terms and conditions under the agreement include:

- Work entrusted to the Society shall be treated equivalent to the work carried out departmentally as per the policy of the government. There shall be no income tax charges.

- The Society is responsible for implementation of the approved work. It is responsible for its own administrative cost but can add 2% of the estimated cost of work as contingency for this purpose. It can also include 2% of the estimated cost to cover labour welfare and 10% to cover the cost of any outside consultancy.

- The Society will have to contribute 10% towards the costs of rehabilitation of existing works and 5% of the cost of new works.

- A project level co-ordination committee shall be formed to meet monthly with the intention of planning the work entrusted to the Society, monitoring its progress and solving problems that may arise at a local level. The committee shall consist of the Executive Engineer, three representatives of the Society and one member of the voluntary organisation.

- The following committee shall be responsible for decisions concerning the work in progress:

    - Superintending Engineer
    - Executive Engineer
    - Representative from voluntary organisation, or a reputed person of the area acceptable to both parties if a voluntary organisation is not working in the area.
    - President of Irrigation Society

- The ownership of the new works shall remain with the government with operation and maintenance being the responsibility of the Society.

Volumetric rate calculation guidelines (September 1997)
The guidelines for working out the volumetric rates for irrigation water to be given to the Water Users' Association are:

- For medium and minor irrigation projects, volumetric rates can be uniform throughout the project provided the crop pattern is by and large uniform in the whole project. If the crop pattern, soil and crop

water requirements are not uniform in major irrigation projects, then different volumetric rates can be devised for different parts of the project.

- The volumetric rates should be devised separately for kharif, rabi and summer seasons based on the actual crop pattern and water consumption for that project or part of the project. The data should be averaged for each season over 4 years of performance and rounded off so that the government does not make a loss.

Monitoring participatory irrigation management (October 1997)
The formation of two co-ordination committees to introduce and implement the principle of participatory irrigation management is encouraged by government order. The committees are responsible for satisfactory planning, implementation and successful operation and monitoring of participatory irrigation management at two different levels.

- The Circle Co-ordination Committee should consist of:
    - Superintending Engineer
    - Executive Engineers
    - Representative from voluntary organisation
    - Representative from Irrigation Co-operative society
    -
- The committee shall be held every three months commencing at the beginning of the irrigation season. The committee is responsible for overseeing:
    - Planning
    - Formation of Farmers associations
    - Repair and Rehabilitation works
    - Water distribution and recovery of water charges
    - Observing the irrigation society's performance
    -
- The Project Co-ordination Committee should consist of:
    - Executive Engineer of concerned project
    - Deputy Executive Engineer
    - Sectional Officer
    - Representative from voluntary organisation
    - Representative from Irrigation Co-operative society
    -
- The committee shall be held every three months commencing at the beginning of the irrigation season. The committee is responsible for:
    - Reviewing the management of irrigation co-operative society
    - Guidance on repairs and maintenance of canals
    - Guidance on agricultural production

A5 Maintenance under Turnover- Worldwide Literature

A5.1 Introduction

Much of the literature on Irrigation Management Turnover acknowledges the importance of maintenance – however, few papers provide convincing arguments supported by qualitative or quantitative data. In the current literature review, of the 70 papers examined, only 10 could provide some detailed analysis of IMT.

Svendsen *et al*. (1997) highlight the fact that all irrigation systems require periodic rehabilitation. Without maintenance, however, systems can soon deteriorate and so require rehabilitation. Several authors raise concerns about transferred systems falling into this cycle of rehabilitation-decline-rehabilitation (Vermillion, 1991; Joshi, 1999; Molden and Prasad, no date).

Another concern is the lack of data on the performance of irrigation systems, both before and after transfer, and of means to collect data (de Fraiture and Adhikari, 1998; Joo, 1998; Sharma and Shrestha, 1998; Pant, 1999; Peter, 1998). There is also a recognised need for on-going monitoring and record keeping (Patil and Lele, 1995; ADB Nepal Resident Mission, 1998; Sharma and Shrestha, 1999; Government of Nepal, 2000; Vermillion, 2000; Molden and Prasad, no date). These issues make it increasingly difficult to establish the effect of transfer, in terms of comparison before and after IMT, "except in an *ad-hoc* manner" (Pant, 1999). As Poudel *et al*. (1997) comment, with reference to Nepal, "the fact that most FMISs (Farmer Managed Irrigation Systems) are well-managed institutionally and are working satisfactorily does not necessarily mean that their technical efficiency is high." Maintenance is one aspect of the complex process of IMT.

In this literature review, ten papers, which have direct reference to either qualitative and/or quantitative data on the impact of transfer on infrastructure, have been examined in detail. The examples are from Sri Lanka (Samad and Vermillion, 1999), India (Brewer and Sakthivadivel, 1999a, 1999b), Indonesia (Vermillion *et al*., 2000), Colombia (Vermillion and Garcés-Restrepo, 1996; Vermillion and Garcés-Restrepo, 1998)**,** Nepal (de Fraiture and Tuladhar, 1998; Fraiture and Prasad, 1999) and Mexico (Johnson, 1997; Kloezen *et al*., 1997). Each case-study is presented separately. It is worth commenting that Svendsen *et al*. (1997), in their paper examining IMT in five countries, show that in Mexico and the Philippines farmers can refuse transfer, however, in Turkey, Argentina and Colombia, transfer is compulsory.

The review begins with a summary of Vermillion (1997)'s literature review on irrigation management transfer.

A5.2 The impact of transfer on infrastructure (Vermillion, 1997)

Vermillion (1997) provides a comprehensive evaluation of current literature on irrigation management transfer, examining data from 29 studies. Ten case studies deal with the effects of transfer on maintenance. Of these ten, five studies report some deterioration in irrigation structures after transfer; four studies note an increase in maintenance investment and one states that levels of maintenance remain the same (Vermillion and Garcés-Restrepo, 1996).

Deterioration of the infrastructure is common in pump irrigation systems (e.g. in Indonesia and Senegal), due to a withdrawal of government subsidies. Maintenance tends to be sustained where the economic value of irrigated agriculture is relatively high. However, a case study from the Columbia Basin Project in the USA shows that although there has not been a breakdown in the system, the quality of maintenance has decreased over time. (Vermillion, 1997). This is supported the fact that over a period of 15 years there has been a drop in the conveyance efficiency (Svendsen and Vermillion, 1994).

According to many of the studies, transfer improves the quality of the operations and maintenance (O&M). However, there are limitations – many studies are based on qualitative data and/or cover relatively short time sequences after transfer. Farmers often detect change after turnover. Also, a temporary decrease in performance can occur immediately after transfer.

Transfer programs often involve rehabilitation of infrastructure, which can overestimate its impact. Vermillion (1997) states that studies should include comparisons with transferred but not rehabilitated systems or rehabilitated but not transferred systems.

Vermillion (1997) concludes, "the literature is a disparate collection of definitions and methodologies from which it is difficult to deduce g*eneral conclusions or policy implications*".

A5.3 Rehabilitation vs. no rehabilitation in two transferred systems, Sri Lanka (Samad & Vermillion, 1999)

Samad and Vermillion assess the impact of participatory management on maintenance at two transferred irrigation systems in Sri Lanka - Nachchaduwa and Hakwatuna Oya. Nachchaduwa, rehabilitated between

1984 and 1991, represents the rehabilitated system. (Management transfer and rehabilitation were unrelated). Hakwatuna Oya represents the non-rehabilitated system, although physical improvements were made in the early 1980s. An analysis of the infrastructure before and after transfer was not feasible. The Irrigation Agency controls the headworks and main canal system.

In Nachchaduwa, nearly 60% of farmers interviewed felt that the functional condition of the canal system had deteriorated after transfer. (Rehabilitation was carried out without participation of farmers) In Hakwatuna Oya, there was a more even balance between those who considered conditions had improved and those who considered conditions had worsened.2.2.3 Infrastructure – field inspections
The average percentage of main canal length that was defective was approximately 15% in both schemes, a relatively high figure (Table A3). In Nachchaduwa only 3.2% of distributary canals were defective, compared to 15% in Hakwatuna. In the distributary canals, a higher percentage of defective canals are located near the head of the canal in both systems. There is no pattern to the location of defective lengths in the main canal (Table A3).

Table A3 Functional condition of canal (channel) lengths inspected at the Nachchaduwa and Hakwatuna irrigation systems (Samad and Vermillion, 1999)

Canal (channel) type	Quartile reaches	Nachchaduwa		Hakwatuna Oya	
		Length (m)	% defective	Length (m)	% defective
Main canals	Q1	10,007	20.5	4,686	5.4
	Q2	10,007	13.5	4,686	14.9
	Q3	10,007	5.7	4,686	39.1
	Q4	10,007	23.7	4,686	2.1
	Total	40,027	15.9	18,745	15.4
Distributary canals	Q1	2,453	11.4	8,164	23.7
	Q2	2,453	0	8,164	19.5
	Q3	2,453	1.4	8,164	9.6
	Q4	2,453	0.2	8,164	6.6
	Total	9,812	3.2	32,657	14.9

*Listed from head (Q1) to tail-end (Q4) of canals.

Although there appear to be anomalies in the results, both systems had a low percentage of dysfunctional structures (Table A4).

Table A4 Functional condition of structures inspected at the Nachchaduwa and Hakwatuna irrigation systems (Samad and Vermillion, 1999)

Type of structure	Total structures	Number of dysfunctional inspected	Percentage dysfunctional
Nachchaduwa			
Water control	191	44	18.7
Water conveyance	67	1	1.5
Water measurement	0	0	0
Ancillary	267	1	0.4
Total	525	25	5
Hakwatuna Oya			
Water control	164	4	2.4
Water conveyance	180	18	9.1
Water measurement	3	0	0
Ancillary	177	3	1.7
Total	524	25	5

At main system level, the percentage by which routine expenditure would have to increase in order to take care of all routine, essential and preventive maintenance requirements within three years is comparable for both systems. For Nachchaduwa the figure is 211% and Hakwatuna Oya, 221% (Table A5). At the distributary canal level, Nachchaduwa and Hakwatuna Oya would require a 30% and 275% increase in budget, respectively. The percentage increase required for the whole system is therefore substantially less for the Nachchaduwa than for Hakwatuna Oya (119%, compared with 249%).

Table A5 Percentage by which routine expenditure would have to increase in order to take care of all routine, essential, and preventive maintenance requirements within three years at the Nachchaduwa and Hakwatuna Oya irrigation systems (adapted from Samad and Vermillion (1999))

	Main system level	Distributary canal level	Entire scheme
Required budget increase (%): Nachchaduwa	211	30	119
Required budget increase(%): Hakwatuna Oya	221	275	249

Conclusions

In both systems there has been a substantial amount of deferred maintenance, which would require increased investment by both farmers and government, raising questions about the sustainability of systems under participatory management.

A more extensive study by the authors of 50 systems, showed that only in schemes where both management transfer and rehabilitation have occurred, have there been any significant effects on agricultural productivity levels and economic returns.

A5.4 Comparative study between a transferred and non-transferred canal, India (Brewer & Saktivadivel, 199a, 1999b)

Brewer and Sakthivadivel's case study in Maharashtra, India, examines transferred minor canals (Mula Right Bank Minor 7, transferred in 1989 and Bhima Left Bank Minor 10, transferred in 1992) and non-transferred canals (Mula Right Bank Minor 6 and Bhima Left Bank Minor 16).

In the surveys, 100 farmers were interviewed from Mula Minor 7 and 50 from Bhima Minor 10; 100 were interviewed from Mula Minor 6 and 50 from Bhima Minor 16.
The Irrigation Department carries out maintenance above the outlet and in non-transferred canals.

The transferred canals have been rehabilitated since transfer (1992-1995). Some maintenance was carried out in non-transferred Bhima Minor 16 between 1995 and 1996 and it was rehabilitated in 1985-86. Both maintenance and rehabilitation has been carried out in non-transferred Mula Minor 6 (no date given).

Table A6 shows that there is a greater percentage of defective length of canal in non-transferred canals than in transferred canals – 27% in Mula Minor 6 and 35% in Bhima Minor 16, as compared with 0% in both Mula Minor 7 and Bhima Minor 10.

Table A6 Conditions of minor canals and structures (Brewer and Sakthivadivel, 1999a, 1999b)

Minor canal	Transferred	Canal length (m)	% of length defective	Number of structures	% Defective
Mula Minor 7	Yes	2175	0	35	6
Mula Minor 6	No	3750	27	43	49
Bhima Minor 10	Yes	400	0	20	5
Bhima Minor 16	No	1060	35	11	9

66% of farmers interviewed in Mula Minor 7 and 54% in Bhima Minor 10 said that their system is in excellent condition. In non-transferred canals, 2% of farmers in Mula Minor 6 and 6% in Bhima Minor 16 stated that their canals were in excellent condition.

The farmers were asked to compare the present condition of the canal compared to its past condition - before transfer in the transferred canals and 10 years ago in the non-transferred canals. In the transferred canals, 68% of farmers in Bhima Minor 10 and 90% in Mula Minor 7 said that canal conditions are better now. This compares with 4% of farmers in Bhima Minor 16 and 18% in Mula Minor 6. In non-transferred canals, 44% in Mula Minor 6 and 22% in Bhima Minor 16 felt that canal conditions had worsened.

In the transferred canals, 67% and 71% (Bhima Minor 10 and Mula Minor 7, respectively) stated that there were no maintenance problems. In non-transferred canals, 12% and 23% (Mula Minor 6 and Bhima Minor 16, respectively) said there were no maintenance problems. The most importance maintenance problem in all canals related to the field channels. However, this is a greater problem in non-transferred canals than transferred canals.

The evaluation of system condition was made relatively close to system rehabilitation. Any statements about system condition must therefore be qualified. The present condition of the system at Khageri (Nepal) also appears good; however, rehabilitation has also recently been carried out. At Khageri, the farmers seem to be active and engaged in maintenance. Time will tell how they respond once the first genuine enthusiasm for turnover begins to be dissipated (Personal communication, J. Skutsch, 2001).

Expenditures are similar in transferred and non-transferred canals. However, farmers in the transferred canals are more satisfied with maintenance performance than those in the non-transferred canals.

Conclusions

The authors conclude that the management process has the greatest impact – with the WUAs providing a more flexible and more effective service. However, they acknowledge that four minor canals are not a representative sample (Brewer and Sakthivadivel, 1999a).

A5.5 Sustainability of four rehabiliated and transferred systems, Indonesia (Vermillion et al, 2000)

Vermillion *et al*.assess the Irrigation Management Transfer program in Indonesia. Four systems are examined in detail – Planditan and Kaliduren in Central Java, Cipanumbangan, and Cinangka II Systems in West Java. The systems in West Java were transferred in 1990; those in Central Java were transferred in 1990. During and after turnover, some improvements were made to the intake and/or main canal in all four systems, but no work was carried out on the subsidiary network.

The Irrigation Agency still controls the intakes in Cipanumbangan, and Cinangka II, and has some control over the main canal systems in Planditan, Kaliduren and Cinangka II.

No field data are available from the period before turnover.

Comparing the periods before and after transfer, in Central Java and Cinangka II, West Java, most farmers interviewed reported no variation in the level of labour for canal maintenance. In the Cipanumbangan system, of the 89% of farmers sampled who pay fees in kind, 59% said their fee payments had increased after turnover and 39% said they had remained the same. In Centra Java, the majority of farmers interviewed stated that the condition of the canal network and structures improved after turnover. Most farmers in the two systems in West Java said that maintenance had either improved or was good both before and after turnover. In Planditan and Cipanumbangan, between 15% and 20% of farmers interviewed said that the infrastructure was worse afterwards. Most farmers felt that the most important maintenance problems related to the main or distributary canals.

In Planditan, Kaliduren and Cinangka II, between 93% and 96% of the canal lengths inspected were fully functional (Table A7. In Cipanumbangan, 33% of the canal lengths were nearly dysfunctional.

Table A7 Functional condition of canal lengths inspected in the four systems (Vermillion *et al*., 2000)

District	Total length of canal network (km)	Dysfunctional length (%)	Nearly dysfunctional (%)	Functional length (%)
Planditan	4.0	0	6	94
Kaliduren	6.5	1	3	96
Cipanumbangan	6.5	0	33	67
Cinangka II	7.8	0	7	93

In both Planditan and Kalidure, 76% of the structures were fully functional, and between 17% and 18% were nearly dysfunctional (Table A.8). In Cipanumban, only 55% of structures were fully functional, 41% nearly dysfunctional, and 4% dysfunctional In Cinangka II 68% of structures were functional, 16% were nearly dysfunctional and 16% dysfunctional.

Table A8 Functional condition of structures inspected (Vermillion *et al*. 2000).

District	Total structures in system	Dysfunctional structures (%)	Nearly dysfunctional structures (%)	Functional structures (%)
Planditan	42	7	17	76
Kaliduren	51	6	18	76
Cipanumbanan	22	4	41	55
Cinangka II	49	16	16	68

For each system, the authors calculated the percentage increase in maintenance investment which would be required to handle current routine maintenance requirements and all essential maintenance requirements within one year as well as all preventive maintenance requirements within three years. Investment would need to increase by 719% at Planditan, 36% at Kaliduen and 140% at Cinangka II. (No data were available for Cipanumbangan, due to lack of records.) There is thus major under-investment in all systems.

Conclusions

The extent to which farmers have deferred maintenance spending threatens the sustainability of the systems. WUA leaders expected the government to re-intervene within five years' time to rehabilitate their systems. No significant changes were observed in agricultural performance.

The lack of impact of the program can be explained by the high levels of agricultural production already achieved and the partial nature of reforms in Java.

A5.6 Turnover in two rehabilitated systems, Colombia (Vermillion & Garces-Restrepo, 1996)

Vermillion and Garcés-Restrepo examined turnover in two irrigation districts in Colombia – Coello and Saldaña. In 1976, the farmers were granted the right to take over management of the districts. The report examines the impact of turnover on the physical infrastructure 19 years after turnover. Rehabilitation of irrigation canals and natural drains was carried out before turnover (in Coello, between 1968-73, and in Saldaña between 1969-72), but was not related to turnover. In 1976 the infrastructure was in good condition. Users felt that the government had responsibility to maintain the infrastructure, because they still owned it. Following feasibility studies in 1984 by a government agency, rehabilitation and system expansion has begun in Coello, where farmers agreed to pay some of the costs, but not in Saldaña.

In both districts, the percentage of total district income going towards maintenance (55-60%) did not change significantly after turnover. In Coello, water is relatively more scarce than in Saldaña.

In Coello, 68% of the total canal length was fully functional (Table A.9). Partially functional canal sections were distributed relatively evenly between main, secondary and tertiary canals. 4% of the sample lengths were found to be dysfunctional, and these were only at the tertiary level. In Coello, 71% of the 1,666 structures were fully functional and 15% were dysfunctional. Two-thirds of the dysfunctional structures were small flumes used for measuring water at field turnouts. These were installed in the rehabilitation period during the late 1970s and early 1980s. They had not been requested by the farmers.

In Saldaña, 48% of the total network was fully functional. 79% of the main canal was fully functional, whereas only 33% of secondaries and 28% of tertiaries were fully functional. 44% of the total canal length was partially functional, mainly in secondaries and tertiaries. Dysfunctional sections were located only in tertiary and secondary canals with 19% of observed tertiary lengths and 5% of secondary lengths being found dysfunctional. 19% of the total tertiary length was judged dysfunctional. In Saldaña, 69% of the 756 structures observed were fully functional; 12% were dysfunctional. Of the dysfunctional structures, 64% were small measurement flumes at turnouts.

