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OD 150

Water Charging in Irrigated Agriculture

Lessons from the Field

(KAR Project R8027)

Report OD 150
November 2003

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DFID Department For International Development

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HR Wallingford

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Summary

Water Charging in Irrigated Agriculture

Lessons from the Field

G A Cornish
C J Perry

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November 2003

This report has been prepared as part of a research project on Irrigation Charging, Water Saving and Sustainable Livelihoods, funded by the British Government's Department for International Development. It complements an earlier report, "Water Charging in Irrigated Agriculture: Lessons from the literature". Together these reports present a state-of-knowledge review of the role of irrigation water pricing, either as a means of achieving financial sustainability through cost recovery, or as a tool to bring about water savings, and potentially the reallocation of water 'savings' to higher value uses.

Case studies are presented from the following locations:

- Two areas of India – Haryana, a relatively prosperous state with a long history of publicly managed surface irrigation, and northern Gujarat, where private exploitation of deep aquifers has been developing rapidly over the past 20 years.
- Sindh province in Pakistan, where the underlying legislation and infrastructure are identical to Haryana, but the institutional environment differs.
- Six government schemes in Nepal – five surface and one groundwater-based.
- Two schemes in Morocco, both surface irrigated, but with private groundwater development.
- Schemes in Macedonia, originally constructed by the government but now in a process of transfer to user organisations.

In selecting these countries, and the specific schemes, the aim was to cover a range of experience from countries with differing degrees of economic development, varying degrees of water scarcity, and differing agricultural and water management practices. The studies obtained sufficient breadth and detail of data, from primary and secondary sources, to support quantitative analysis of the current and potential role of irrigation charging in achieving cost recovery, or as a means of influencing water demand and allocation, in these locations.

The purpose of this analysis has been to draw broad conclusions rather than to focus at length on the detail of a given study. Details relating to annual O&M costs, farm input prices, crop yields and market values will inevitably change from season to season but we have sought to highlight the underlying trends and draw conclusions from them. It is expected that the analysis set out in this report will find wider application than just within the countries providing case study data. The conclusions regarding the effectiveness of irrigation charging as a tool to meet

different policy objectives will remain valid, despite changes in detail from site to site.

The main discussion and synthesis of the report are contained in the first 20 pages. Section 2 of the report provides brief summaries of the case studies, including summary financial data. Analysis of the studies is set out in Section 3 and conclusions are presented in Section 4. The five annexes contain the full details of the case studies by country, including representative farm budget data from the selected schemes and information describing the context within which irrigated agriculture is practised.

Analysis of the case studies examined the extent to which irrigation charging fulfilled the objectives of either:

- Cost recovery – recovery of annual O&M costs or O&M plus elements of capital investment and depreciation
- Demand management – any reduction in the amount of water diverted by farmers or changes in water productivity, prompted by price.

Other potential objectives of charging, such as the taxation of beneficiaries, improvements to income distribution or recognising the cost of impacts on the environment did not feature in any of the case studies. Based on the literature review and the information collected in these field studies, it is the view of the authors that these additional objectives are more theoretical than practical. It should not be concluded that there was any oversight or deliberate avoidance of these issues in the selection of the study areas.

The key findings are summarised here.

Achieving cost recovery
All the agencies concerned in these case studies cite the recovery of O&M costs as the primary objective of irrigation charging but this objective was only realised in three of the eight cases – in Haryana, Gujarat and Morocco (Tadla). Farmers in Gujarat, and the agencies in Macedonia and Morocco, aim to go beyond the recovery of annual O&M costs and include the recovery of some element of capital investment from irrigators. This objective is partially achieved in Tadla but not in Macedonia. Only the privately owned and operated tubewells in Gujarat achieve full recovery of capital costs.

Willingness to pay, rather than ability to pay, is the primary determinant of whether the costs of scheme O&M are recovered. Willingness to pay is, in turn, greatly influenced by the reliability of the water supply and by farmers' perceptions of the transparency and equity of the billing system. Achieving a reliable supply and establishing transparent and accountable systems for determining the fees due and enforcing their collection, are essential preconditions for achieving high and sustainable levels of cost recovery.

Any measure of the "affordability" of a given fee needs to consider not only the cost of the fee relative to a farmer's incremental net income, compared to rainfed agriculture, but also the magnitude of that incremental income.

Summary continued

Farmers with a total income of only a few hundred dollars per year - as in Nepal where the annual income is equivalent to only about $US 300 on the better schemes - will find it difficult to pay even 5 – 10% of that income in fees. Poverty concerns suggest that governments may need to continue to subsidise O&M costs in such conditions.

However, the studies demonstrate that in the majority of cases, it is reasonable to use water pricing as a tool to recover at least annual O&M costs. Such charges constitute a relatively small proportion of the benefits derived from irrigated cropping. However, this may not be the case in the poorest countries where supplemental irrigation is used for the production of low value crops.