Table A9 Results of canal maintenance survey, Coello and Saldaña districts, 1994 (Vermillion and Garcés-Restrepo, 1996)

	Main canal		Secondaries		Tertiaries		Total network	
Condition	km	%	km	%	Km	%	km	%
Coello								
Functional	46.8	68	54.6	76	68.5	63	169.9	68
Partially functional	22.3	32	17.3	24	35.7	33	75.3	30
Dysfunctional	0	0	0	0	5.0	4	5.0	2
Total	69.1	100	71.9	100	109.2	100	250.2	100
Saldaña								
Functional	47.8	79	14.6	33	15.2	28	77.6	48
Partially functional	13.0	21	27.6	62	30.8	53	71.4	44
Dysfunctional	0	0	2.4	5	10.6	19	13.0	8
Total	60.8	100	44.6	100	56.6	100	162.0	100

Farmers were asked to comment on the functional condition of the secondary canal that delivers water to their field over the past 10 years. In both Coello and Saldaña the majority of farmers (81% and 73%, respectively) said it had stayed the same (n = 44 in Coello and n = 49 in Saldaña).

District staff are concerned that farmers' emphasis on cutting costs will eventually lead to the deterioration of the system

Increases in gross value of output per hectare and per unit of water increased dramatically, while the cost of irrigation to farmers remained roughly the same after turnover. Improvements in economic performance after turnover can be attributed to factors such as new district policies, cultivation improvements and crop prices. Concerns have been raised about the long-term sustainability of the systems, as farmers have not raised a capital replacement fund. Farmers insist that the government should finance future rehabilitation and modernisation.

There is a problem of inequitable water distribution to tail-enders, due partly to siltation.

A5.7 Transferred systems, Colombia (Vermillion & Garces-Restrepo, 1998)

Vermillion and Garcés-Restrepo conducted a study in five irrigation districts in Colombia - RUT (Roldanillo-La Unión-Toro), Río Recio, Samacá, San Rafael and María La Baja. RUT and Río Recio were transferred in 1990, Samacá in 1992. Some rehabilitation occurred in all three systems. In RUT, Río Recio, and Samacá comparisons of performance can be made for 4-5 years before and after transfer. San Rafael and María La Baja were transferred at a later stage – in 1995 and 1996, respectively. This enables comparison between transferred and non-transferred systems between 1986 and 1995. María La Baja was undergoing rehabilitation at the time of the study; in San Rafael repairs had been made to the pump station.

The government owns the infrastructure and is also responsible for financing future rehabilitation and modernisation of the systems.

As no field inspections were carried out before transfer, no direct comparison can be made of the infrastructure before and after transfer. Sample sizes of farmers interviewed were greater than 5%. This constituted 91 farmers in RUT, 59 in Río Recío, 88 in Samacá, 56 in San Rafael and 90 in María La Baja.

Only 62% of the total canal length inspected in María La Baja was functional (Table A.10). In the other four systems between 75% and 90% of the observed canal length was functional. María La Baja had the

highest percentage of dysfunctional canal lengths, at 19%. The percentage of nearly dysfunctional canal lengths varied between 10% and 19% of those observed.

Table A10 Functional condition of canal lengths inspected (Vermillion and Garcés-Restrepo, 1998).

District	Total canal network length	Length inspected (%)	Length dysfunctional (%)	Length nearly dysfunctional (%)	Length functional (%)
RUT	170.7	10	0	17	83
Río Recio	135.8	12	0	10	90
Samacá	58.0	28	6	19	75
San Rafael*	30.0	15	3	12	85
María La Baja**	284.7	13	19	19	62

*Network inspected was drainage network. San Rafael has no surface irrigation canals.
** Some canals inspected are already under rehabilitation, as part of the IMT process.

Regarding structures, 82% of observed structures in Maria La Baja were either dysfunctional or nearly dysfunctional (Table A.11). In Samacá, only 62% of observed structures were fully functional.

Table A11 Functional condition of structures inspected (Vermillion and Garcés-Restrepo, 1998).

District	Total structures in scheme	Structures inspected (%)	Dysfunctional (%)	Nearly dysfunctional (%)	Functional (%)
RUT	80	50	4	14	82
Río Recio	234	17	0	3	97
Samacá	525	60	11	28	62
San Rafael*	40	25	0	12	88
María La Baja**	250	22	52	30	18

*Network inspected was drainage network. San Rafael has no surface irrigation canals.
** Some canals inspected are already under rehabilitation, as part of the IMT process.

The increase in maintenance investment required to deal with current routine maintenance requirements within one year as well as all preventive maintenance requirements within three years, can be seen in Table A.11. RUT would have to raise the average maintenance budget by 2% and Río Recio by 1.3%. In Samacá, the figure is relatively higher, at 21.7%.

Table A11 Percentage by which routine expenditure would have to increase in order to take care of all routine, essential, and preventive maintenance requirements within three years – at RUT, Rio Recio and Samacá (Vermillion and Garcés-Restrepo, 1998).

	RUT	Río Recio	Samacá
Required budget increase (%):	2.0	1.3	21.7

Most farmers in RUT and Río Recio perceived maintenance to be adequate before and after transfer. Positive farmer perceptions in RUT and Rio Recio and more divided perceptions in Samaca, correspond generally with the results of the system inspections. Farmers in Maria La Baja are very dissatisfied with canal maintenance.

Conclusions

Most of the transferred systems appear to be physically sustainable, assuming increases in investment can be made. However, there are a number of other factors which could affect their sustainability:

- in RUT, the condition of pump stations was not examined
- no district has set up a capital-replacement fund for basic infrastructure
- systems transferred more recently tend to have high maintenance costs (San Rafael) or poor infrastructure with high costs for repair (María La Baja).

Transfer has not had substantial impacts on the performance of operations and maintenance, or on the agricultural and economic productivity of irrigated land or water.

Irrigation Management Transfer in Colombia is not complete. More research is needed to establish whether a more integrated and comprehensive policy of transfer would have a more significant impact.

A5.8 Farmers' perceptions of transferred and non-transferred systems, Nepal (De Fraiture & Tuladhar, 1998)

De Fraiture and Tuladhar examined farmers' perceptions of transfer in selected irrigation systems in Nepal; Fraiture and Prasad (1999) continue this study. Three minor canals in the West Gandak scheme are examined. The Palhi minor, transferred in May 1993, represents the "with IMT" situation; the Manjhariya minor, transferred in October 1996, represents the "without IMT" situation and the Parsuani minor, transferred in September 1994, is also selected for study. In Bhairahwa-Lumbini Ground Water Project (BLGWP), two non-transferred schemes (tube wells nos. 5 and 58) and two transferred schemes (tube wells nos. 13 and 48), both transferred in July 1995, are chosen. Samples of 96, 76 and 80 farmers were selected from the Manjhariya, Palhi and Parsuani minors, respectively. 50 farmers from the four BLGWP systems were also selected.

Farmers were asked to compare the past (1993) and present (1998) condition of the infrastructure. Regarding the non-transferred tube wells, in TW 58, 92% of farmers state that the pump and canals have deteriorated. In TW 5, 60% of farmers think the pump condition has remained about the same, and 25% think it was better before. With reference to the canal, in TW 5, 42% state that it was better before and 43% about the same.

In the transferred systems in BLGWP, most farmers said that the pump and canals have either remained the same or have improved. In West Gandak, in both transferred and non-transferred systems, most farmers stated that the canals and structures have either remained the same or were better before.

The above conclusion for West Gandak was perhaps premature. Detailed analysis of infrastructure condition and interviews with farmers at West Gandak under the present project have shown that there are major problems with the condition of the system, and that maintenance is not being carried out by farmers. This is despite the fact that the entire system, including the main canal, has been transferred to their responsibility. Farmers clearly recognise that the system below the main canal is theirs to maintain, though there is general confusion about responsibility for the main canal (Personal communication, J. Skutsch, 2001).

The farmers have mixed perceptions about the present condition of infrastructure in transferred and non-transferred study units. In West Gandak, more canals and structures with IMT are said to be in excellent condition, than those without.

With reference to the present condition of structures and pumps in BLGWP, the authors state that the condition of canals and pumps is better in transferred tube wells. However, the results suggest that the canals and pumps without IMT are in slightly better condition than those with IMT.

A5.9 Irrigation management transfer in Mexico (Johnson, 1997)

Johnson provides an overview of Irrigation Management Transfer in Mexico. Transfer has not resulted in an increase in crop production, which could be due to drought, the financial crisis of 1995-96 and/or the fact that the systems to be transferred first already had high levels of agricultural production.

Fees collected by the WUAs cover routine and some deferred maintenance and the infrastructure is no longer deteriorating. However, there are some limitations:

- in order to carry out all rehabilitation and deferred maintenance, a substantial increase in investment would be required, which might be unfeasible for many users
- districts charge water on a volumetric basis – they have no income when there is no water
- there is no reserve fund for emergency situations

Although the area under irrigation was reported to have increased, in practice it is likely that there have been no changes in irrigated area, and the discrepancy is due to underreporting by staff when under the control of the Irrigation Agency. Under these circumstances, the question remains why farmers were keen to accept greater cost and responsibility? The answer appears to be that they wanted greater control over water, a primary input into the agricultural enterprise (Personal communication, S. Johnson, 2000).

In the early stages, the expenditure on maintenance certainly increased beyond that allotted by the Irrigation Agency. However, recently, world crop prices have been so low that perhaps 50% of WUAs are increasingly unable to cover O&M costs. An attempt by the Mexican government to reduce subsidies met with wholesale resistance from farmers and had to be abandoned (Personal communication, J.Trava, 2001).

A5.10 Transferred irrigation district without rehabilitation, Mexico (Kloezen et al, 1997)

Kloezen *et al*. examined the effects of transfer on the Alto Río Lerma Irrigation District (ARLID) from October 1982 to October 1996. Transfer took place in 1992.

In Mexico, IMT is a rapid top-down process that "has met with relatively little resistance from farmers". It has been instigated by international banks and implemented by the government. The Mexican IMT program aims to involve farmers in representative governance, not maximize direct user participation in O&M.

The 11 modules comprising ARLID are responsible for maintaining secondary canals, irrigation canals and drains. CNA (the National Water Commission) maintains dams, main diversion structures, main canals and drains. Farmers felt that rehabilitation should have accompanied transfer. However, CNA did lend the WUAs some of its heavy machinery so some work could be carried out.

The effects of maintenance on the operational performance were not examined. Direct comparison of the infrastructure before and after transfer was not possible, due to a lack of quantitative data.

The level of investment appears to have remained the same (comparing three years before and after transfer), which could indicate that no real improvements have taken place. However, this does not take into consideration the economic crisis of 1994 or the fact that, as the results suggest, the same level of maintenance has been achieved with fewer staff.

There has been an increase in total volume of desiltation carried out in primary and secondary canals after transfer: 438,581 m^3/year (average of 1982-1992) compared to 1,257,421 m^3/year (average of 1993-1996). There is now greater emphasis on the lower system levels – the secondary canals and drains – rather than the main canals.

Module field staff and managers explained that because farmers were dissatisfied with the maintenance carried out by CNA before transfer, especially the drains, they made these their priority to clean soon after

transfer. Even though some CNA staff and module managers felt that the expensive process of desiltation has had no impact on hydraulic performance, managers see it as a way of gaining credibility among users.

Of those farmers interviewed, few stated that the irrigation and drainage network had deteriorated as a result of IMT or that conditions had been poor both before and after IMT (table 1.12). 64% of the ejidatorios (members of the land reform communities) and 47% of the private growers stated that the condition of the irrigation network had improved since transfer. 11% of ejidatarios and 24% of private growers stated that the irrigation network was in a good condition both before and after IMT. 54% of ejidatarios and 38% of private growers said that the condition of the drainage network had improved. 33% of ejidatarios and 41% of private growers state that the drainage network has remained in a good condition.

Table A12 Farmers' perceptions of the change in maintenance service as a result of IMT (Kloezen *et al*., 1997)

	Ejidatarios (n=90)		Private growers (n=35)	
	Condition of the irrigation network (%)	Condition of the drainage network (%)	Condition of the irrigation network (%)	Condition of the drainage network (%)
Poor before and after IMT	7	3	6	0
Poor before, good after IMT	64	54	47	38
Good before and after IMT	11	33	24	41
Good before, poor after IMT	9	1	6	9
Other*	9	9	17	12
Total	100	100	100	100

*"Other" includes 'don't know,' 'no response,' and 'not applicable because respondent only uses a private well'.

On average, modules desilt their canals approximately once every 3 years. However, some have cleaned only 60% or less of their network during the four years after transfer.

Conclusions

At ARLID, both land and water have relatively high productivity values. However, any changes in agricultural and economic productivity are related to the agricultural and economic reforms that started in the 1980s, rather than transfer. There is strong evidence that transfer resulted in improvements in system maintenance and cost recovery. However, there were concerns that some of the maintenance was carried out because of farmer pressure, not because of its impact on hydraulic performance.

Kloezen *et al*. (1997) acknowledge that a post-transfer period of 4 years is quite limiting for assessing the sustainability of the system. Other important aspects affecting sustainability include:

- none of the modules have funds for emergencies or basic repairs
- none of the WUAs have the means to cope with high annual inflation rates

In broader terms, the authors are concerned that international organisations have promoted the Mexican IMT programme, without acknowledging the different ways in which it has been adopted. It may not, therefore, be applicable in countries with different agrarian structures.

A5.11 Summary of Conclusions

The diverse nature of the systems described makes direct comparison difficult. However, the following conclusions can be drawn:

- The long-term sustainability of infrastructure in transferred systems (whether rehabilitated or not) is a continuing problem, with a backlog of deferred maintenance
- Deferred maintenance requires an increase in investment, which may be unfeasible for users – some WUAs have no emergency funds
- It is often unclear who has responsibility for the infrastructure
- In one case, transfer resulted in improvements in system maintenance and cost recovery, though some maintenance was carried out because of farmer pressure, not because of its impact on hydraulic performance
- Where agricultural production has increased, it is because of changes in policy or the combined effect of rehabilitation and turnover
- In some cases, transfer has not resulted in significant improvements in either operation and maintenance or agricultural activity – this may be due to the partial nature of transfer.

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Appendix B

Details of studies in Nepal and Gujarat, India

Appendix B Details of studies in Nepal and Gujarat, India

B.1 Summary of studies in Nepal

The detailed assessments of asset condition on the four schemes investigated in Nepal are included in a separate volume. Table numbers in the text refer to this supplementary volume, OD/ITM 62, unless otherwise noted. Two summary tables below give the principal characteristics of the systems (Table B.1) and farmers' perceptions of water supply and system operations (Table B.2). Further summary tables are included in the main text at Section 4.3.6. This Appendix contains a narrative description of the conditions on the four schemes. Appendix D contains example blank forms of the type used in the field survey.

Table B1 Summary of structures and canals investigated

Scheme/system level	Canal length (km)	Command area (ha)	No. structures (per km)	No. structures (per 100 ha)
Kankai	17.7	7,000	5.5	1.4
Main	12.6	1,380	11.4	11.1
Branches [1]				
Khageri	22.7	3,900	4.9	2.8
Main	9.7	620	15.7	24.4
Branches				
Tilawe	12.0	5,600	7.4	3.2
Main	10.0	1,300	16.1	11.3
Branches				
West Gandak	32.8	8,700	5.7	2.1
Main	15.1	1,335	10.8	25.2
Branches				

Note: [1] "Branches" refers to branch canals included in study

Table B2 Farmers' perceptions of water supply and system operation

		Kankai	Khageri	Tilawe	West Gandak
Supply adequate [1]	Monsoon	94%	48%	64%	55%
	Winter	35%	8%	49%	30%
	Spring	17%	15%	3%	0%
Main constraint	Monsoon	Operation	Water resource	Operation	Operation
	Winter	Operation	Water resource	Operation	Operation
	Spring	Water resource	Water resource	Operation	Operation
Distribution fair [1]	Between branches	61%	83%	46%	21%
	Along branches	34%	10%	50%	74%
Supply improved over 5 years [2]		7%	10%	10%	5%
Effectiveness of main system operation [2]		45%	68%	20%	21%
Operation better over 5 years [2]		44%	15%	69%	74%

Notes: [1] % of farmers agreeing

B1.1 Kankai irrigation scheme

B1.1.1 Background

Location and climate

Kankai irrigation scheme is located in Jhapa District in the Eastern Development Region of Nepal. The main command area is located to the south of the East-West highway approximately 5 km from the village of Dudhe. The nearest city, Biratnagar, is 75 km to the west. Kankai sits in the sub-tropical climate belt. Mean annual rainfall is 2858 mm with approximately 80% of this falling during the monsoon (June to September). Rainfall in July averages 835mm. Average monthly temperatures vary from 14^{O}C in January to 30^{O}C in July.

Cropping pattern

During the monsoon season there is a mono-crop of paddy. This is followed by irrigated wheat during the winter season and then paddy and maize during spring, see Table B3. Farmers' interest in growing vegetables is increasing due to demand from India but still represents a small proportion of the total cropped area.

Table B3 Cropping pattern, area and average yields at Kankai

Season	Crop	J	F	M	A	M	J	J	A	S	O	N	D	Area (ha)	Ave yield (t/ha)
Monsoon	Late paddy						■	■	■	■	■			7,000	3.2
Winter	Wheat	■	■	■								■	■	4,000	1.5
Spring	Early paddy			■	■	■	■							2,500	4.5
Spring	Maize			■	■	■	■							1,500	1.6

Only 4,000 ha is cultivated in winter and spring, the remainder of the command area is left fallow, and is mainly due to insufficient water to irrigate the whole area and also because there is considerable low land on which it is difficult to cultivate non-paddy crops. An annual rotation system is in place to ration water for early paddy.

Operation and maintenance

The Department of Irrigation is responsible for operation and maintenance of the headworks, main canal and secondary canals (except those handed over to the water users association). There is a total of about 44 project staff comprising one senior divisional engineer, one irrigation engineer, two overseers and about twenty *dhalpas*.

The headworks are operated year-round. Annual maintenance is carried out during the winter season when water demand is less. The main canal is closed each Friday evening and reopened on Sunday morning so that desilting and flushing through the escape channel can be carried out.

During the monsoon the secondary canals are operated continuously with farmers controlling their turnouts as arranged by the water users association or as necessary. During occasional low flow periods, farmers manage water in the lower section on an ad hoc basis whilst in the upper section, *dhalpas* manage water distribution according to their judgement.

Supply exceeds demand in the winter season and the scheme is operated on demand. During the spring season the scheme is divided into two blocks, each block receiving water in alternate years. Block 1 comprises secondaries S0 to S2, S13 to S20 (extension area) and Block 2 secondary canals S3 to S12. Within blocks, canals operate continuously.

Maintenance of the headworks, main canal and secondary canals (except those handed over) is the responsibility of Department of Irrigation. However, in practice the Department of Irrigation maintains the main system while the farmers maintain the secondary canals with financial assistance from Department of Irrigation. Lower order canals are maintained wholly by the farmers using their own resources.

Annual operation and maintenance spending during the period 1989/1990 to 1999/2000 has averaged NRs 4.2 million. This equates to approximately NRs 600 per ha although this does include a component of construction cost in the extension area.

The budget for 1999/2000 was NRs 3.1 million and was divided between the system components as:

- Main system NRs 862,000
- Distributaries NRs 200,000
- Lower order canals NRs 640,000
- Drainage system NRs 80,000
- Roads NRs 150,000
- Emergency repairs NRs 1,000,000
- Others NRs 150,000

B1.1.2 Headworks and Main Canal

The overall condition of the infrastructure at Kankai is good. The scheme was designed and built only twenty or so years ago to a high standard. A large part of the main canal is lined and remains in good condition.

Headworks

The headworks are generally in good condition. However, there are a number of problems:

- Two metres depth of mass concrete located downstream of the scouring blocks in the main weir has been badly scoured. The reported magnitude of the scour is about 1.0 m.
- Continuous flow of water over a long period of time has eroded the slopping profile of the main weir. As a result, it is no longer uniform. At the central portion of the weir, its sloping profile is tending to vertical due to wear and tear.
- The end sill of the downstream cut-off wall of the main weir has been badly damaged.
- Piping has started through the main weir. Interviews with the concerned engineers suggest that during the period of low flow leakage can be clearly seen.
- A cavity has formed in the sloping profile of the under-sluice.

These conditions indicate that the diversion weir needs immediate protection, especially downstream. Deterioration has occurred as a result of a steady degradation process. According to the Department of Irrigation engineers the cost of required maintenance is approximately NRs 25,000,000. This work is certainly beyond the technical and financial capacity of the farmers.

Intake canal

The main problems in the intake canal are on the canal culverts crossing small drainage channels. Since the construction of the weir across the Kankai River, certain stretches of the river down stream of the weir have eroded about 1.5 to 2.0 m in depth, which in turn caused its tributaries (local drains) steeper and deeper. As a result of this, almost all the canal culverts, which were originally embedded below the drain, are now exposed with significant erosion in the local drains downstream of the culverts. For the last few years, although some minor maintenance is being done, a suitable bioengineering approach is needed to stabilize the local drains from further scouring. It is estimated that such bioengineering works require about NRs 2,500,000. They are beyond the technical capacity of farmers.

Main canal

The upper portion of the main canal is lined with concrete in a trapezoidal section. In stretches where the canal is in deep cut, the canal is lined with concrete blocks. The rest of the upper main canal is lined with concrete slabs. As the canal has relatively steep gradient, about 1 in 1000, there is no problem of siltation. In general, this portion of the canal is in good condition and it is operating satisfactorily. However, in some places, a few physical works are damaged requiring immediate maintenance.

Of the several damaged physical works, damage to canal lining is the most serious one. At several places, the concrete linings have been either lifted up or settled from their original locations causing cracks in them. This may have happened due to excess pore water pressure. It has been reported that most of the water pressure release valves in the concrete lining works are already choked. At some places, damage of canal lining works due to bank slippage and drainage overflow into the canal was also observed.

In some places, damaged canal lining works have been replaced by gabion mattress, while in other places they are not even protected to avoid further damage. This has happened mainly due to lack of an adequate maintenance budget leading to deferred maintenance works.

Further, replacement of concrete lining by gabion mattress has increased friction to flow, which in turn reduces the designed conveyance efficiency. Thus, the damage to canal lining works should be given due consideration in order to maintain the designed conveyance efficiency.

In this portion of main intake canal, the structures that have problems include canal culverts, regulator gates, drainage canal and causeway. Followings are some of the observed problems that require immediate attention.

- As in the case of head reach canal, local drains where canal culverts are constructed are eroded down stream of the structures. These drains also require bioengineering measures.
- Most of the regulator gates, especially head regulators of tertiary canals are not functioning.
- At a few places in the head reach of the canal, farmers have encroached upon the drainage canal causing localized flooding during periods of intensive rain. This has caused drainage overflow into the canal damaging canal banks and lining.
- One causeway collapsed a decade ago, and still needs re-construction. Although this has not hampered the flow in the canal, it has restricted movement of vehicles on the canal bank service road, which in turn hampered supervision of the system performance.

This lower section of the main canal is unlined. Parts of the canal, especially at the tail reach are in partial filling. In rest of the portions, canals are in cutting except at a few stretches upstream of the drop structures. In major stretches, the canal section has changed. Minor slippage of the bank, especially the left bank, is common. It seems that the canal is finding its own regime. In some stretches, canal section has been enlarged. This might have been caused primarily due to bank slippage.

At chainages between 16.2 km and 16.8 km, the canal left bank has breached at three locations. This may be either due to bank failure or due to unauthorized bank cut. At this chainage, for about 160 m, the canal has limited freeboard. This portion of the main canal does not have much of a siltation problem. Most of the structures are in good condition, except for some minor scour downstream. Most of the gates of tertiary off takes are not functioning.

To summarise: this portion of main intake canal is still operating reasonably. However, as the friction to flow has increased due to weed growth and bank slippage, its conveyance efficiency has decreased considerably.

Asset survey summary for headworks, intake canal and main canal

There are a total of 97 structures along the 17.66 km length of intake and main canal with a command area of 7,000 ha. This equates to a structure density of about 5.5 per km of canal or 1.4 per 100 ha. Of the 97 structures, 41% were found to have one or more defects, Table K 1.1. The most common defect was a defective gate or gate mechanism (18 structures) followed by scouring of the canal or banks downstream (13 structures). There appears to be very little effect on the flow – flow is restricted to 70% to 80% of design discharge at only one structure, Table K 1.6. Only one structure, a gated offtake, is regarded as redundant. It is estimated that the total cost to repair the defects is NRs 26,893,000, Table K 1.4 (although NRS 25,000,000 of this is allocated to the headworks structures).

Of the 17.66 km of intake and main canal it is estimated that there are 65 instances of defects to the banks and/or bed, Table K1.2. The total length of these defects is 6.65 km or 38% of the length, Table K1.3. The most common defect is slippage, scouring or other defect in the canal embankment. There were 28 such defects noted affecting 3.5 km of canal. There were also fifteen instances of significant enlargement of the canal affecting a total of 1.4 km. Only 609 m of canal lining was identified to be in need of repair. Two-thirds of the defects were expected to have no observable effect on flow. The other problems were judged to have a minimal affect on the capacity of the canal (between 90% and 100% of design flow), Table K1.7.

A total of NRs 1,767,000 is estimated to correct these problems, Table K1.5. Repair to canal lining is expected to cost NRs 380,000.

B1.1.3 Secondary canal S2

Secondary canal S2 is about 4.0 km long and irrigates about 226 ha of cultivated land. The canal is in good condition, well shaped, and it is functioning satisfactorily. This secondary canal has 13 tertiary off takes, one water measuring flume, five VRB and fifteen drops with stop log checks. A service road is aligned parallel to the canal through its right bank. As the service road is earthen, it is not serviceable during the monsoon season.

In the head reach, for about 400m, the canal is in deep cut and does not irrigate lands located in its banks. As a result, farmers obstruct the flow at a VRB located at chainage 386 m in order to raise the canal FSL by about 1.0 m with a view to irrigate high lands located in its banks. This action, however, has not affected the physical condition of the canal in its upstream.

The first 400 m of this secondary canal is lined with concrete in a trapezoidal section. However, about half of the lining works is already damaged due to bank slippage, and farmers removed the broken concrete slabs from the canal. Such portions are now functioning as an unlined canal.

The measuring flume installed immediately downstream of the secondary canal head regulator is not functioning as designed. This is because there is no water level measuring gauge in the structure, and the discharge is never measured. Thus, the structure is dysfunctional.

Most of the gates installed at tertiary head regulators do not function because they are already damaged. Whenever needed, farmers close/ regulate the flow in the tertiary canal by stones and mud.

The remainder of the structures are functioning as designed and they are in good condition, except for minor bank erosion downstream of a few structures. At several locations upstream of the drop structures, the canal seems to have reduced free board. As a result, at a few places, water from the nearby field is entering into the canal through bank overflow, while in some places, canal water is spilling out over the bank crest. There may be two reasons for this. Firstly, the canal may be discharging more than its designed capacity. Secondly, height of the canal embankment may be low, especially upstream of the drop structures, causing overflow of the canal water. This aspect, however, is not a serious problem.

The first tertiary located at the head of the secondary canal is heavily silted, while the last tertiary located at the tail end of the secondary canal is cleaned and well maintained. In both the above tertiary canals, several field channels offtake from them. The density of field channels (in terms of their length per unit irrigated area) is not known.

Asset survey-Secondary Canal S2

Of the 32 structures on S2, eleven had defects, Table K 1.1. Seven of these defects were missing or damaged gates on outlet offtake structures. The total cost to repair the structures is estimated at NRs 59,500, Table K 1.4.

Defects to the canal bed and banks were only noted in eleven locations, Table K 1.2, affecting just over 200 m, Table K 1.3. Only one defect was noted in lined sections. There was no observable effect on flow in all but one location, where the canal was significantly oversized. It was estimated that only NRs 2,000 is required to repair the canal, Table K 1.5.

B1.1.4 Secondary canal S5

Secondary canal S5 is one of the largest secondary canal systems in the Kankai Irrigation System. Its length, irrigated area, and the discharging capacity at its head reach are about 5.75 km, 800 ha and 0.91 m3/sec respectively. At about 1300 m from the intake (head regulator) of this secondary canal, one sub-secondary canal (S5A) takes off from the left bank and runs east. Till this point, 9 tertiary canals take off through both banks. The canal is thus a ridge canal. Just upstream of the offtake of sub-secondary canal S5A, the secondary canal is on filling where frequent breaching has become a routine. The rest of the canal section is in fairly goods condition except for minor bank erosion and slippage at a few places. As the canal is earthen, there is moderate weed growth throughout its length.

The secondary canal that continues after the take off point of the sub-secondary canal was also found to be stable, but most of its stretches are in fill. This portion of the canal is filled with weeds, which might have affected the flow considerably.

The sub-secondary canal continues till the Kankai River. The tail end area of this sub-secondary canal is being continuously eroded by the Kankai River. The canal section is stable, but there is a great deal of weed growth throughout its length. The canal is earthen and there are no major problems except some bank erosion and slippage.

Water is controlled in both the secondary and sub-secondary canals by cross regulators and stop log checks. Offtaking tertiary canals consist of overflow weirs controlled by manually adjustable steel gates. However, almost all the gates are defective, and they have not been functioning since many years. There is a need to re-think the types of water division structure while rehabilitating irrigation systems. Measuring structures located at the head end of the secondary canal are redundant, as there are no measuring gauges.

Asset Survey-Secondary canal S5

There are a total of 51 structures along S5 and S5A. Defects were noted at 21, Table K 1.1. Again, defective gates were the most common fault (ten structures) followed by defective civil works (seven structures). There was a minimal effect on the flow capacity at only two structures, Table K 1.6. NRs 227,900 is required for repairs, Table K 1.4.

Of the total canal length of 5.76 km, defects were noted along 3.2 km, Table K 1.3. The most common problem was of significant weed growth in the channel. It was thought that flow would be restricted to some degree at 26 locations, Table K 1.6. A total of NRs 65,000 would be required to fix the problems, Table K 1.5.

B1.1.5 Secondary canal S7

This secondary canal is 1.71 km long, and it irrigates about 230 ha of cultivated land. Farmers recently cleaned the canal using the resource allocated by Department of Irrigation. As a result, the canal is well shaped, clean and is functioning satisfactorily.

This secondary canal has six tertiary offtakes. Four are located on the right bank, one on the left bank, and one runs further downstream from its tail end. Although all he tertiary head regulators are gated, they do not function.

As in other secondary canals, the measuring device installed immediately down stream of the head regulator is not functioning. This is because there is no water level measuring gauge in the structure and the discharge is never measured.

RCC Hume pipe of one VRB located at chainage 233 m downstream of head regulator is broken. This VRB is dysfunctional. Instead of this, another VRB has been constructed at about 15m upstream of this dysfunctional VRB.

At chainage 620 m downstream from the head regulator, a temporary VRB has been constructed using local materials like timber, stones and mud. This VRB constricts the canal flow. As a result, both the canal banks are scoured downstream of the temporary VRB.

In the middle reach of this secondary canal, open cut in its left bank were observed at four different locations. These open cuts seems to have multiple functions. During the dry season, they are used as unauthorized off takes from the secondary canal, while during the monsoon season they are used as drain inlets into the canal.

This secondary canal is in fill except in its middle reach. As a result, canal breaches were observed at several locations, especially in the tail portion of this secondary. These canal breaches, however, were maintained simply by earth filling.

Part of the irrigated area in the tail end of this secondary canal is being eroded by the Kankai River.

In general, this secondary canal and its structures are in good conditions, except gates tertiary head regulator. The canal system is functioning well.

Asset survey - Secondary canal S7

Defects were only found at five of the 26 structures along S7. Of these, four had missing or faulty gates, Table K 1.1. To repair these structures, NRs 20,500 is needed, Table K 1.4.

Only one small length of canal was identified as having a problem, Table K 1.3. However, NRs 20,000 is required to fix the problem, Table K 1.5.

B1.1.6 Secondary canal S9

As mentioned earlier, a few secondary canals were handed over to the concerned farmers for management. This is one such secondary canal.

This secondary canal off takes from the sub-main canal SMC-2 through a gated overflow weir. The first 300 m of the canal section is lined with concrete (in both sides) in a trapezoidal section, and the next 150 m is lined only on its left side (opposite to service road). The rest of the canal section is unlined. Being a small canal section, there are no major problems in the canal. However, there is heavy weed growth in the unlined section.

As in other canals, offtakes to the tertiaries are overflow weirs regulated by manually adjustable gates. Check in the secondary canal is made through stop logs. All most all the gates are not functioning and need improvement. The service road, aligned parallel to the canal along the right bank, is in fair condition. However, it needs gravelling.

In this secondary canal, there are no major (or even minor) problems. What is required is the proper cleaning of the canal system.

Asset survey results - Secondary canal S9

Six of the sixteen structures were found with defects, Table K 1.1 and required NRs 35,000 to repair, Table K 1.4.

Eight instances of defects to the canal bed and banks were observed, Table K 1.2, including three locations where the section was enlarged and two areas of significant weed growth. The total length of canal affected was 820 m or 70% of the total. Approximately NRs 5,100 is required to repair the canal, Table K 1.5.

B1.1.7 Summary of asset survey at Kankai

A summary of the asset survey results is given in Table B 4. The costs shown in the table represent the total required to bring the canals and structures to a fully functioning condition.

Table B 4 Summary of asset survey results - Kankai

	Intake/main	S2	S5	S7	S9
Canal length (km)	17.66	3.95	5.76	1.71	1.17
Canal command area (ha)	7,000	226	798	230	126
No. structures	97	32	49	26	16
No. structures per km	5.5	8.1	8.5	15.2	13.7
No. structures per 100 ha	1.4	14.2	6.1	11.3	12.7
% defective	41%	41%	43%	19%	38%
Cost of required maintenance (NRs)	26,893,000	59,500	227,900	20,500	35,000
Cost of required maintenance per ha	3,842	263	286	89	278
% length with major or minor defects	38%	8%	55%	1%	70%
Cost of required maintenance	1,767,000	2,000	65,000	20,000	5,100
Cost of required maintenance per ha	252	9	81	87	40
Total cost per ha	4,094	272	367	176	318

B1.2 Tilawe Irrigation Scheme, Nepal

B1.2.1 Background

Location and Climate

Tilawe Irrigation Scheme is located in Parsa District in the Central Development Region. The irrigated area is about 10 km west of Birgunj city and is connected by gravel road. The scheme is in the sub-tropical zone with an average annual rainfall of about 1400 mm. Monthly rainfall varies from 4 mm in November to 470 mm in July of which some 83% falls in the monsoon period.

Cropping pattern

Monsoon cropping of paddy is practised during the monsoon season although about 15% of the command area receives no irrigation water and is entirely rainfed. Wheat is grown during the winter season with a third of the land left fallow. The land is left almost entirely fallow during spring apart from about 700 ha of pulses, oilseed, vegetables and maize. Table B 5 shows the cropping pattern along with areas and average yields.

Table B 5 Cropping pattern, area and average yields at Tilawe

Season	Crop	J F M A M J J A S O N D	Area (ha)	Ave yield (t/ha)
Monsoon	Late paddy		5,600 [1]	2.7
Winter	Wheat		3,800	1.9
Spring	Pulses, oilseed		500	0.9
Spring	Maize		200	3.0

Note 1: Approximately 800 ha of this area is rainfed paddy

Cultivation of winter and spring crops appears to be in decline, probably due to off-farm employment opportunities in Birgunj and the development of Nepal's dry port nearby.

Operation and maintenance

Being an integral part of the Narayani Irrigation System, operation of Tilawe is dictated to some degree by the operation of the larger system. Tilawe is designed for rotational delivery of water among the secondary blocks during winter and spring. Within the blocks, all tertiary canals are designed to operate continuously at full discharge capacity. This has never been achieved in practice however, perhaps because of insufficient flows. Currently both main secondary canals of Tilawe operate on a continuous basis throughout the year irrespective of canal discharges. Since the regulating structures were not designed on this basis, the farmers have resorted to constructing unauthorised direct outlets, damaging structures and abandoning tertiary canals. Not surprisingly farmers at the head tend to receive more water than those at the tail of the system.

Maintenance of the system is the responsibility of Department of Irrigation except tertiary canals. Farmers are of the opinion that Department of Irrigation should also maintain the lower order canals. Consequently, little maintenance is carried out and farms have encroached on tertiary canals in many places. General maintenance is usually carried out during the winter and spring seasons when there is less demand for water. Budget limitations have meant that only high priority works have been completed. The maintenance budget for the left bank part of Tilawe for 1999/2000 was NRs 1.3 million (390/ha).

i)	main canal	NRs 677,000
ii)	distributaries	NRs 197,000
iii)	minor canals	NRs 266,000

iv) operation NRs 150,000

The greater part of this total was spent on cleaning and desilting of the canals in the upper part of the scheme. As a result the condition of the middle and tail parts has been gradually declining.

During 1999/2000, Tilawe consumed 33% of the total budget for Narayani Irrigation System despite commanding less than 20% of the total area.

B1.2.2 Headworks and Main Canal

Headworks

The headworks consists of a barrage, two under sluices, and two head regulators (one on the right and other on the left bank of the river) for regulating flow into the right and left main secondary canals. In general, the headwork is in good condition, and it is functioning well. However, the right bank of the river in the down stream of the barrage is continuously eroding which has threatened the solidity of NEC located at about 2 km downstream of the headwork. It is estimated that about NRs 1400,000 is required in order to protect NEC and the right bank of the Tilawe River.

Main secondary canal

The left main secondary canal (MSC) is an earthen canal in a trapezoidal section. In its head reach (chainage 0 to 3500m), the canal is in fairly good condition except some minor weed growth and enlargement of section in a short stretches. These enlargements are seen especially close to the village, and they are the results of human and livestock encroachment (buffalo bathing) in the canal.

In a stretch between chainage 3500 and 5600m, the first 1000m is well maintained and cleaned. However, in this portion, the left back of the canal does not have sufficient height to allow designed free board. The rest of the canal in this stretch has minor weed growth and siltation.

The volume of weed growth and siltation increase as the canal runs further downstream. In its tail reach, weed growth is intensive, and the enlargement of canal section, especially close to the villages is invariably encountered.

In general, most of the structures in the MSC are in fairly good condition. However, some common defects are:

- Minor scour downstream of structures is common
- Almost all of the gated structures are not functioning. Although they are not needed from the perspective of system design, actual operational practice suggests that they are needed.
- The canal siphon located at chainage 3450m is leaking. The volume of leakage is about 5-10 per cent of total incoming water.
- Parapet walls of most of the village road bridges (VRB) are either cracked or do not exist at all.
- Crests of a few regulating structures are broken.

There are several tertiary canals off-taking directly from the MSC. Of these tertiary canals, some are aligned perpendicular to the main secondary canal, while some of them are aligned parallel to it. Of the several tertiary canals aligned perpendicular to the MSC, only a few tertiary canals exist up to a certain length. The remainder of the canals are already encroached upon by the farmers and converted into cultivated lands. Similarly, all the tertiary canals aligned parallel to the MSC do not exist at all. In these tertiary canals, only the damaged structures are seen. As a result, there exist large numbers of open cuts in the canal banks for unauthorized withdrawal of water directly from the MSC.

Asset survey - headworks and main canal

Results from the asset survey analysis can be found in the Supplementray Volume OD/ITM 62.

There are a total of 89 structures along the 12km long main canal with a command area of 2,800 ha. This gives a structure density of 7.4 per km of canal or 3.2 per 100ha. 34% of structures were found to have one or more defects, Table T 2.1. The most common defect was in the civil works (15 cases). None of the structures adversely affect flow. Only one structure, a gated offtake, is regarded as redundant.

The estimated cost of repairs to all the structural defects is NRs 2,215,600, Table T 2.4. NRs 1,500,000 of this is the cost to repair the defective canal siphon at chainage 3450m.