Charges per unit water delivered varied widely in the case studies where recovery of O&M costs was being achieved. In the Gujarat study, where farmers irrigate from collectively owned private wells, charges for O&M exceed US cents 5/m^3. The well managed, surface schemes of Morocco charge fees of at least US cents 2 /m^3, equivalent to as much as 17% of net income, and these are successfully collected. In Haryana full recovery of O&M requires a charge of only US cents 0.11/m^3 due to the simple method of water control (low establishment costs) and cross subsidies from other water use sectors.

However, payment for either ‘sunk’ capital costs or the depreciation of assets is only seen in the conditions of the small, privately owned tubewells of Gujarat, where the payment was made at the time of construction. Raising charges to a level where capital or depreciation charges are covered may be financially viable on many schemes but unless users have confidence in the efficiency, probity and accountability of the irrigation service provider and billing systems, levels of fee collection are likely to remain low. Achieving these goals will often require substantial institutional reform.

Achieving demand management

The case studies included no examples of irrigation authorities using water pricing as a tool to bring about reductions in water consumption, or improvements in water productivity, or to drive the reallocation of water between economic sectors.

In all the locations where water is scarce – Haryana, Pakistan and Morocco – systems of water allocation or rationing, rather than price, are used to limit consumption. In Haryana and Pakistan, the allocated volume is distributed to users according to the Warabandi system with farmers having a right to the volume available according to their land area. In Morocco, farmers are allocated a fixed total volume which they cannot exceed, although they order and pay for diversions up to that maximum on a volumetric basis.

An attempt was made in the case studies to compare the unit value of water (indicated by net income divided by quantity of water used) and the unit cost of water (indicated by the irrigation charge divided by the quantity of water used). The indicator is far from perfect, but the higher the value:cost ratio the greater will be the demand for water, and the larger the increase in price required to influence demand.

Summary *continued*

The indicator varies from a factor of 3:1, for the tubewell users of Gujarat, to a factor of more than 200 in the surface systems of Haryana. A 10 to 20 fold ratio between value and cost is seen in the other cases, consistent with values found in the wider literature review. Such a difference between benefits and costs of irrigation to farmers indicates that prices would have to be increased very substantially, *and actually be imposed*, before farmers will begin to reduce water consumption.

These observations from the field studies confirm the conclusions presented in the earlier literature review: water charges that cover O&M are generally affordable, such charges will have a limited impact on water consumption and are unlikely to bring demand and supply into balance. The definition and allocation of water rights to users is a more effective means of ensuring the rational allocation of water between and within sectors. Once water rights are defined, the development of water markets can bring about short or long-term reallocation between users, providing greater benefits to small farmers than purely price-driven mechanisms. But the institutional reforms, in terms of defining and enforcing water rights and providing mechanism to protect third parties in case water trading is allowed, will require huge effort.

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1. INTRODUCTION

This report has been prepared as part of a research project on Irrigation Charging, Water Saving and Sustainable Livelihoods, funded by the British Government's Department for International Development. It complements an earlier report, "Water Charging in Irrigated Agriculture: Lessons from the literature". Together the two reports present a state-of-knowledge review of the role of irrigation water pricing, either as a means of achieving financial sustainability through cost recovery, or as a tool to bring about 'water saving' through changes in field water management or reductions in farmer demand. That review and these studies indicate that other potential objectives of pricing, such as taxing of benefits, remain theoretical possibilities but are not widely found in practice.

The series of case studies presented here serves to reinforce the focus of the earlier literature review, which avoided the large body of academic debate in favour of reviewing and presenting the 'real world' experiences of irrigation charging practice. This process has helped to identify the important political, institutional and technical preconditions that must be met before a given pricing tool can be realistically applied with a view to achieving a well-defined objective.

2. AN OVERVIEW OF THE COUNTRY CASE STUDIES

The case studies presented in the annex to this report cover a range of countries and situations. Our objective has been to explore the extent to which irrigation charging (a) does (or could) play a role in ensuring the financial viability of irrigation schemes; (b) does (or could) play a role in water saving; and (c) the consequent impacts of charging on rural livelihoods.

Any analysis of data related to agriculture in developing countries is inevitably hindered by difficulties of access, nomenclature, and the intrinsic variability of agricultural "indicators". To assemble statistically reliable samples requires repetitive sampling over a number of years – an approach that was beyond the scope of this study. However, the general situation regarding whether systems are stable, improving or declining; the nature of policies governing irrigation development; and the role of charging as a source of funds for operation and maintenance (O&M) and as a tool for influencing demand for water has been effectively captured and described, based on rapid case studies.