There are an estimated 36 defects to the banks and/or bed of the main canal, Table T 2.2. These defects occur along the entire length of the 12 km main canal, Table T 2.3. The most common defects are significant weed growth in the canal and problems due to siltation, reduced freeboard, slippage and enlargement of the cross section. There were 10 instances of significant weed growth affecting 5.3 km, nearly half, of the canal. 6 instances of siltation with encroachment of freeboard occurred along 3.6 km. of canal. None of the canal lining was deemed to be in need of repair.

Just over half the defects to the canal were expected to have no observable effect on flow. One third of the defects were expected to have a minimal effect, allowing a flow of between 90% and 110% of design flow. In the remaining 6 defects it was anticipated that flow restrictions would restrict flow to between 70% to 90% of design.

An estimated total cost of NRs 803,000 is estimated to be required to correct all problems associated with the canal structure, Table T 2.5.

B1.2.3 Branch secondary canal BSC-1

The branch secondary canal (BSC-1) leaves the main secondary canal (MSC) at chainage 2670 m. The BSC-1 draws water through a stop log check head regulator. Although a cross regulator is located downstream of BSC-1 bifurcation point in the MSC, it is not functioning. A drop with stop log check constructed at chainage 2715 m in the MSC regulates the flow into BSC-1.

The canal (BSC-1) is about 2 km long and it is designed to irrigate about 280 ha of cultivated land. The design discharge of the canal is about 330 lps. The canal is earthen in a trapezoidal section and its bed width is about 1.5 m. A service road is aligned along the left bank.

The canal is well maintained and cleaned by Department of Irrigation. However, around the structures minor scour is common.

According to design, the BSC-1 is supposed to supply water to one sub-secondary canal and six tertiary canals. However, most of the tertiary canals, especially those which are aligned parallel to BSC-1, do not exist. Only the structures constructed on them exist-they are dysfunctional. As a result, this canal has 29 informal offtakes (open cut in the canal banks) towards its both banks. Widening of the canal section and minor scour around informal offtakes is common.

The sub-secondary canal is well-maintained and lined. As both the branch secondary and sub-secondary canals are well maintained and cleaned, it seems that the area belongs to some influential person.

Hydraulically, most of the structures (other than tertiary offtakes) in the BSC-1 are functioning satisfactorily. However, the crests of most of the regulating structures are broken.

Asset survey data- branch secondary canal BSC-1

Only 8 structures out of 44 on BSC-1 had defects and none of them have any affect on flow, Table T 2.1 and Table T 2.6. Six of these defects consisted of damage to civil works. The total cost to repair the structures is estimated at NRs 29,000, Table T 2.4.

There are 8 defects to the canal bed and banks, 5 of which are enlargements of the cross-section, Table T 2.2. These defects occur along 160m of the canal, Table T 2.3. Two of these locations had a minimal effect, creating a flow between 90% and 110% of design flow. The remaining canal defects had no observable effect on flow. It is estimated that total cost of repair to the canal is NRs 25,000, Table T 2.5.

B1.2.4 Branch Secondary Canal BSC-3

The branch secondary canal BSC-3 bifurcates at chainage 3900 of the MSC. It draws its water through a stop-logged offtaking structure, which is attached with a drop structure. There also exists a regulating check structure across the MSC for easier diversion into BSC-3. The canal is about 5.58 km long and is in stable condition.

The bank condition throughout the canal reach is good, except for some enlargement upstream and downstream of permanent structures, especially the cross regulators. Such widening is the result of cattle crossing and buffaloes bathing in the canal.

The system was designed in such a way that water distribution to field channels (field channels deliver water to individual fields) is done through the tertiary canals which receive water from the secondary canals through tertiary turnout structures. However, almost all the tertiary are encroached and converted into the crop fields by the farmers. Irrigation is through several open cuts in the canal banks and field-to-field irrigation is practised.

The first and last reaches of the canal are covered by minimal weed growth, which has nominal effect on flow, whereas the middle reach is affected by significant weed growth with a minor effect on flow. But the problem can be solved with a little effort by farmers.

Hydraulically, most of the structures are functioning well. However, they need some structural improvement. Replacement of gates, construction of parapet walls of VRB, and repair of offtake structures are some of the examples of structural improvements needed.

The flooding of the well siphon at chainage 4200 m made it impossible to continue the walk through the remaining portion of the canal. Review of the L-section drawing of the canal and interviews with farmers showed that beyond this siphon there are no important structures in the canal except some turnouts for tertiary canals. Thus, the physical asset survey of the canal beyond chainage 4200 was not done.

Asset survey- branch secondary canal BSC-3

There are 46 structures along BSC-3, 18 of which suffered some kind of defect, Table T 2.1 but none of them affect the flow. All the defects recorded were either damaged civil works (11 structures) or missing gates (seven structures). Repair is estimated at 375,000, mostly for the defective civil works, Table T 2.4.

There were 3.2km of defects noted along the 5.58km long canal, Table T 2.3. The most frequently occurring problems are enlargement of the cross section and significant weed growth. 14 sections of canal had nominal effect on flow, restricting it to between 70% and 90% of design. 2 sections had a minor effect on flow restricting it to between 50% and 70% of design Table T 2.6. A total of NRs 266,000 was deemed necessary to repair the problems, Table T 2.5.

B1.2.5 Branch Secondary Canal BSC-5

The branch secondary canal (BSC-5) bifurcates from the main secondary canal at its chainage 8800 m. Locally, the village area where BSC-5 bifurcates from the main secondary canal is known as Harpatjung. The arrangements for regulating flow into BSC-5 are similar to that of BSC-1 described earlier.

Locally the canal (BSC-5) is known as Sugauli Canal. The canal is 2.445 km long and it is supposed to irrigate 420 ha of cultivated land. The design discharge of the canal is about 314 lps. The canal is earthen with trapezoidal section. Its bed width is about 1.5 m.

In most of the stretches of this canal, a service road is aligned along the left bank, while in a few stretches, the service road follows the village. As a result, in such stretches, it is even difficult to walk along the canal due to dense bushes grown in the canal banks. The service road is earthen and it is not serviceable during the monsoon season.

Types of structures that exist in this canal include mainly drops with stop log checks, VRBs, formal and informal turnouts, and cross drainage works. Except for some of the turnouts, most of the structures are hydraulically functioning. However, structurally, many of them require immediate maintenance. The common defects are: parapet walls of most of the VRB are either cracked or do not exist; minor scour around structures; approach lining of many structures is cracked; crests of many regulating structures are broken; and almost all the gates are non-functioning.

As in the case of branch secondary canal BSC-1, many tertiary canals are already encroached upon by farmers and they are converted into cultivated land.

Unlike branch secondary canal BSC-1, this secondary canal (BSC-5) is not cleaned. As a result, there is considerable growth of weeds and deposition of silt in the canal. This, however, can be cleaned with minor effort. Except around the structure, especially close to the village, where the canal sections have enlarged due to human and livestock encroachment, the rest of the canals are in fairly good condition.

Asset survey - branch secondary canal BSC-5

12 of the 44 structures were found to be defective but none of the defects affect the flow, Table T 2.1. and Table T 2.6. Defective civil works were again found to be the most common problem with 9 occurrences in total, Table T 2.1. NRs 122,000 is estimated to be the cost of repair of all structures. NRs 70,000 of this sum is the cost to repair the road bridges alone.

2.7km of the 2.45km canal were found to be defective, suffering mainly from siltation problems and excessive weed growth Table T 2.3. 13 out of the 17 cases of defective canal were deemed to have a minor affect on flow restricting it to between 50% and 70% of design, Table T 2.6. The cost of repair was estimated to be NRs 84,975.

B1.2.6 Summary of asset survey at Tilawe

A summary of the asset survey results is given in Table B 6. The costs shown in the table represent the total required to bring the canals and structures to a fully functioning condition.

Table B6 Summary of asset survey results - Tilawe

	Main	BSC-1	BSC-3	BSC-5
Canal length (km)	12.00	2.00	5.58	2.45
Canal command area (ha)	2,800	280	600	420
No. structures	89	44	46	44
No. structures per km	7.4	22.0	8.2	18.0
No. structures per 100 ha	3.2	15.7	7.7	10.5
% defective	34%	18%	39%	27%
Cost of required maintenance (NRs)	2,215,000	29,000	375,000	122,000
Cost of required maintenance per ha	791	104	625	290
% canal length defective	100%	8%	57%	110%
Cost of required maintenance	803,500	25,000	266,000	84,975
Cost of required maintenance per ha	287	89	443	202
Total cost per ha	1078	193	1068	492

B1.2.7 Farmers' assessments

Water supply

65% of farmers agree that they receive enough water and at the right time during the monsoon. About half the farmers are satisfied and the other half dissatisfied with the quantity and timing of the water supply in the winter. Virtually no farmers (3 out of 27 respondents) are satisfied in the spring. The main reasons given by farmers for a poor water supply are bad control or operation (53% in monsoon, 54% in winter and 16 out of 28 respondents in spring) and that other farmers take too much water (24% in monsoon and 39% in winter).

Farmers believe the supply is slightly worse now than it was five years ago (20% the same, 43% slightly worse and 26% worse). Operation of the main system is, in farmers' opinion, also slightly worse (14% the same, 52% slightly worse and 27% worse). 50% of farmers think that the operation of the main system is currently poor but 43% say that it is acceptable.

Over half the farmers agree that the water distribution between and along branch canals is not fair (67% unfair, 33% fair distribution between branch canals, and 55% unfair, 41% fair distribution along branch canals). A majority (57%) say it is easy to arrange water supply to their farms (16% sometimes difficult, 25% difficult).

Canal and structure condition

The farmers are generally divided on their opinion of the condition of canals and structures. Half (50%) of farmers think that the main canal is in reasonable condition and half think that it is in a poor condition. 37% think that the branch/ distributary canals are in reasonable condition and 60% say that they are in a poor condition. The opinion of the condition of the tertiary/ field channels is similar to the that of the main canal (42% reasonable, 39% poor, 20% don't know). Compared with five years ago most farmers were in agreement that the whole system has deteriorated (main system – 4% better now, 26% the same, 69% worse now, secondary system – 3% better now, 15 % the same, 78% worse now, tertiary system 4% better now, 32% the same, 46% worse now).

Maintenance

76% of farmers think that Department of Irrigation is responsible for regular maintenance of the main canal structures. 41% think that Department of Irrigation is responsible for the regular maintenance of secondary canals and 44% don't know who is responsible. If structures are damaged, 91% of farmers think that Department of Irrigation is responsible for repairing main system structures and 58% think that Department of Irrigation is responsible for secondary canal structures.

On the main canal system, 100% of farmers agree that Department of Irrigation is responsible for desilting. Opinions on the responsibility for desilting secondary and tertiary canals were less clear cut (Secondary - 55% Department of Irrigation, 17% water users association, 10% other; Tertiary – 21% Department of Irrigation, 16% water users association and 30% other). About half the farmers helped to desilt secondary and field channels and 17% helped to desilt the main canal. The number of days given to this activity varied wildly with the majority giving either 2 days or more than 10 days. Most farmers didn't help with any other maintenance tasks apart from desilting last year (only17% said they did help with other tasks). The majority (79%) also agreed that all farmers contribute similar amounts of labour for maintenance tasks. On the other hand, 76% of farmers felt that inadequate maintenance was carried out last year.

70% of farmers thought that there was a problem with quality of maintenance

B1.3 Khageri Irrigation Scheme, Nepal

B1.3.1 Background

Location and climate

Khageri Irrigation System (KHIS) is situated in the Western part of the Chitwan district of the Narayani Zone in the Central Development Region of Nepal. The service area is connected to the district headquarters by several village road networks.

The system sits in the sub-tropical climate. The mean annual rainfall is about 2000 mm with about 80% of this falling during the monsoon (June to September). Average monthly temperatures vary from 14 ^{0}c in January to 35 ^{0}c in July.

Cropping pattern

Paddy is the only crop grown during the monsoon period. It is followed by a crop of wheat, which is unirrigated in spite of the fact that water may be available. The popularity of pulses is increasing at this time due to ease of cultivation. 500ha of irrigated paddy and non-irrigated maize are grown in the spring.

Table B 7 Cropping pattern, area and average yields at Khageri

Season	Crop	J F M A M J J A S O N D	Area (ha)	Ave yield (t/ha)
Monsoon	Late paddy		3,900	3.2
Winter	Wheat		1,200	1.8
Winter	Pulses, oilseed		700	1.0
Spring	Early paddy		500	4.2
Spring	Maize		900	1.6

Operation and maintenance

The operation and maintenance responsibility of the main canal and headworks lies with Department of Irrigation but activities are carried out in co-operation with the water users association main committee. The water users association main committee prepares the type of distribution pattern among the branches during the irrigation period. The respective branch water users associations are responsible for their branch canal operation and maintenance.

The headworks and the 9 km of main canal running through the Chitwan buffer zone are operated year round. This keeps water in the natural reservoirs, sustaining wildlife and providing a reserve of water for early paddy. A cross regulator and escape at the end of the park area control water entering the rest of the scheme.

The water distribution method is dependent on the amount of water in the main canal. In water-short periods, the branch canals located in the head, middle and tail sections of the main canal receive water for 4, 5 and 6 days in turn. During periods of slight water shortage, branches in the head and tail sections receive water for a week each. When water supply is adequate, all branches receive flow continuously.

No irrigation is supplied in winter and only branches One and Two receive water in spring for early paddy.

Maintenance of the headworks and main canal is the responsibility of Department of Irrigation. Branch canals are maintained by the respective branch water users associations and farmers take the responsibility of tertiary and field channels.

In recent years some areas have had their regular maintenance included in the rehabilitation under IMTP.

The operation and maintenance budget for 1999/2000 was NRs 2.5 million:

i)	main system	NRs 400,000
ii)	headworks	NRs 1,600,000
iii)	operation	NRs 500,000

The principal physical assets of the Khageri Irrigation System include the head works, main canal, branch canals, and the service road. The system has twelve second order canals. Of them, the first eight bifurcating canals are termed branch canals (BC) and the last four bifurcating canals are termed minor canals (MC). Among the branches, branch number Six is the largest one, irrigating about 800 ha of land. This branch further bifurcates into two sub-branches SBC-6E and SBC-6W at a distance of about 1.6 km downstream from the offtake point in the main canal. There are no major problems in all of these branch canals. As noted above, all the minor canals bifurcate from the tail end of the main canal. Although the last four bifurcating second order canals are termed minor canals, they irrigate areas comparable to the commands of other branch canals. This study has considered them to be branch canals.

Head works, main canal, branch canal number 1 (BC-1), branch canal number 5 (BC-5), and minor canal number 1 (MC-1) were included in the study.

B1.3.2 Head works and main canal

The principle component of the headworks includes a gated barrage with two bays each of 11m span, which are manually operated. The downstream of the barrage consists of the horizontal RCC floor with baffle blocks (no specific type) followed by loose gabion protection work. The down stream protection was washed away in last year flood and has been recently repaired. The headworks are in good condition even though constructed some 35 years ago.

The headwork does not divert the whole discharge coming from the river. When the depth of the flow in the river (U/S of the barrage) is above 5 m (from the river bed), part of the flow is diverted to another bridge, constructed across the east west highway. As the headworks are adjacent to the National highway, they are well protected against flood damage. The highway acts as protection/control embankments for the headworks.

Offtake to the main canal is through two gated regulators. Orifice flow occurs except in low flow periods. The operation and maintenance responsibility of the headworks lies with Department of Irrigation.

Main canal

The main canal is 22.7 km long, of which the first 9 km is aligned through the Royal Chitwan National Park . Except for irrigating about 100 ha of cultivated land located in the head reach of the first 9km of main canal does not have any canals. An ungated turnout located at about 400 m down stream of the head regulator supplies water to this area.

The first 1 km length is in fill, about 400 m are lined with RCC. The canal then enters into the forest area, which is the buffer zone of the Royal Chitwan National Park. Inside the forest, the canal has only one (left) embankment. The right embankment is left free. Within this reach, several small-scale reservoirs are formed due to topographic depressions. Among these reservoirs, the Bees Hazar Tal (meaning a reservoir located at 2000 RD[3]) is the largest one. These reservoirs are interconnected. They also function as intermediate storage for the canal system. As a result, they have great importance in operating the main canal, especially during the period of water scarcity and during the cultivation of early paddy.

[3] RD refers to reduced distance, probably in feet.

A number of. incoming drains join these reservoirs, and thus feed the canal system. Several overflow spillways and cause-ways in the service road have been provided for the safe over flow of the excess discharge. The canal section is mostly irregular, but has nominal effect in the flow. There are problems of bank slippage and vegetation growth. Most of the reservoirs are now covered by vegetation, and if proper cleaning measures are not taken, these may be converted into marshy/swamp land instead of clean water reservoirs in the future. Over the last few decades, this reach has also been an attraction to tourists, as the area is full of different types of habitat and birds including birds migrating from Siberia and other parts of the world.

At the end of the 9km section through the Chitwan Buffer Zone, a cross regulator and a bottom escape are provided, through which the flow is controlled to the rest of the main canal.

Once the canal leaves the Chitwan Buffer Zone it becomes a contour canal. Thus, it has a few cross drainage structures. The major cross drainage work is an aqueduct at chainage 13+00. The rest of the cross drainage works include both siphon and supper passages depending upon the topography of the location. The interesting feature of the system is that most of the drain water is used for irrigation at downstream of the command area. All of these structures were constructed during initial construction of the system and are still at good condition. The only problem in all of these structures is the minor score around them.

Water is controlled by cross regulators equipped with manually adjustable steel gates. There are about 7 such cross regulators in the whole length. Off takes to the secondary canals are through gated regulators, which are in good condition. There are also about 40 direct outlets, which are both gated and ungated type. Some of these gates are not working.

The cross sections of the 3km of the main canal (from chainage 9 to 12 km.) were found to be enlarged compared to the original design. Such enlargements are mainly due to bank slippage. In this portion, at a few places, slippage of the embankment is still continuing. In general, the enlargement of the canal section has nominal effect on canal flow and has not posed any threat to canal stability. However, at a few places the embankment needs to be protected where the canal is likely to breach.

The rest of the canal is in good condition except for minor scour around the structures.

The canal section is almost free from silt problems. There is moderate weed growth between chainage 18 to 21 Km, but its effect on canal flow is nominal. Both sides of the canal embankments are planted with tree. Though planting has not affected canal operation and maintenance activities at present, it may cause operational problems in the future.

The canal service road aligned along the left bank is in poor condition.

Asset survey data for headworks and main canal

There are a total of 111 structures along the 22.7km length of main canal with a command area of 3,900ha. This is equal to a structure density of about 5 per km of canal or 2.8 per 100ha. Of the 111 structures, only 23% were found to have one or more defects, Table KG 3.1. The most common problem being defect to civil works (15 structures) followed by scouring of canal or banks at structures (6 structures). Only one structure was deemed to have any affect on flow, restricting it to between 70% and 80% of design, Table KG 3.6. Only 2 gated offtakes were considered redundant structures, Table KG 3.7.

The total estimated cost of repair to the defects to structures is estimated at NRs 349,500, Table KG 1.4.

It is estimated that there are 21 instances of defects along 26% or nearly 6km of the banks and/or bed of the main canal, Table KG 3.2 and KG 3.3. The most frequently occurring defect is slippage and scouring of the canal embankments of which there were 12 instances along nearly 3km of canal. This was followed

by 5 cases of cross section enlargement and 3 cases of significant weed growth, both occurring along about 1.5km of canal each. Only 100m of lining was identified as needing repair.

13 out of the 21 canal defects were identified as having an effect on flow. In all 13 cases the flow was restricted to no less than 70% of design, Table KG 3.6.

A total figure of NRs 1,110,000 was estimated to be the cost of repair to the main canal. A large proportion of this sum, NRs 805,000 was estimated as the cost to repair the embankments, Table KG 3.5.

B1.3.3 Branch canal BC-1

This is the first off taking branch of the Khageri system. It is 4.1 Km long and it has command area of about 237 ha. Most of the canal section is in filling varying from 0 to 4 m in height.

Most of the canal section is lined using both concrete and brick masonry, using resources from Irrigation Management Transfer Project[4] (IMTP). As the canal system is recently rehabilitated, it seems to be in good condition. Earlier, encroachment of the embankment has been one of the major problems, but has reduced now after the management transfer to the water users association. Holes in the canal embankment made by the rats and other similar animals are major problems for farmers, requiring continuous attention.

The major structure in this canal system is an aqueduct, which was constructed 35 years ago, but still is in stable condition. Other structures include tertiary outlets, which are of different sizes depending upon the area irrigated. The canal does not have service road along its bank.

This branch receives water for both early paddy and monsoon paddy. The branch committee carries out water distribution activities. Generally sectional rotation is practised, dividing the whole area into three sections. However, whenever there is no restriction for withdrawal from the main canal, canals are run bankfull, supplying continuous flow to the tertiary canals as observed during a field visit. As a result, possible damage to the wetted portion of the canal could not be assessed. As the canal was flowing at full capacity till the tail end, it can be presumed that its condition is reasonable.

One of the problems with system operation is the obstruction from a check gate placed just downstream of the head regulator to divert water to a tertiary. Upon examination of this check gate, it appeared that withdrawal in the canal is drastically decreased owing to backwater effects. Another operational problem is that farmers do not care about the canal free board. In the past, this practice has caused breaches in the canal.

The major maintenance activities include de-silting and vegetation clearing. These activities are carried out twice a year, just at the beginning of each paddy plantation season. So far farmers do not have experience of maintenance of a lined canal system, both in terms of technical requirements and financial need, which could be a problem in future.

Asset survey data for branch canal (BC-1)

8 structures out of a total of 62 that had an observable defect, Table KG 3.1. There were 3 defective gates, 3 cases of scouring and 2 damaged approach sections. The total cost to repair the structures was estimated at NRs 50,000, Table KG 3.4.

Defects to the canal bed and banks were recorded in 18 locations, Table KG 3.2, affecting just over 6.5km of canal, Table KG 3.3. Significant weed growth and seepage were the most common problems recorded. Most cases were found to restrict the flow to no less than 70% of design but there were 3 cases where flow was restricted to between 50% and 70% of design, Table KG 3.6. It is estimated to cost a total of NRs 211,000 to repair the canal.

[4] More than 70 per cent of the expenditure during rehabilitation under the IMTP was spent for such lining.

B1.3.4 Branch canal BC-5

This branch lies at about middle of the command area. It is 2.44 Km long and irrigates about 195 ha of cultivated land. About half of the canal is lined mostly by concrete, in trapezoidal section. Like branch canal-1, it is also a ridge canal, and irrigates both sides of its banks. Besides its share from the main canal, it also receives water from a nearby drain through a drain inlet structure.

In general, the canal and its structures (lined canal and outlets) are in fairly good condition.

During the field visit, water was up to the top of the canal section and the condition of the lined portion of the canal could not be assessed. However, farmers mention that the condition of the canal is satisfactory. As they are not concerned about free board, a minor canal breach has taken place at two places at the tail end. Thick vegetation growth on the canal bank at several places made it difficult to walk along the canal.

Except for tertiary outlets, the canal does not have any control structures. As a result, operation of the canal is simple.

In general, rotational water delivery is practised throughout the cultivation period except at times of heavy rain, when continuous flow is practised. The branch canal committee is responsible for water allocation and distribution.

Canal maintenance activity includes de-silting and clearing of vegetation, which is carried out once a year. Since canal lining was done four years ago, it has not needed any maintenance activity. But maintenance may be problem in future, as it involves high cost. Farmers have not given much attention to this aspect.

Asset survey data for branch canal BC-5

Only 5 out of the 36 structures along the 2.45km length of BC-5 were found to have defects, Table KG 3.1. The defects will require an estimated NRs 32,000 to repair, Table KG 3.4.

There were only 4 sections of defective canal bed and banks, covering 431m in total and creating a restriction to flow of between 70% and 90% in all locations. Repair cost is estimated at NRs 30,5000.

B1.3.5 Minor canal MC-1

This is the tail end branch of the Khageri canal system. It is 3.1 Km long and irrigates 189 ha of land. Being the tail end canal, it is a relatively water- scarce area compared to other branches. Lining of the canals and management improvement in both main and branch systems has helped to reduce water scarcity after management transfer. The canal system is mostly earthen and consists of heavy fill at several locations. There are no major structures in the canal. During field visit, water was flowing till the end of canal. The canal condition is fairly satisfactory.

The branch committee carries out water distribution using rotational delivery. Being water- scarce, this branch can not have continuous flow like the others. De-silting and clearing of the vegetation are the major maintenance activities to be performed by the farmers. Lining the canals will change the maintenance pattern in the future, but this has not been given much attention presently by the farmers.

Asset survey data for minor canal (MC-1)

Out of a total of 54 structures along MC-1, only 3 were found to be defective. There was a restriction of flow to between 70% and 80% of design at one of the defective structures, a village road bridge. The estimated cost of repair was therefore only NRs 10,000. Table KG 3.1 and Table KG 3.4.

Of the total canal length of 3.1km, there were found to be 6 instances of defective canal bank or bed occurring along only 110m of canal, Table KG 3.3. Repair costs were thought to be in the region of NRs 88,000 the bulk of the cost going to repair the 50m of damaged lining, Table KG 3.5.

B1.3.6 Summary of asset survey at Khageri

A summary of the asset survey results is given in Table B 8. The costs shown in the table represent the total required to bring the canals and structures to a fully functioning condition.

Table B 8 Asset survey at Khageri

	Main	BC-1	BC-5	MC-1
Canal length (km)	22.7	4.12	2.45	3.1
Canal command area (ha)	3,900	237	194	189
No. structures	111	62	36	54
No. structures per km	4.9	15.0	14.7	17.4
No. structures per 100 ha	2.8	26.2	18.6	28.6
% defective	23%	13%	14%	6%
Cost of required maintenance (NRs)	349,500	50,000	32,000	10,000
Cost of required maintenance per ha	90	211	165	53
% canal length defective	26%	158%	18%	4%
Cost of required maintenance	1,110,000	211,000	30,500	88,000
Cost of required maintenance per ha	285	890	157	466
Total cost per ha	375	1,101	322	519

B1.3.7 Farmers' assessments

Full results of the farmer survey are contained in the Supplementary Volume. This section highlights the responses given by the farmers regarding the condition of the irrigation infrastructure and the way the system is operated and maintained.

Water supply

Farmers do not agree (48% yes, 38% no) that they receive adequate water during the monsoon season and that they get it at the right time (41% yes, 47% no). A majority say that they do not receive enough water in the winter (80% not enough) and summer (77% not enough). When asked why the supply is not good, the primary reasons given are insufficient water in the river (39% in monsoon, 65% in winter, 64% in spring) and poor condition of the main system (30% in monsoon, winter and spring). Lack of water is clearly a main constraint, with 38% of farmers leaving land left unplanted in winter and 25% in spring.

Farmers feel that the supply has generally stayed the same over the last five years (0% better now, 10% slightly better, 68% the same, 12% slightly worse, 3% worse). 82% of farmers feel that the operation of the main system is currently acceptable and that it has been more or less the same over the last five years (0% better, 18% slightly better, 57% the same, 18% slightly worse, 2% worse).

A majority of farmers think that distribution of water between branch canals is fair (65% fair, 29% unfair) with a similar picture of fairness along branch canals (59%fair, 31% unfair). Under half say that it is easy to arrange for water to their farms (45% easy, 30% sometimes difficult, 20% difficult).

Condition of canals/structures

Most farmers think that the condition of the main system is reasonable (0% excellent, 69% reasonable, 25% poor). The condition of the secondary/branch canals (3% excellent, 85% reasonable, 7% poor) and tertiary/field channels is similar (2% excellent, 76% reasonable, 3% poor). Compared with five years ago, farmers consider system condition to be mostly unchanged / slightly improved (main system – 7% better now, 62% the same, 25% worse now, secondary system – 14% better now, 72% the same, 8% worse now, tertiary system – 9% better now, 68% the same, 7% worse now).

Maintenance

37% of farmers think that Department of Irrigation is responsible for maintaining the main canal structures but 39% thought it was the responsibility of the water users association. 66% thought that the water users association was responsible for maintaining secondary canals. If structures are damaged, 42% think that

Department of Irrigation is responsible for repairing main system whilst 29% thought it was the responsibility of the water users association. A majority (75%) saw repair of secondary canal structures as the responsibility of the water users association.

Farmers were similarly unclear as to who has the responsibility of desilting the main canal (32% Department of Irrigation, 41% water users association, 19% other). Again, the responsibility for lower order canals received a much clearer response with 90% agreeing that the water users association is responsible for the secondary canals and 79% that the water users association is responsible for the field channels. 75% of farmers helped to desilt secondary channels, 67% field channels and 36% to desilt the main canal. On average, farmers gave two days labour for these activities. Only 28% said that they also helped with maintenance tasks other than desilting. Most farmers (74%) agreed that all farmers contribute about the same amount of labour for maintenance tasks. However, only 39% thought that adequate maintenance was carried out last year. 50% of Farmers felt that more maintenance was carried out five years ago compared to now.

B1.4 West Gandak Irrigation Scheme, Nepal

B1.4.1 Background

Location and climate

Nepal West Gandak Irrigation System (NWGIS) is located in Nawalparasi District in the western development region of the Nepal Terai. The main command area is south of the East-West highway and continues to the Indian border. The nearest city, Narayanghat, is 60km to the east

NWGIS is in the sub-tropical climate region. The mean annual rainfall is 1500mm with more than 80% of this falling during the monsoon period. Rainfall in July averages 400mm.

Cropping pattern

Although paddy is grown over the largest area in the monsoon, wheat is still the preferred crop in the area. Sugarcane cultivation is increasing due to the fact that it is resistant to waterlogging in the rainy season, it is easy to grow, and there are more sugar mills in the area. Much of the land remains irrigated year- round, including the winter season. Table B 9 shows the cropping pattern but does not include 904ha of waterlogged land where some sugarcane is now being grown.

Table B9 Cropping pattern, area and average yields at West Gandak

Season	Crop	J F M A M J J A S O N D	Area (ha)	Ave yield (t/ha)
Monsoon	Late paddy		6,700	2.9
Winter	Wheat		3,400	1.8
Winter	Pulses, oilseed		1,500	0.5
Year round	Sugarcane		1,500	53.3

Operation and maintenance

The Indian Government is responsible for the operation and maintenance of the barrage across the Narayani River and the clearing of drainage works that cross the Indian Main Canal. The rest of the management of the WGIS was turned over to the water users association in November 2000 with the provision of intensive government post-turnover support till 2001. The system is designed to provide year-round irrigation but the main canal cannot usually be operated in March/ April due to the opening of the barrage to enable the Indian government to carry out maintenance tasks. Unfortunately, the time of this water shortage means that the sugarcane crop suffers and that early paddy cannot be grown in the WGIS.

Schedules prepared during turnover recommended continuous operation during the monsoon, with a rotation system to be employed during times of water scarcity. The poor functioning of the water users association means, however, that at present there are no clear mechanisms for water allocation and distribution in the system.

System maintenance is the responsibility of the water users association. The government is providing post turnover technical support and a certain budget for three years following turnover. Apart from this expenditure, the water users association have failed to generate resources, and as a result maintenance has been seriously neglected. Siltation, canal breaches and a non-functional major branch canal are symptomatic of the situation

The budget for 1999/2000 of NRs 1.6 million came from the Department of Irrigation as post-transfer support and was divided as follows:

i) main system NRs 726,000
ii) distributaries NRs 610,000

iii) roads NRs 277,000

The principal physical assets of the West Gandak Irrigation System include the intake structure, a hierarchy of canal systems, drainage networks and service roads.

B1.4.2 The main canal and headworks

The main canal is 32.7 km long with designed discharge capacity of 8.3 m3/s (300 cusecs). The designed diversion water requirement is thus about 1 liter per second per ha. A minimum free board of 60 cm was provided in the original designed section. It is a contour canal and thus irrigates only those areas that lie left of the alignment.

Most of the first 12 km reach is in deep cutting. In such areas, the canal section is lined with boulder masonry to prevent the bank slippage and scouring. But cuts under rainfall and bank slippage of the upper part of the section are very common in most parts.

Both sides of the canal embankments are planted with trees, which has further complicated the de-silting process, as they obstruct the movement of the mechanical equipment. The trees have also damaged the regular section of the canal embankment.

Silt intrusion in the canal has been the major problem in operating and maintaining the main canal. During the field visit, it was observed that silt occupies more than 70 per cent of the canal section. As noted earlier, efforts to control the silt in the main canal by the construction of a silt ejector has so far been unsuccessful. As a result, silt is removed using mechanical equipment like loaders, excavators and dump trucks. Silt is deposited on the canal embankments, which has rather increased the problem of bank slippage and rain cut because the deposited silt flows back into the canal during rain through small gullies down the face of the embankments, later on seriously eroding the section.

The construction of the main canal has blocked many natural waterways. The canal system includes several cross drainage structures like aqueducts, canal siphons, and drain siphons. Provisions for interceptor drains to connect the natural waterways into these cross drains have been also made. However, change in land use pattern and de-forestation in the catchments have changed the flow regime of these drains. Many cross drainage structures, especially the drain siphons, require both structural and hydraulic improvement for effective functioning and to prevent the canal breaches which have occurred frequently in recent years. However, aqueducts and the canal siphon are in sound condition. Some of the canal siphons require minor structural improvement works.

Gates in most of the flow regulating structures are not working and require maintenance and greasing. In a few cases, gates are missing and require replacement. In many cases, farmers have used informal checks to divert the water in the off-taking canals. But these are immediately removed as soon as the diversion is over.

The positive aspect of the main canal is that, as the section is mostly in cutting, it is stable despite a few problems of bank slippage and scouring upstream and downstream of the structures. There is no problem of canal seepage. However, vegetation growth has been observed in the downstream reaches, especially beyond 25 km, as this section rarely receives water. The canal service road is in good condition and has recently been gravelled.

During the field survey, as the barrage gates were totally opened to pass the flood of the Narayani River, the main canal was not operating.

Asset survey data for headworks and main canal

The main canal with a command of 8,700ha is 32.8km long and has a total of 187 structures along its length. This equals a structure density of 5.7 per km of canal or 2.1 per 100ha. Of the 187 structures a total

of 67 or 36% were identified as having one or more defects, Table WG 4.1. The most common problem was a defect to civil works (27 structures) followed by a defective gate or gate mechanism (26 structures) and missing gate (11 structures). Only one structure, a cross regulator, adversely affected flow, restricting it to between 70% and 80% of design flow, Table WG 4.6. 3 cross regulators are regarded as redundant structures, Table WG 4.7.

The total estimated cost to repair the structures on the main canal is estimated to be NRs 1,495,000, Table WG 4.4.

It is estimated that there are 51 defective sections of the canal banks and/or bed occurring along 34.2km of canal length. 30 km of this defect, occurring in 29 places, is visible siltation/ encroachment on the freeboard, Table WG 1.3 There are 15 instances of slippage, scouring or other defects in the canal embankment. 85% of the defects affect the flow. 14 defects were estimated to restrict the flow to between 50% and 70% of design and 22 to between 70% and 90% of design flow, Table WG 4.6.

A total of NRs 1,284,000 is estimated to be the cost of repair to the canal, Table WG 4.5.

B1.4.3 Minor canal MC- 5

This branch canal (MC-5) is about 2300 m long and irrigates about 98 ha (official record) of cultivated land. The canal section is totally earthen and does not have major structures.

This canal draws water through a gated offtake from the Main Canal. It rums parallel to a drain for about 950 m and then deviates away from it. The offtakes to the fields are usually through piped outlets that deliver water to the watercourses. Stop log checks have been provided at three different locations for easy diversion flow into the watercourses. Several open cuts were also found along the canal alignment as some of the watercourses have been already destroyed. Throughout the command area, field-to-field irrigation is practised.

Several open cuts also function as drain inlets into the canal, some of which bring a considerable amount of silt in the canal. In the absence of any drainage system, farmers have no option but to use the canal as a drain. There are no complicated structures and the canal can be maintained at nominal cost.

The first 450m of the canal is affected by heavy weed growth along the banks and it was impossible to walk through. Further downstream of 450 m, a service road is aligned along the right embankment of the canal, which is fairly in good condition. However, the other embankment (left) is much narrower due to continuous encroachment by the farmers. The tail end section has some weed growth throughout the canal perimeter. This could have a small effect on the canal flow. Owing to the incidence of sufficient rainfall during the monsoon, the canal had not been used for the previous month. It was observed that farmers have not cared for the canal. Good rainfall might be the reason.

The water users association of MC-5 is supposed to carry out canal operation and maintenance activities. But system operation is unclear. Irrigation is done on an individual basis – anyone who needs water opens the gate. There are no operational plans, even though rotational distribution was proposed during earlier intervention. Rice is the main crop in the command area, followed by sugarcane. Sugarcane is grown mostly at the middle and tail end of the canal section, especially in the low lands, where inundation during the monsoon is frequent.

Though the canal is relatively simple to operate, and free from problems like breaching and scouring, several maintenance works are still being deferred.

Asset survey results for minor canal MC- 5

There are total of 30 structures along MC-5. Defects were recorded at 9, Table WG 4.1. Scouring of canal or banks at structure being the most common fault (7 structures). There was no effect on flow, TableWG 4.6. NRs 24,000 is the estimated cost of repair, Table WG 4.1.

Of the total canal length of 2.3km, defects were noted along a total of 2.2km, Table WG 4.3. Significant weed growth is the most common problem, occurring along 1.6km of canal. Flow is restricted in four instances to between 70% and 90% of design flow, Table WG 4.6 NRs 29,000 is the total estimated cost of canal repair. Of this total, NRs 11,000 is estimated to cover the cost of weed clearance.

B1.4.4 Mangharia Minor

This branch canal is about 9.8 Km long and irrigates about 1080 ha of cultivated land. The canal ends in Bhujahawa Village.

The Mangharia Minor is the fourth largest branch canal off-taking from the main canal. Being near to the project office[5] it has comparative advantage in matters relating to system operation as compared to other branch canals. Unlike many other branch canals, it is free from inundation problem. Also, in the areas served by this branch canal, there are no flooding problems.

The canal draws water through a single gated head regulator placed at the left bank of the main canal. The water level at this reach of the main canal is controlled by a cross regulator placed just downstream of this head regulator. Thus, this branch canal receives water even during the period of low flow in the main canal.

The first 1500m of the canal is in cutting and it is in good condition. However, several open cuts in the canal banks were found, mainly for drain inlet. Though this is a temporary arrangement, it may weaken the canal banks in future. There has already been some scouring and canal widening in such open cut areas.

Further downstream of chainage 1500 m, the canal is mostly in filling, varying from 1 to 3 m. In such filling areas the canal has been silted up since many years, which has substantially reduced the flow section. However, no efforts are made to remove the silt.

Scouring of canal banks around structures is common. At one point, for a length of about 10 m, the canal section had breached, but was temporarily repaired. If not maintained properly this section is likely to collapse, jeopardizing irrigation to downstream users. Minor canal breaches were observed at several other locations.

Off-takes to the tertiary or lower order canals are both gated and ungated piped outlets, depending on the size of the off-taking canal. The cheek structures are also of both types, gated and stop log cheek. Spindles of the most of the gates (both cross regular and head regulators) have been twisted, making the gates of limited use. In some cases, gates have been damaged totally or stolen. Almost all of the gated structures need structural improvement.

The remaining structures are in fairly good condition. The parapet walls of all the VRBs are either missing or damaged, but these do not obstruct the system performance. At the tail end of the canal, several open cut were observed. Many of them have multiple functions (drain inlets or canal water out let).

The irrigated area located in the tail end of this branch canal had never received water in this irrigation season. There exits no rules and regulation for water allocation and distribution. Water distribution is highly unclear and non-transparent. During field survey, paddy was cultivated in about 70 per cent of the

[5] The canal off-takes just in front of the project office.

irrigated area served by this branch canal, and the rest of the area was under sugarcane. Usually, wheat is grown in about 40 per cent of the command area.

Asset survey results for Mangharia Minor

Defects were found at 49 of the 79 structures along the 8.7km long Mangharia Minor. 18 of these defects were cases of scouring of the canal or banks around the structures. 16 were defective or faulty gates and 9 were missing gates, Table WG 4.1. None of the structures were deemed to have an adverse effect on flow. To repair the structures, NRs 538,500 is needed, Table WG 4.

18 sections of canal covering a length of nearly 7km were identified as having a problem, Table WG 4.3. As with the main canal, most of the problems (6km) were attributed to siltation and reduction of freeboard. Flow is affected along 18 sections of canal. 5 cases of flow being restricted to between 50% and 70% of design and 9 cases of flow being reduced to between 70% an 90% of design, Table WG 4.7 The cost of repair is estimated to be NRs 187,500.

B1.4.5 Germi Minor

This branch canal lies at the tail end section of the main canal. The canal is 4.4 km long and irrigates about 190 ha of cultivated land. It draws water from the main canal through a gated off-take combined with a cross regulator. The head regulator gate does not work properly and maintenance is required.

The first 900m length of this branch canal is in deep cut (about 2-3 m deep) and does not provide any irrigation. In order to prevent bank slippage, this portion of the canal is lined with dry boulder up to the canal free board. At a few places, due to loosing of the boulder, lined canal is damaged. From chainage 900 m onward, the canal is earthen in a trapezoidal section. The entire length of the canal has been silted up for a depth of about 25cm.

Heavy bushes growing on the canal banks (between chainage 2450 and 3000 m) have made walking along the banks almost impossible. Except at the tail end, where the canal section is severally damaged, rest of the canal is fairly in good condition. The canal ends at Germa Village at the Indo-Nepal border.

At a few places, especially in those areas where cross drainage structures are lacking, canal breaches were observed. These open cuts function as drain inlets. Thus, the canal needs a few additional cross drainage structures in order to avoid direct drain inlet into the canal system.

Most of the off-takes are piped out let and cheek structures are of cross regulators using manually adjustable steel gates. However, gates are missing in most of these cross- regulators.

Most of the field channels are already destroyed. As a result, in most of areas, field to field irrigation is practice. The number of open cuts in the canal bank has increased owing to the lack of lower order canals (tertiary and field channels). Many of these open cuts have multiple functions (drain inlet and canal water outlet)

As this branch canal is located at the tail end of the main canal, water rarely arrives here. The situation is further aggravated due to heavy silt deposited in the main canal. As a result, it is almost impossible to get required amount of water to the tail end of this branch canal (Germi Minor). However, the standing crop of paddy seems to be good. It is mainly due to good monsoon.

Rice is the predominant crop grown in the area followed by wheat. Unlike in other branch canals, sugarcane is not popular here.

Asset survey results for Germi Minor

Of the 42 structures on Germi Minor, 14 had defects, Table WG 4.1. The most common defect is scouring of the canal section or banks around a structure. The total cost of repair to structures is estimated at NRs 120,500.

Defects to the canal bed and banks were noted in 24 locations along the 4km long canal, Table Wg 4.2, affecting about 6.5km of bed or bank. Flow is restricted to between 50% and 70% in 5 location and between 70% and 90% in 9 locations, Table WG 4.7. The estimated cost to repair the canal is NRs 121,500.

B1.4.6 Summary of asset survey at West Gandak

A summary of the asset survey results is given in Table B 10. The costs shown in the table represent the total required to bring the canals and structures to a fully functioning condition.

Table B10. Asset survey at West Gandak

	Main	MC5	MM	GM
Canal length (km)	32.8	2.3	8.7	4.07
Canal command area (ha)	8,700	65	1,080	190
No. structures	187	30	79	42
No. structures per km	5.7	13.0	9.1	10.3
No. structures per 100 ha	2.1	46.2	7.3	22.1
% defective	36%	30%	62%	33%
Cost of required maintenance (NRs)	3,495,000	24,000	538,500	120,500
Cost of required maintenance per ha	402	369	499	634
% canal length defective	104%	95%	80%	158%
Cost of required maintenance	1,284,000	29,000	187,500	121,500
Cost of required maintenance per ha	148	446	174	639
Total cost per ha	550	815	673	1,273

B1.4.7 Farmers' assessments

Water Supply

55% of farmers are of the opinion that they receive enough water and at the right time during the monsoon. 28% feel that they don't receive enough water at this time and 17% reported that they only sometimes received enough water. There is a similarly mixed experience in the winter, although a majority of farmers (45%) agree that they do not receive enough water or that it comes at the right time. 30% say that they do enough water whilst 25% said that they only sometimes receive enough water. No farmers receive water in the spring. The main reasons given by farmers for a poor water supply are bad control or operation (78% in monsoon, 72% in winter and 18 out of 32 respondents in spring) and the poor condition of the main system (38% in monsoon and 34% in winter).

Farmers believe the supply is slightly worse now than it was five years ago (21% the same, 43% slightly worse and 31% worse). Operation of the main system is in the farmers opinion also slightly worse (12% the same, 57% slightly worse and 30% worse). 74% of farmers agree that the current main system operation is poor, only 21% say that it is acceptable and 0% say that it is good.

A majority of farmers agree that the water distribution between and along branch canals is not fair (74% unfair, 13% fair distribution between branch canals and 73% unfair, 18% fair distribution along branch canals). A majority (52%) say it is easy to arrange water supply to their farms (10% sometimes difficult, 35% difficult).

Condition of canals and structures

Farmers believe that the condition of canals and structures is generally poor. 28% of farmers think that the main canal is in reasonable condition and whereas 78% think that it is in a poor condition. 26% think that the branch/ distributary canals are in reasonable condition and 74% say that they are in a poor condition. The opinion of the condition of the tertiary/ field channels is less clear (38% reasonable, 43% poor, 19% don't know). Farmers are reasonably unified in the opinion that the whole system has deteriorated over the last five years (main system – 0% better now, 24% the same, 76% worse now, secondary system – 0% better now, 19% the same, 81% worse now, tertiary system 0% better now, 30% the same, 52% worse now).

Maintenance

100% of farmers are unclear about maintenance responsibilities. All respondents stated that they don't know who is responsible for regular maintenance of the main canal structures or secondary canal structures. However, if structures are damaged, 70% of farmers think that Department of Irrigation is responsible for repairing main system structures and 55% think that the water users association is responsible for secondary canal structures.

On the main canal system 68% of farmers agree that Department of Irrigation are responsible for desilting. 65% think that the water users association is responsible for secondary canal desilting. Opinions on the responsibility for desilting of tertiary canals were less clear cut, although no respondent thought it was a Department of Irrigation responsibility (46% water users association 19% other, 37% don't know). 59% of farmers helped to desilt secondary, 64% field channels and 12% helped to desilt the main canal. The average number of days given to this activity was two. Most farmers (78%) didn't help with any other maintenance tasks apart from desilting last year. The majority (77%) agreed that all farmers contribute similar amounts of labour for maintenance tasks. On the other hand, 80% of farmers felt that inadequate maintenance was carried out last year and 81% of farmers thought that there was a problem with quality of the maintenance.

B2 Studies in Gujarat

Climate
The north western part of the state is dry, with less than 500 mm rain a year. In the southern part of Gujarat, rainfall averages 2000 mm a year. In winter temperature average between 12° and 27° C, although freezing levels have been recorded in the state. In the summer temperatures average between 25° and 43° C and have been known to reach as high as 48° C.

B2.1 Dharoi Irrigation Scheme, Gujarat

Background
Dharoi Irrigation Scheme is located in Mehsana District in the North East of the state of Gujarat. The nearest city and District Headquarters, Mehsana is located 15 km south-west of the scheme. Visnagar, the Taluka headquarters, is located centrally within the scheme.

The dam was completed in 1978 with irrigation commencing in 1980. Although the right bank canal system was designed to irrigate 45,550 ha, a maximum of 40,000 has been achieved so far. The main canal currently serves Kheralu, Vijapur, Visnagar, Mehsana and Siddhpur Talukas but plans for a significantly extended command area are under way.

In 1994 the government of Gujarat selected 13 pilot projects as learning laboratories of participatory irrigation management in different agro-climatic regions of the state. Thalota irrigation co-operative society was such a pilot project. Irrigation turnover is now taking place on a village by village basis, as other farmers are encouraged to form a society like that in Thalota. Out of a total of 120 villages, five water users associations have been formed with a further 20 currently in the process of turnover.

All the water users associations visited in Dharoi scheme have involvement from the Non-Government Organisation DSC.

The Sabarmati River provides the main source. The dam across the river provides a gross storage capacity of 907.84 M.m^3.

The main canal serves three secondary canals

Cropping pattern
There is a great diversification of crops grown on the scheme. Average yields for each crop vary widely. Selection of crops and success in growth is dependent on factors such as water availability, local market conditions and existence and leadership of water users association. Crops include: millet/sorghum, cotton, castor, pulses (kharif); wheat, mustard, cotton, castor, fodder (rabi); millet/sorghum, fodder (summer).

Operation and maintenance
The Government operates the main canal, dam and headworks. Operation of lower order canals depends on the stage of turnover. Four villages were visited, in varying stages of turnover:

- Rangpur – Middle / tail end
  Rangpur village is in the process of turnover. Irrigation takes place in the winter and summer seasons only and not in kharif. The farmers submit individual requests for irrigation to the society according to crop being grown and on what area. The society may limit the area according to water availability. The society has had no need to carry out any maintenance to date, due to the fact that rehabilitation is ongoing and there has been no water for the last two years.

- Thalota - Middle / tail end
  The participatory irrigation management process is complete in the village of Thalota. The irrigation schedule is drawn up by the society, based on the request for water by society members, balanced

against the availability of water advised by the government. The government supplies the water on an area basis. Four to five gatekeepers are employed to operate the schedule according to the timetable. A ramp flume is used to measure actual volumes of water and the farmers agree with the approximate values calculated. The society has a discipline committee to take care of abusers of the system. If a farmer is found to be at fault then the water supply will be stopped and a fine will be imposed. Before participatory irrigation management there were an estimated 21 illegal offtakes along one of the minors. There are now only five official offtakes. The system isn't totally equitable due to the fact that head end farmers take too much water. The capacity of the canal also limits the flow to the downstream users.

The 20% rebate received for administration is deemed to be insufficient. The society therefore plans to raise extra money from additional water fees. The society receives the 30% maintenance rebate and has Rps 14,000 so far in a separate account. It has spent Rps 3000 per year for 2 years on paid labour to carry out de-silting water courses and outlets, grass cutting (canal banks) and weed clearance activities. Due to the high cost of external labour, the society has tried to encourage members to clean field channels but has found farmers reluctant to contribute labour. They would rather pay, even to clean the field channels. It is thought that the government is to provide funds for emergency maintenance, although the division of responsibility is not clear.

- Kiyadar - Middle
  The village is irrigated by two minors fed from branch canal number 2. Minor M8R1 branches off minor M8R at the head. During rehabilitation the society demanded connection of one of the two minors M8R1 directly to the main canal. The society manages the rotation in 12 days. Irrigation takes place on a rotation system from tail to head. The society employs two watchmen to operate and manage the system. The outlets have been fitted with lockable gates as part of the rehabilitation. As yet there has been no experience of conflict but the locks are there as a precaution. The society collects all the farmers' water requests and present them to the government.

  Prior to participatory irrigation management the allocation of maintenance budget from the government was on the basis of area irrigated. Since there was little to no irrigation, there was no maintenance. The society now has only Rps 5000 in reserve for emergency maintenance. After they begin to irrigate, following completion of the rehabilitation they society plan to increase fees and have up to Rps 1 lakh in reserve.

- Dedeshan – Head end
  The participatory irrigation management process has just begun in the village of Dedeshan. The government is currently in charge of all operation. The village has had a limited supply of irrigation water since construction of the scheme. This is due to a problem with canal levels at the offtake from the main canal. The problem is compounded by seepage from the minor due to poor quality brick and tile lining.

  The government repairs the minor canals but the farmers have been responsible for maintenance of sub-minors and field channels. There are some problems with the outlets and seepage in the sub-minor canals.

B2.2 Guhai Irrigation Scheme, Gujarat

Background

Guhai Reservoir Project is situated in Sabarkantha District of Gujarat. The nearest city and district headquarters, Himatnagar is located to the east of the scheme. The mean annual rainfall is 931mm.

Irrigation commenced in 1993. The system was designed to irrigate a command of 7100 ha but currently achieves a total irrigation of 5800ha over one year. A number of minor canals are in the process of

participatory irrigation management since about 1997 but the main system and remaining minors are still under government control.

The headworks consist of a 800 m long earthen dam constructed across the Guhai river. The reservoir behind the dam has a live storage of 57.04 Mm^3. There is an 88 m long spillway and six gates to pass floods. The right bank main canal serving the area has a capacity of 4.98 m^3/s.
Of the 38 km lined, main canal, the first 17km of the main canal is a contour canal, with the command to the left and the last 21 km of the canal is on a ridge. Due to the steeply sloping command area, underground pipes supply the water at the tertiary level. Black cotton soil has tended to move and lift pipes and lining across the scheme leading to heavy seepage and waterlogged areas.

Cropping pattern
Principal crops are paddy rice, maize, groundnut and pulses (kharif); wheat, mustard, cumin and forage grass (rabi); HY cotton, castor, vegetables and minor crops in summer.

Operation and maintenance

Hapa canal– Middle / tail end
Before participatory irrigation management, the government on-supply system of water distribution was set up so that water flowed continuously by proportional division into all 5water courses. After participatory irrigation management the society decided to switch to "on demand" supply and added gates and broad crested weirs to the water course outlets. They can now control water flow so that each water course is supplied in turn and the amount of water is measured. This ensures a more efficient water supply, especially when there isn't enough water in the main canal for proportional division to work. The society has been able to manage this system of water delivery but doubts whether it would have been so successful if the government had tried something similar before participatory irrigation management.

The water distribution problem in the area is compounded by the existence of about 100 pumps lifting water for irrigation from the main canal. The practice was illegal at first but the government has since given permission.

The society is in the process of changing to volumetric charging. Water has been charged on a crop basis in the past. The society used to collect Rps 110 / ha / season for wheat compared to Rps 7000 / ha / season being charged for tubewell water in places outside the irrigation command.

Parabada Canal
Parabada farmers were dissatisfied with the water delivery and therefore requested participatory irrigation management. Since participatory irrigation management, the water delivery is reported to have improved, although there has been a drought for two years so the rehabilitated system has not been fully tested.

The Parabada society is in charge of 1 minor canal, 5 water courses and 35 turnouts flowing off distributary branch canal, D4 on the Guhai Reservoir Project. The canal is owned by the government and managed by the farmers.

There are 106 irrigators within the Parabada command, of which 70 are society members. A significant proportion of the 36 non-members are from another village. As part of the participatory irrigation management process, the society demanded that the field channels were lined before turnover. The society agreed a 50% contribution and want to negotiate 50% matching funds form the government. The cost of this work is Rs 1500/ ha.

The society takes charge of maintenance and describes it as an improvement on government maintenance. Recent activities include de-silting of canal structures and re-joining pipes. Farmers are asked to contribute to maintenance costs with cash payments. Those who can't afford to pay can give a labour contribution. If

there is no labour contribution, then the society will pay for materials and attempt to get skilled labour from outside.

The society is of the opinion that the amount it receives at present for maintenance is insufficient - the amount of Rs12,000 should be doubled. At present, everyone is reported to pay their water fees and there is no need for sanctions.

No emergency maintenance has been required so far. Society members stated that they would try and do the work themselves but they may ask the government for a contribution. If a major structure such as a bridge collapses, then the government would have to repair it.

B2.3 Pingot Irrigation Scheme (Left Bank Canal)

Background

Pingot Irrigation Scheme is medium sized scheme located in South East Gujarat in the state of Baruch.

The system was completed in 1989 and irrigation on the left bank began in 1990. The left bank has a design command area of 808 ha and serves four villages (The right bank supplies 598ha).

In 1995 a co-operative society was formed with the help of AKRSP(I). The society includes all four villages in the command area. The society is responsible for operation and maintenance of the system from the main canal downwards. The dam and headworks remain the responsibility of the Government

The main source of water for the scheme is the river Tokri. The headworks completed in 1983 consist of an 1.3km earthen dam with an overflow weir and two head regulators serving left and right bank canals. The dam has a live storage of 7.27mcm. The Left Bank Canal is 6km in length and the Right Bank Canal is 4.5km. long.

Cropping pattern

The cropping pattern includes green gram, ground nut, sugar cane, paddy rice and various minor crops.

Operation and maintenance

The Department of Irrigation release water from the dam. The society manage the water from the dam downstream, irrigating on a head to tail basis. No water was received in the left bank canal prior to participatory irrigation management and the rehabilitation works accompanying it. The Department of Irrigation could only offer 2 waterings this year. The society realises that it is too little to be of use and have written to the Department of Irrigation to request that the water be kept back solely for drinking and cattle watering.

The society employs 4 gatekeepers. Before the advent of participatory irrigation management, the government employed 10-15 gatekeepers. The scheme was originally designed to irrigate areas of 40ha for each outlet. During rehabilitation it was converted to irrigate 8 ha units through the construction of extra pipe outlets. The aim was to make the scheme easier to manage by having fewer farmers per outlet. The system was reported to have reduced the amount of wastage water and reduced the maintenance cost.

There were reports that head farmers are taking too much water and therefore creating shortage at the tail. This is in part due to scheme design and the fact the head farmers have to block the main canal and "head up" to allow flow to minors.

The Department of Irrigation is responsible for the maintenance of the main canal and the society are responsible for the minors. The Department has carried out de-silting once, otherwise the farmers have done it themselves. Maintenance work on minors is carried out by the farmers themselves and paid for by the society. There is very little voluntary labour contribution. The society has received no maintenance training but agreed that it would be useful. To date, the society has carried out canal breach repair, de-

silting, erosion repair. The erosion is due to cattle and people for want of canal crossings. AKRSP(I) have provided technical supervision, in particular for a repair carried out last year.

The society receives the maintenance rebate of 30% from the Department of Irrigation but states that it is not enough for the tasks that need doing.

The Department of Irrigation has carried out de-silting, jungle cutting and fixing of pipe joints on the main canal. The siphons and pipelines are susceptible to cracking caused by crabs which get into the joints and open them up. According to the Department of Irrigation engineer, the society lets the government clean the siphons as this job is considered "dirty work" which farmers are not prepared to tackle.

Some illegal offtakes from a watercourse have damaged the watercourse lining. The society stated that the farmer responsible would be fined during a watering but not otherwise, even though the damage has already been done.

Emergency maintenance has been carried out by the society when the main canal suffered a breach. The society paid a sum of Rs.10,000 to get the repairs done immediately. The Department of Irrigation agreed to pay for the works but it took three months to pass through the bureaucracy to obtain Rps. 8,000. The Department of Irrigation also failed to provide any construction advice or support at the time of the repairs.

B2.4 Issar Irrigation Scheme, Gujarat

Background

The Issar scheme is situated in Mandvi block of Surat district, 15km from the block headquarters, Mandvi.

An earth dam was constructed in 1977 but an irrigated area of only 50ha was possible until rehabilitation. In 1995 AKRSP(I) became community organisers after requests by farmers. It is currently overseeing rehabilitation of the scheme and assisting the irrigation co-operative society. The society took charge of water distribution in 1996-7 but is still awaiting confirmation of its status under a Memorandum of Understanding with Government. The society has now achieved an irrigable area of 164ha out of possible maximum of 354ha which it hopes to extend as rehabilitation proceeds.

Operation and maintenance

Since participatory irrigation management, the society have decided to alter the operation of the scheme in an attempt to best utilise the amount of water supplied and take into account the irregularity of supply. The society employs 2 watchmen to manage the irrigation. There are three minor canals which are supplied with water in rotation. Each minor receives water for 15 days in turn. Irrigation along the minor takes place from the head to the tail. Two outlets, supplying 12 to 15 farmers are open at a time. There are on average 6 farmers per field channel and no water courses.

The gate at the intake does not shut properly at present so there is difficulty in enforcing water rotation. Farmers in the head reach of the main canal pay the society to lift water from the canal with diesel pumps. The irrigation department supplied the pumps free of charge in 1998 following a request from the society. There is one pump for per group of 9 to 10 farmers. The farmers pay 50% of the society's water charge for this pumped water and the society allocates pumping time and duration. These head end farmers were the only group currently irrigating with scheme water as they are able to make use of the dam leakage water.

Allocation of water is carried out efficiently. Farmers fill in water demand forms based on crop choice, area and number of waterings. The society provides a summary to Department of Irrigation as a request for water from the dam. A copy of the forms is given to the gate operators who can then control supply according to allocation. If there is insufficient water, then certain crops such as groundnut are not permitted. Any further deficit must be made up by the farmers themselves from other sources. In order to ensure that farmers grow what they have stated, the society visits each farm, at the end of each season. The society has found that there is rarely any deviation from the water allocation forms.

In the past, the society has carried out repair of siphons and outlets with large crack or broken joints. A 10% contribution was paid to the society based on the number of beneficiaries downstream of the affected structure or reach.

The Department of Irrigation carries out desilting and grass cutting once per year. Gate greasing and maintenance of the field channels are the responsibility of the society. The Department of Irrigation refused to let the society carry out maintenance tasks until the MOU had been signed. The society prefers to do the maintenance itself because it can employ society members to do the tasks, the tasks are more likely to be carried out in time and it can supervise more easily and ensure quality construction.

B2.5 Lakigam Irrigation Scheme, Gujarat

Background

The Lakigam Irrigation Scheme is located in the Surat District in the south of Gujarat State. It is 45km from the block headquarters at Mandvi.

The scheme was completed in 1982, but due an iicomplete distribution system until 1993 it was only possible to irrigate 25-30ha with water leaking from the dam from the dam. After rehabilitation 125ha are irrigable out of a total command of 350ha. Leakage of the earth dam is still a problem

In 1994 an irrigation society was formed with AKRSP(I) involved as community organisers. Irrigation serves four villages.

The main water source for the scheme is the Dhakni river. The reservoir is formed by an earth dam with a short concrete spillway. Leakage is thought to occur around the walls of the spillway.

The distribution system comprises 6.2km Left Bank Main Canal with five minors of total length 4.66km.

Operation and maintenance

The irrigation department is now responsible for releasing water into the main canal. The society then manages the operation from this point. Since water is short, the society has chosen to open the minor canals in rotation, opening two minors at a time for three days each. There are a total of 5 minor canals four of which receive irrigation though the 4th minor generally receives less water. There are three to four outlets per minor canal each serving 4 to 5 farmers. In addition, there are extra outlets directly off the main canal. A total of 125 ha is being irrigated since the advent of participatory irrigation management. The greater part of the irrigated area is at the head of the first two minors. Minor 1 serves 30%, and Minor 2 some 20%, of the area currently irrigated.

The Department of Irrigation has agreed to supply irrigation water up to the 15 March as the dam was designed for irrigating kharif and rabi crops only. The society would like greater flexibility. At present there are no irrigation request forms for the farmers. Water demand is agreed informally with the society, up to a maximum of 5 waterings. The society does not have any idea of crops grown per area irrigated. It reports equitable distribution of water except for head end farmers who receive oneextra irrigation at the end of a season, when reservoir levels are low.

The right bank scheme is the same size as the left bank. There is more irrigated land on the right bank, since most of the water leaking from the dam is collected by the right bank canal.

The main canal is in good condition, showing minor leakage at a few of the structures. The main canal and all the minors are lined. The minors are also in good condition. The major problem is continuing leakage through the earth dam around the spillway wall. Some grouting has been carried out in the past with little effect. The society has commissioned its own study. A value of Rps 17 lakh was put on the repair cost.

A Memorandum of Understanding with Government has been signed but the society does not yet receive the 30% rebate for maintenance. Government carries out repairs on the main canal and the society is responsible for everything at and below minor canal level. The society organised de-silting and cutting activities one year, having raised money for the maintenance itself. Farmers did the work themselves but were paid by the society. Maintenance of the minor canals has been carried out using paid labour. During the rehabilitation work, the farmers kept half of their wage and gave the other half to the society.

Emergency maintenance has been carried out by the society on one occasion. Following a breach in the main canal, the society opted to raise Rps 30,000 and carry out repairs themselves, rather than inform the Department of Irrigation and wait for action. The society described an informal system, where the Department of Irrigation is informed of a problem and the society then waits to see if there is likely to be any action. If the Department of Irrigation refuses to carry out the work or will take too long before starting work then the society will assume responsibility.

Smaller canals are also breached but are repaired immediately by the farmers affected.

B2.6 Chopadvav Irrigation Scheme, Gujarat

Background

Chopadvav Irrigation Scheme is located in the Sagbara Taluka of Baruch District. It is 50km from the town of Netrang.

The main water source for the scheme is the river Doman. The headworks consist of an earthen dam, spillway and intake. The dam was completed in 1986 but the rest of the canal work was not completed until rehabilitation under participatory irrigation management in 1994. A small number of head end farmers were able to irrigate with leakage water up until then. Participatory irrigation management began in 1993 when AKRSP(I) assisted with the formation of a co-operative society forming.

There are 7.89km of mostly unlined main canal and 38kms of distributaries.

Operation and maintenance

The scheme consists of a main canal, feeding 10 minors. The Department of Irrigation controls the dam and headworks, and releases water into the main canal. The society employs 2 watchmen to operate the main canal. Half the minors receive water at one time for five days, followed by the remaining minors. There is then no irrigation for 10 days before the cycle is repeated. Those minors at the tail of the scheme may get 7 days “on” followed by 3 days “off”.

Each minor canal has a committee, and some outlets have farmer groups. Every farmer requests water by filling in a water allocation form. The leaders of the minor committees agree water distribution with the main society, AKRSP(I) and the Department of Irrigation. The leaders oversee the release of water into their minor with a watchman from the main canal. Co-operation between the minor committees in different villages is said to be good. If farmers on one minor have finished irrigating within the allocated time, they will close their outlet and pass the water on to the next minor committee.

Each minor committee decides on its own system of operation. Small minors tend to operate on a head to tail basis, whilst larger minors operate tail to head. Outlets serve 4-5 farmers and are gated.

The society has developed a disciplinary system and has imposed and collected fines of Rs1000 for tampering with the minor gates and Rps 100 for damaging the canal.

Farmers are responsible for the maintenance of field channels and small repairs, including greasing gate mechanisms, on the minor canals. Government carries out large repairs on the minor canals for which farmers contribute labour. Since1999, the society has carried out de-silting of minors at a total cost of Rs

115,000, significantly more than the 30% maintenance rebate of Rs 20,000 given to societies by Government. Funds accumulated by the society were used to make up the difference.

Government is responsible for all maintenance on the main canal. De-silting of the main canal is carried out once per year and is often a bit late.

In farmers' opinion, the system is deteriorating under the current level of maintenance. They attribute problems to:

- Unlined canals and leaking gates
- Erosion under rainfall on the hilly terrain
- Structures not correctly set to level, leading to water ponding
- Canal bank erosion due to lack of crossings.

The society has therefore prepared an action plan listing specific problems. It has submitted the plan to the Department of Irrigation, without response.

For emergency maintenance, farmers estimate a cost and submit it to Government.

Appendix C

Cropping patterns and intensities – Nepal

Appendix C Cropping patterns and intensities- Nepal

Table C1 shows the cropping patterns and intensities recorded in the farmer survey and those assumed in the CGISP, NISP and ISP reports. The three irrigation units in each scheme are arranged in order of location down the system. For example, at Kankai the S-2 unit is nearest the head.

Table C1 Cropping on schemes in Nepal

Scheme	Branch	Monsoon paddy	Wheat	Wheat mixed [2]	Spring paddy	Maize	Sugarcane	Oilseeds [3]	Pulses [4]	Others	TOTAL
Kankai											
i) Farmer survey data	S-2	89	33	-	78	-	-	1	-	2	203
	S-5	95	38		61	-	-	-	-	-	194
	S-7	85	31	8	48	-	-	-	-	-	172
	Average	90	34	3	62	0	0	0	0	1	190
ii) CGISP [1]		100	38	-	-	28	-	-	-	-	168
Khageri											
	B1	95	46	8	40	43	-	-	-	-	232
	B5	91	47	2	3	24	-	-	-	-	167
	M1	94	25	22	-	67	-	14	-	2	224
	Average	93	39	11	14	45	0	5	0	1	208
Tilawe											
	BS1	97	77	13	-	-	2	-	-	9	198
	BS3	99	93	5	4	-	-	-	-	-	201
	BS5	100	92	-	-	-	-	5	1	-	198
	Average	99	87	6	1	0	1	2	0	3	199
W Gandak											
	MC5	89	67	17	-	2	9	3	-	-	187
	Manjaria	86	80	6	-	1	6	-	-	-	179
	Germi	91	70	18	-	-	-	-	-	2	181
	Average	89	72	14	0	1	5	1	0	1	182
CGISP Overall	Irrigated	82	42	-	26	10	6	8	8	3	185
NISP	w/o project	100 [4]	40	-	10	10	-	15	12	10	97
	with proj.	80 [4]	20	-	-	-		10	10	15	55

[1] Survey for shallow tubewell project at Sharnamati, Jhapa

[2] In the farmer survey wheat was recorded as being grown mixed with a wide variety of crops, mainly pulses and oilseeds.

[3] Oilseeds and pulses receive little irrigation and are often grown on residual moisture and rainfall alone.

[4] With Project, 80% HYV, 20%LV, without project 40% HYV 40% LV

Source: Farmer survey unless otherwise stated
CGISP Sharnamati, Jhapa, STW (June 1997)
NISP Data for "major tarai schemes" from mid term review May 2000

Cropping intensities on all four schemes are high, with more or less full double cropping except in West Gandak and one of the three sample irrigation units in each of Kankai and Khageri. However, the survey only covered a single year and this did not detect the annual rotation of winter irrigation supplies at Kankai, where double-cropping of paddy is only possible in alternate years. As would be expected, the land is almost fully cropped with paddy in the monsoon. Based on information from the group interviews, at Tilawe the monsoon paddy crop is largely HYVs, Mansouli being the most popular. On the Manjaria Branch of West Gandak , local varieties (LVs) are dominant, whereas on MC5 HYVs are more popular and on Germi Minor both HYVs and LVs are grown.

The rice season is earlier at West Gandak than at Tilawe. At the time of the group interviews, between 4th and 8th November 2000, the rice harvest had been virtually completed at West Gandak but was still in full swing at Tilawe. An earlier monsoon rice harvest is beneficial for the following rabi crops, especially wheat, the yield of which is reduced if planting takes place after November. The reason for the earlier rice transplanting at West Gandak is presumably that irrigation water is more available there before and during the early stages of the monsoon than is the case at Tilawe, which is dependent on supplies from a poorly maintained canal running through India.

Other points concerning cropping patterns are as follows:

- There is a rotation managed by Department of Irrigation at Kankai, under which each half of the system is given water in alternate dry seasons.
- There is no system of rotation at Khageri, between branches and thus spring paddy is always grown only at the head of the system. This includes the sample canal B1 but not the other two sample units which are in the middle and tail.
- The cropping system is dominated by paddy and wheat. Wheat normally receives one or two irrigations, the rest of its moisture requirements being met from residual moisture and rainfall. Wheat is sometimes grown mixed with other crops such as pulses. Many farmers consider wheat to be a unprofitable crop - the yields are well below those of paddy yet its price is similar and its input requirements are substantial. Sugarcane is important in West Gandak, where there are sugar factories nearby. Much of its irrigation supplies there comes from farmers' shallow tubewells rather than the canal system, due to the annual closure in March-April, when the crop water demand is high. Maize is important at Khageri, probably due to water shortage, although it is also a popular crop amongst hill migrants who are dominant at Khageri

With the already high cropping intensities, there is limited scope for further intensification if the irrigation service were to be improved. As discussed previously, the main effect of any such improvement would be on crop yields and, possibly, a change in crop types including an increase in the acreage of spring paddy and (in the case of Khageri) a switch from maize to paddy. Spring rice is an attractive crop but few farmers can grow it because of irrigation supply constraints (although there are also problems with harvesting and quality control during the monsoon).

Crop yields

Table C2 shows the irrigated crop yields recorded from the farmer survey and from the group interviews at Tilawe and West Gandak and, for comparison purposes, those assumed in the CGISP, NISP and ISP reports. Monsoon paddy yields on the four schemes appear to be broadly in the 2-3 t/ha range, with rather higher yields in Khageri. Comparison with both the farmer survey results and the three project reports suggests that the yields quoted in some of the group interviews may be on the high side. In the one scheme where it is grown on any scale, Kankai, the spring paddy yield (2.66 t/ha) is not much above the monsoon paddy yield (2.33 t/ha), despite the higher yield potential of the spring crop. Irrigation supply constraints may hold down yields. Water availability at Kankai is limited during this season, as demonstrated by the annual canal rotation system which has had to be adopted.

Table C2 Irrigated crop yields

Scheme	Branch	Monsoon paddy	Wheat	Spring paddy	Sugarcane	Oilseeds [2]	Pulses [2]	Maize
Kankai								
i) Farmer Survey data	S-2	2.90	2.40	2.80	-	-	-	-
	S-5	2.20	2.90	2.80	-	-	-	-
	S-7	1.80	1.90	2.40	-	-	-	-
	Average	2.30	2.40	2.70	-	-	-	-
ii) CGISP [1]		2.70	2.50	-	-	-	-	-
Khageri								
Farmer survey data								
	B1	3.70	2.30	-	-	-	-	-
	B5	3.10	1.90	-	-	-	-	-
	M1	2.60	2.00	-	-	-	-	-
	Average	3.10	2.10	-	-	-	-	-
Tilawe								
i) Farmer survey data	BS1	2.90	1.60	-	-	-	-	-
	BS3	2.60	1.30	-	-	-	-	-
	BS5	3.00	1.80	-	-	-	-	-
	Average	2.80	1.60	-	-	-	-	-
ii) Group interviews	BS1	3.00	1.60	-	-	-	-	-
	BS3	3.80	1.30	-	-	-	0.40	-
	BS5	3.20	2.40	5.90	-	-	-	-
	Average	3.30	1.80	-	-	-	-	-
West Gandak								
i) Farmer survey data	MC5	2.40	1.10		-	-	-	-
	Manjaria	1.80	1.00		-	-	-	-
	Germi	2.80	3.30		-	-	-	-
	Average	2.30	1.80	-	-	-	-	-
ii) Group interviews	MC5	4.40	2.70	-	56.25	-	-	-
	Manjeria	2.40	1.30	-	51.80	0.30	0.30	-
	Germi	3.30	2.60	-	51.80	0.70	-	-
	Average	3.40	2.20	-	53.30	0.50	-	-
CGISP Overall		2.60	1.60	2.75	25.00	0.60	0.50	1.90
NISP	w/o project	1.90	1.20	-	-	0.50	0.40	1.50
	with project	2.90	2.00	2.20	-	0.90	1.00	2.50
ISP [2]	w/o project	2.40	1.70	-	-	-	-	-
	with project	2.70	1.90	-	-	-	-	-

[1] CGISP for Sharnamati, Jhapa

[2] ISP PCR Jan 99 Rehab tarai project

[3] Oilseeds and pulses are often grown on residual moisture and rainfall

In the group interviews farmers were asked what the yield difference is between irrigated and unirrigated monsoon paddy in average years. In many places this question could not be answered, because all the paddy in the vicinity is irrigated and other crops are grown on unirrigated land. Where it could be answered, the consensus was that unirrigated paddy yields would be somewhere between 25% and 50% below irrigated yields. During discussions at the Central Region Agricultural Research Station at Parwanipur it was considered that the average monsoon paddy yield benefit from irrigation could be 0.5

t/ha or somewhat more. In good rainfall years there would be little benefit but in drought years the benefit would be very substantial. A reasonable assumption would be that, if the irrigated yield is between 2 t/ha and 3 t/ha (see above), the unirrigated yield would be 25%, or 0.5 – 0.75 t/ha, lower.

Wheat yields are in the 2.0 – 2.5 t/ha range in Kankai and Khageri but rather lower in Tilawe and West Gandak. The 1.0 – 1.1 t/ha yields reported for the MC5 and Manjeria Branch units in the West Gandak farmer survey seem low, although the yields of 2.6 and 1.3 t/ha, reported from the survey and group interviews appear to be more reasonable. Although wheat generally receives only one or two irrigations, the yield benefit was considered by some farmers to be high, with unirrigated yields up to 50% below irrigated yields. With the very limited winter rainfall this is certainly believable. For analysis purposes it would be reasonable to assume that, on average, unirrigated wheat yields in these schemes are 33% below those with irrigation.

Crop and input prices

Data on crop and input prices were collected for crop budgeting purposes and are shown in Tables C3 and C4. Up-to-date price statistics from the Department of Agriculture's Marketing Development Division were kindly provided by the NISP Consultants in November 2000.

Table C3 Crop prices

Scheme/data source	Monsoon paddy	Wheat	Oilseeds	Pulses	Sugarcane	Maize
Kankai						
Farmer survey	8.40	9.00	-	-	-	-
CGISP 1996 data	7.50	6.50				
Khageri						
Farmer survey	11.20	9.20	-	-	-	-
Tilawe						
Farmer survey	9.50	8.20	-	-	-	-
RRA group interviews						
1999	9.30	-	-	-	-	-
2000	6.50	7.50	14.00	18.00	-	-
West Gandak						
Farmer survey	8.80	8.40	-	-	-	-
RRA group interviews						
1999	10.20	-	-	-	-	-
2000	5.60	7.10	-	22.00	1.20	-
CGISP Overall 1996	7.20	6.60	20.50	20.00	1.00	5.00
NISP MTR May 2000	8.00	9.00	20.00	24.00	-	8.50
Irrigation Sector Project						
PCR, January 1999	7.50	7.50	-	-	-	-
Data from NISP						
Wholesale prices, 1999/00	9.30	10.10	25.40	26.80	-	8.90
Wholesale price Nov. 2000	6.40	-	-	-	-	-

Notes: Farmer survey price estimates obtained from less than five farmers are excluded.
These were the prices reported in early November, during the harvest period.

Paddy farm-gate prices between 1996 (the date of the CGISP estimates) and 1999 were in the NRs 7 – 9 / kg range but have fallen substantially in the current (2000) harvest season, to around NRs 6 / kg (the November 2000 price in Table 4.A.4 is a wholesale market rather than farm-gate price). The 2000 monsoon was a good one and rice output in the region has been correspondingly high and rice prices correspondingly low. For analysis purposes the current low prices have been assumed to be a temporary phenomenon, the "normal" farm-gate price of paddy being taken to be NRs 8/kg.

Other crop farm-gate prices have been taken to be as follows:

Crop	NRs/kg
Wheat	8.00
Oilseeds (mustard)	20.00
Pulses	22.00
Maize	8.00
Sugarcane	1.17

Table C4 Input prices

Scheme	Hired labour per day		Fertilisers (1)			Tractor (hour)	Wheat thresh-ing (%)	STW pump hour	Diesel fuel (l)
	Male	Female	Urea	DAP	MOP				
Kankai									
CGISP 1996 data	70	40	7.50	18.00	9.50	-	-	70.00	15.00
Tilawe									
RRA group interviews	60 (1)	-	9.50	20.50	11.00	375	-	100.00	-
West Gandak									
RRA group interviews	55 (2)	55 (2)	11.00	22.00	-	400	-	85.00	27.50
CGISP overall	58	45	7.20	17.30	8.90	250	10% (3)	60.00	14.50
NISP	70	-	11.00	22.00	12.00	-	-	-	-
ISP	70	-	8.50	19.00	9.00	-	-	-	-

Notes: (1) Food not provided
(2) Plus food provided
(3) Percent of crop output. The threshing is by machine.

The most notable feature of the input prices in Table C4 is the marked increase in diesel fuel prices, to over NRs 27/l. This is a result of the rise in world oil prices over the past two years, to the highest levels seen since the mid-1980s. It is impossible to predict whether these high oil prices will continue in the future or will fall back to the lower levels prevailing up to 1998. Their main direct impact on the farming sector is the increased cost of tractor and irrigation pumping. All wheat threshing and most land preparation and crop transport in the schemes is now done by machine. By international standards the present tractor hire charges of NRs 350-400/hour are very low and are certain to increase if the high diesel fuel prices persist. Given the uncertainty regarding future fuel prices, however, a NRs 400 / hour tractor hire rate has been assumed. Other input farm-gate prices have been taken to be as follows:

	NRs
Hired labour	70/day
Fertilisers:	
Urea	11/kg
DAP (Diammonium phosphate)	22/kg
Muriate of potash	12/kg

Other agricultural information from the field surveys

Table C5 shows the information obtained on agricultural problems and constraints and on land prices. Inadequacy of irrigation supply, including timeliness and reliability as well as quantity, is generally regarded by farmers as their greatest problem. The other most common complaint was about the quality of inputs, especially fertilisers. Adulteration of fertilisers is widespread. The adverse agricultural "terms of trade" (the relationship between input prices and output prices) was the other major complaint, as would be expected with the recent fall in paddy prices.

Table C5 Agricultural problems and constraints

Item	Kankai	Khageri	Tilawe	W Gandak
Most serious constraints				
(a) Survey				
- Irrigation supply	37	31	15	8
- Agricultural inputs, credit	63	4	2	7
- Irrigation and inputs	-	65	83	85
- Total	100	100	100	100
(b) Group Interviews	-	-	Irrigation Prices Quality Capital	Irrigation Prices
Agricultural land prices reported in group interviews (NRs 000/ha)				
- Irrigated	-	-	600	450-600
- Non-irrigated	-	-	450	300
Labour-days per farmer contribution for canal maintenance	?	5	12	4

Relative prices of irrigated and unirrigated land can provide a good indication of the real economic value of irrigation. In principle, the greater the incremental value of irrigated crop output vis-à-vis unirrigated crop output, the greater will be the percentage difference between the market prices of irrigated and unirrigated land. In the group interviews an attempt was therefore made to obtain land price estimates, but with limited success. In many cases there was little unirrigated land in the vicinity of the villages where the interviews were conducted. The limited data obtained indicated that the price premium for land with irrigation is between 33% and 100%, but the sample was too small to enable any firm estimate to be made.

Irrigated and unirrigated crop net returns

Based on the input and output figures discussed in the preceding sections, an assessment has been made of the incremental returns per hectare from irrigation on the four schemes. This is an unavoidably approximate estimate, because of uncertainties concerning average crop yields and the differences in cropping patterns and yields between irrigated and unirrigated conditions. For analysis purposes the following assumptions have been made:

- Despite its higher yield potential, the yield data for Kankai in Table C2 indicate that spring paddy yields there are not much higher than those of wheat. With the similar prices for paddy and wheat, the net returns from spring paddy could be assumed to be similar to those of wheat. This is clearly an over-simplification since spring paddy is a strongly preferred crop, but it is sufficiently accurate for the present analysis. The spring paddy crop areas have therefore been valued as though they were wheat. Comparison of the cropping patterns on the four schemes (Table C1) indicates that, where spring paddy is grown, it is largely at the expense of wheat.

- Maize is assumed to be largely rainfed and has been excluded from the analysis.

- Since the areas of oilseeds, pulses and "other crops" are relatively small and at least some of these crops receive little or no irrigation, they have also been excluded. Sugarcane has been excluded because in West Gandak, the main scheme where it is grown, much of its irrigation comes from private STWs rather than canal water. In this analysis the aim is to assess farmers' capacity to pay for the canal irrigation system operation and maintenance; STW irrigation is outside the analysis.

- The benefits of irrigation are assumed to comprise the increase in monsoon paddy and wheat yields over those under unirrigated conditions. Unirrigated yields of monsoon paddy and wheat have been taken to be 25% and 33% respectively below irrigated yields.

Table C6 Cropping and Yield Assumptions made for the Farmer Income and Payment Capacity Analysis

	Kankai	Khageri	Tilawe	WGandak
Irrigated Crop Areas (% of farm area)				
Monsoon paddy	90	95	100	90
Wheat (including spring paddy area)	50	65	95	85
Crop Yields				
Monsoon paddy:				
- Irrigated	2.6	3.1	3.0	2.7
- Unirrigated	2.0	2.4	2.3	2.0
Wheat				
- Irrigated	2.4	2.1	1.7	2.0
- Rainfed	1.6	1.4	1.2	1.3

Source: Tables C1 and C2 with appropriate rounding and adjustments

Tables C7 to C10 show the scheme-by-scheme paddy and wheat crop budgets formulated on the basis of the above yields. Based on the resultant crop returns, Table C11 then shows the estimated incremental net financial returns (benefits) per hectare that the average farmer on each scheme obtained from irrigation.

Table C7 Monsoon paddy and wheat costs and returns at Kankai (NRs/ha at 2000 financial prices)

Item	Unit	PADDY					WHEAT				
		Price	Unirrigated		Irrigated		Price	Unirrigated		Irrigated	
			Quan.	Value	Quan.	Value		Quan.	Value	Quan.	Value
Gross returns											
- Grain	tonne	8,000	2.00	16,000	2.60	20,800	9,000	1.60	14,400	2.40	21,600
- Straw	"	800	2.20	1,760	2.86	2,288	400	1.60	640	2.40	960
Total				17,760		23,088			15,040		22,560
Costs of production [1]											
Seed	kg	12	50	600	50	600	13.5	110	1,485	130	1,755
Fertiliser:											
- Urea	kg	11	30	330	40	440	11	35	385	60	660
- DAP	kg	22	10	220	15	330	22	10	220	35	770
- Muriate of Potash	kg	12	0	0	0	0	12	0	0	0	0
Manure	tonne	500	1.5	750	1.8	900	500	1	500	1.5	750
Agro-chemicals	NRs/ha			0		100			0		0
Labour:											
- Total input	adult-days	-	120	0	137	0	-	90	0	108	0
- Hired labour	kg	70	30	2,100	40	2,800	70	20	1,400	29	2,030
Farm power:											
- Ox-pair days	days	150	18	2,700	20	3,000	150	14	2,100	17	2,550
- Tractor costs	NRs/ha			2,250		2,500			2,500		2,500
Wheat threshing [2]	NRs/ha								1,440		2,160
Interest on working capital [3]	NRs/ha			537		640			602		791
Miscellaneous costs [4]	NRs/ha			895		1,067			1,003		1,318
Total Costs				10,382		12,377			11,635		15,283
Net returns per ha				7,378		10,711			3,405		7,277
Net returns per family labour-day				82		110			49		92

Notes: [1] Excluding scheme irrigation charges
[2] 10% of grain output
[3] 12% on the above financial costs over 6 months
[4] 10% of the financial costs

Table C8 Monsoon paddy and wheat costs and returns at Khageri (NRs/ha at 2000 financial prices)

Item	Unit	PADDY					WHEAT				
		Price	Unirrigated		Irrigated		Price	Unirrigated		Irrigated	
			Quan.	Value	Quan.	Value		Quan.	Value	Quan.	Value
Gross returns											
- Grain	tonne	8,000	2.40	19,200	3.10	24,800	9,000	1.40	12,600	2.10	18,900
- Straw	"	800	2.64	2,112	3.41	2,728	400	1.40	560	2.10	840
Total				21,312		27,528			13,160		19,740
Costs of production [1]											
Seed	kg	12	50	600	50	600	13.5	110	1,485	120	1,620
Fertiliser:											
- Urea	kg	11	35	385	50	550	11	35	385	50	550
- DAP	kg	22	15	330	20	440	22	10	220	25	550
- Muriate of Potash	kg	12	0	0	5	60	12	0	0	5	60
Manure	tonne	500	1.7	850	2.2	1,100	500	1.4	700	2.1	1,050
Agro-chemicals	NRs/ha			100		300			0		100
Labour:											
- Total input	adult-days	-	132	0	147	0	-	85	0	102	0
- Hired labour	kg	70	36	2,520	48	3,360	70	17	1,190	26	1,820
Farm power:											
- Ox-pair days	days	150	19	2,850	22	3,300	150	14	2,100	15	2,250
- Tractor costs	NRs/ha			2,400		2,800			2,500		2,500
Wheat threshing [2]	NRs/ha								1,260		1,890
Interest on working capital [3]	NRs/ha			602		751			590		743
Miscellaneous costs [4]	NRs/ha			1,004		1,251			984		1,239
Total Costs				11,641		14,512			11,414		14,372
Net returns per ha				9,671		13,016			1,746		5,368
Net returns per family labour-day				101		131			26		71

Notes: [1] Excluding scheme irrigation charges
[2] 10% of grain output
[3] 12% on the above financial costs over 6 months
[4] 10% of the financial costs

Table C9 Monsoon paddy and wheat costs and returns at Tilawe (NRs/ha at 2000 financial prices)

Item	Unit	PADDY					WHEAT				
		Price	Unirrigated		Irrigated		Price	Unirrigated		Irrigated	
			Quan.	Value	Quan.	Value		Quan.	Value	Quan.	Value
Gross returns											
- Grain	tonne	8,000	2.30	18,400	3.00	24,000	9,000	1.20	10,800	1.70	15,300
- Straw	"	800	2.53	2,024	3.30	2,640	400	1.20	480	1.70	680
Total				20,424		26,640			11,280		15,980
Costs of production [1]											
Seed	kg	12	50	600	50	600	13.5	100	1,350	115	1,553
Fertiliser:											
- Urea	kg	11	35	385	50	550	11	20	220	40	440
- DAP	kg	22	12	264	20	440	22	0	0	15	330
- Muriate of Potash	kg	12	0	0	5	60	12	0	0	0	0
Manure	tonne	500	1.65	825	2.15	1,075	500	1.1	550	1.7	850
Agro-chemicals	NRs/ha			0		300			0		0
Labour:											
- Total input	adult-days	-	130	0	145	0	-	81	0	94	0
- Hired labour	kg	70	34	2,380	46	3,220	70	16	1,120	22	1,540
Farm power:											
- Ox-pair days	days	150	19	2,850	22	3,300	150	12	1,800	14	2,100
- Tractor costs	NRs/ha			2,400		2,750			2,500		2,500
Wheat threshing [2]	NRs/ha								1,080		1,530
Interest on working capital [3]	NRs/ha			582		738			517		651
Miscellaneous costs [4]	NRs/ha			970		1,230			862		1,084
Total Costs				11,257		14,262			9,999		12,577
Net returns per ha				9,167		12,378			1,281		3,403
Net returns per family labour-day				95		125			20		47

Notes: [1] Excluding scheme irrigation charges
[2] 10% of grain output
[3] 12% on the above financial costs over 6 months
[4] 10% of the financial costs

Table C10 Monsoon paddy and wheat costs and returns at West Gandak (NRs/ha at 2000 financial prices)

Item	Unit	PADDY					WHEAT				
		Price	Unirrigated		Irrigated		Price	Unirrigated		Irrigated	
			Quan.	Value	Quan.	Value		Quan.	Value	Quan.	Value
Gross returns											
- Grain	tonne	8,000	2.00	16,000	2.70	21,600	9,000	1.30	11,700	2.00	18,000
- Straw	"	800	2.20	1,760	2.97	2,376	400	1.30	520	2.00	800
Total				17,760		23,976			12,220		18,800
Costs of production [1]											
Seed	kg	12	50	600	50	600	13.5	110	1,485	120	1,620
Fertiliser:											
- Urea	kg	11	30	330	45	495	11	30	330	50	550
- DAP	kg	22	10	220	17	374	22	10	220	25	550
- Muriate of Potash	kg	12	0	0	2	24	12	0	0	5	60
Manure	tonne	500	1.5	750	1.95	975	500	1.3	650	2	1,000
Agro-chemicals	NRs/ha			0		150			0		100
Labour:											
- Total input	adult-days	-	120	0	139	0	-	84	0	100	0
- Hired labour	kg	70	30	2,100	41	2,870	70	17	1,190	25	1,750
Farm power:											
- Ox-pair days	days	150	18	2,700	21	3,150	150	13	1,950	15	2,250
- Tractor costs	NRs/ha			2,250		2,650			2,500		2,500
Wheat threshing [2]	NRs/ha								1,170		1,800
Interest on working capital [3]	NRs/ha			537		677			570		731
Miscellaneous costs [4]	NRs/ha			895		1,129			950		1,218
Total Costs				10,382		13,094			11,014		14,129
Net returns per ha				7,378		10,882			1,206		4,671
Net returns per family labour-day				82		111			18		62

Notes: [1] Excluding scheme irrigation charges
[2] 10% of grain output
[3] 12% on the above financial costs over 6 months
[4] 10% of the financial costs

Farmers' Benefits from Irrigation

Irrigation benefits per farm hectare are fairly similar on the four schemes, ranging from NRs 5,200 / ha at Tilawe to NRs 6,900 / ha at Kankai (Table C11). Sensitivity analysis showed that reductions in output prices of 10% and 20% reduced the returns by some 18% and 36% respectively. Assuming that a certain proportion of crop labour inputs are provided by hired labour, farmers' crop net income per hectare increases by between 50% and 80% with irrigation. Irrigation development has thus brought major benefits to the farming community, simply through improvement in crop yield. If cropping intensity were also increased (although clear evidence for this was not found) the irrigation benefits would be correspondingly larger.

Table C11 Estimated net financial returns from Irrigation (NRs at 2000 prices)

Item	Kankai	Khageri	Tilawe	W Gandak
Net Returns/ Crop Hectare (Tables C7- C10)				
Paddy:				
- Irrigated	10,711	13,016	12,378	10,882
- Unirrigated	7,378	9,671	9,167	7,378
Wheat:				
- Irrigated	7,277	5,368	3,403	4,671
- Unirrigated	3,405	1,746	1,281	1,206
Net Returns per Farm Hectare				
(a) Irrigated Cropping				
Paddy:				
- Crop area (ha)	0.90	0.95	1.00	0.90
- Net returns	9,640	12,366	12,378	9,794
Wheat:				
- Crop area (ha)	1.00	0.65	0.95	0.85
- Net returns	7,277	3,489	3,233	3,971
Total net returns	16,917	15,855	15,610	13,764
(b) Unirrigated Cropping				
Paddy:				
- Crop area (ha)	0.90	0.95	1.00	0.90
- Net returns	6,640	9,188	9,167	6,640
Wheat:				
- Crop area (ha)	1.00	0.65	0.95	0.85
- Net returns	3,405	1,135	1,217	1,025
Total net returns	10,045	10,322	10,384	7,665
Incremental Returns per ha from Irrigation	**6,871**	**5,532**	**5,226**	**6,099**
Net return - expressed as Kg paddy / ha	2115	1982	1951	1721
- expressed as kcal/ha/day	13180	12352	12162	10724
Household				
- area	2.1	1.1	1.1	1.8
- household size	7	7	9	9
Production (kcal/pers/day)	3,954	1,941	1,486	2,145
Household income				
- NRs /month	2,960	1,453	1,431	2,065
- % poverty line	104%	51%	51%	73%

Apart from its effects on income and food grain self-sufficiency, irrigation has reduced farming risk. For most farmers in this part of the tarai the greatest danger to their incomes and staple (mainly rice) food supply is a poor monsoon, with less rainfall than normal. The introduction of irrigation greatly reduces this risk.

Appendix D

Asset survey forms

Appendix D Asset Survey Forms
Form 1

TOOLKIT FOR SUSTAINABLE IRRIGATION TURNOVER

HR Wallingford Ltd & Department or Irrigation, HMG Nepal
RAPID ASSET ASSESSMENT FORM – STRUCTURES AND CANAL REACHES

Scheme: **Canal name:** **Date of inspection:**
Total scheme area: **Canal length:** **Inspected by:**
Canal command area:

Struc or canal	Structure chainage/ start chainage of canal reach	End chainage of canal reach	Bank (left/ right/ both)	Structure type/ canal type	Defect code	Length of defect to canal reach	Duration of defect (if known)	Fitness for purpose	Redun-dant structure (Y/N)	Effect on flow	Repair within farmers' capability (Y/N) Technical/Financial		Comm-ents	Estimated cost to repair
S/C	S/C	C	S/C	S/C	S/C	C	S/C	S	S	S/C	S/C	S/C	S/C	S/C

Form 2

ASSET ASSESSMENT CODES - STRUCTURES

Code	Type	Description
1	Intake	Weir and intake structure from river to intake canal
2	Cross regulator/check	Gated cross regulator across canal
3	Gated outlet offtake	Offtake to lower order canal with gate
4	Head regulator	Structure at head of canal controlling flow
5	Secondary/branch canal offtake	Offtake from main canal to secondary or branch canal
6	Drop/chute	Drop structure
7	Flow measurement	Structure to measure flow
8	Aqueduct/flume	Structure carrying canal over drain/depression
9	Canal syphon	Canal passing through culvert under pressure
10	Drain inlet	Inlet to canal from drain
11	Cross drainage culvert	Drain passing beneath canal in culvert, not under pressure
12	Escape/flushing gate	Escape channel from canal or desilting basin
13	VRB	Village road bridge over canal
14	Washing/cleaning structure	Structure on canal bank for washing or cleaning
15	Stop log check	Ungated check structure with grooves for stop logs
16	Retaining wall	Retaining wall along canal bank
17	Spillway/overflow	Weir structure for removal of excess water in canal
18	Superpassage	Canal in culvert not under pressure below drain
19	Pipe canal	Canal in pipe
20	Informal offtake	Informal offtake from canal to lower order channel/field
21	Ungated outlet offtake	Offtake to lower order canal with no gate
22	Drain syphon	Drain passing beneath canal in culvert under pressure
23	Desilting basin	Basin along canal for removal of sediment
24	Informal drain inlet	Informal inlet to canal from drain
25	Service road	Road alongside canal
26	Service road bridge	Bridge carrying service road over drainage channel/river
27	Causeway/Irish bridge	Causeway for service road through drainage channel

DEFECT CODES

Code	Description
1	Scouring of canal or banks at structure
2	Damaged approach section
3	Defective gate or gate mechanism
4	Defect to water measurement device, ie gauge board missing
5	Defect to civil works
6	Missing gate
7	Leaking gate

FITNESS FOR PURPOSE

F = Fully functional L = Limited functionality D = Dysfunctional

EFFECT ON FLOW

Major: < 50% Qd Minor: 50% - 70% Qd Nominal: 70% - 80% Qd

Minimal: 80% - 100% Qd None: No effect on flow

Form 3

RAPID ASSESSMENT CODES – CANAL REACHES

CANAL TYPE CODES

Codes	Description
1	Earthen canal
2	Concrete lined canal – both banks
3	Concrete lined canal – one bank
4	Brick lined canal – both banks
5	Brick lined canal – one bank

DEFECT CODES

Code	Description
1	Enlargement of cross-section
2	Constriction of canal section
3	Visible siltation/encroachment of freeboard
4	Significant weed growth in channel
5	Slippage, scouring of other defect in canal embankment
6	Cracks or other damage to canal lining
7	Visible seepage
8	Reduced embankment width
9	Reduced freeboard

EFFECT ON FLOW

Major: < 50% Qd Minor: 50% - 70% Qd Nominal: 70% - 90% Qd

Minimal: 90% - 110% Qd Over: > 120% Qd