The case studies cover:

- Two areas of India – Haryana, a relatively prosperous state with a long history of publicly managed surface irrigation, and northern Gujarat, where private exploitation of deep aquifers has been developing rapidly over the past 20 years or so.
- Sindh province in Pakistan, where the underlying legislation and infrastructure are identical to Haryana, but the institutional environment differs.
- Six government schemes in Nepal – five surface and one groundwater-based.
- Two schemes in Morocco, both surface irrigated, but with private groundwater development.
- Schemes in Macedonia, originally constructed by the government but now in a process of transfer to user organisations.

Basic economic data for the countries where the studies are located are presented in Table 1. In selecting these countries, and the specific schemes, the aim was to obtain a spread of experience from countries with differing degrees of economic development, varying degrees of water scarcity, and differing agricultural and water management practice. In short, this report considers a wide cross-section of irrigation types and settings. Figures 1 and 2 show where the case study sites lie within the wider range of water pricing levels that were identified in the earlier literature review.

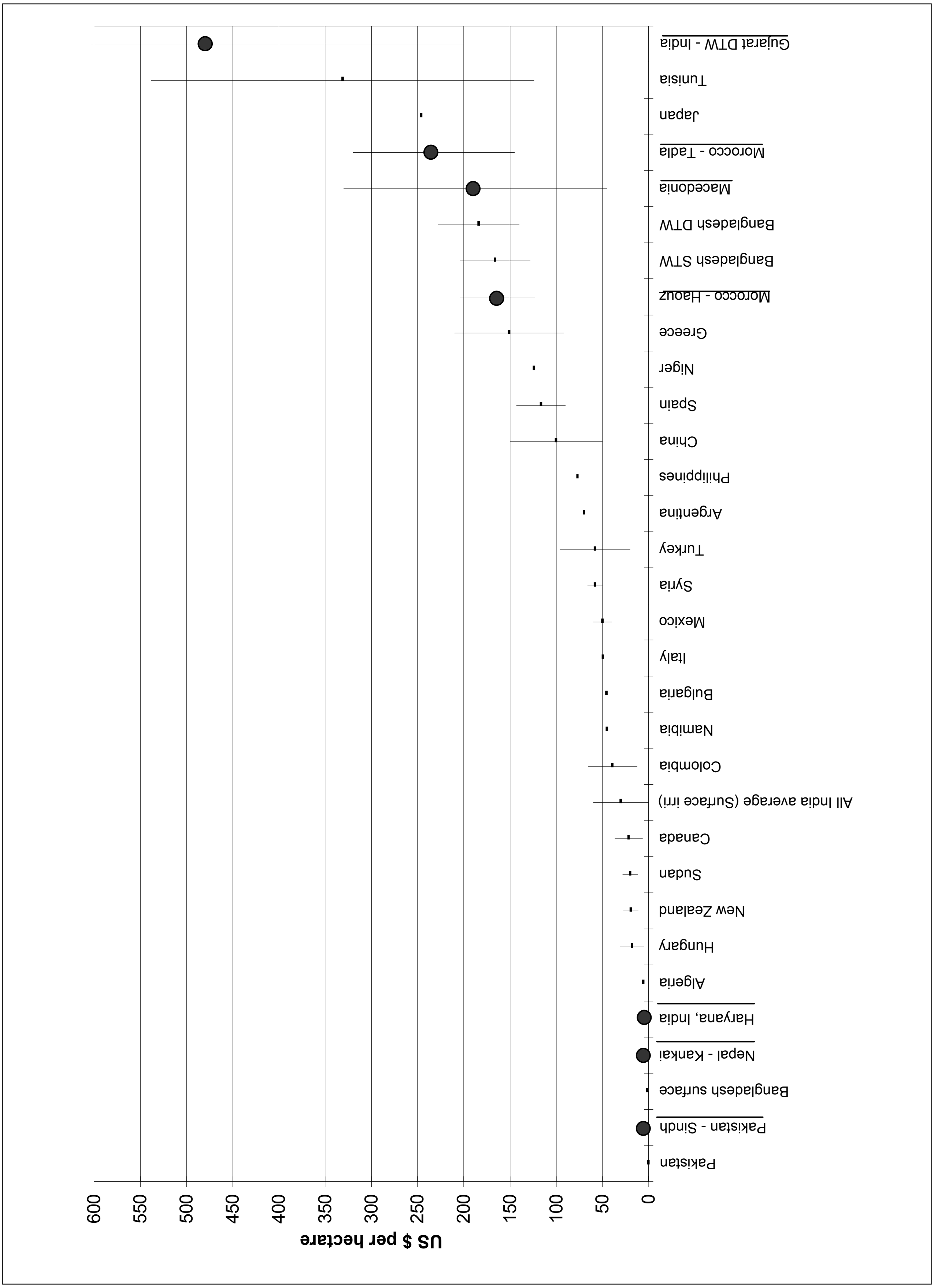

Figure 1 Case study data and the range of irrigation water prices in US $ per hectare

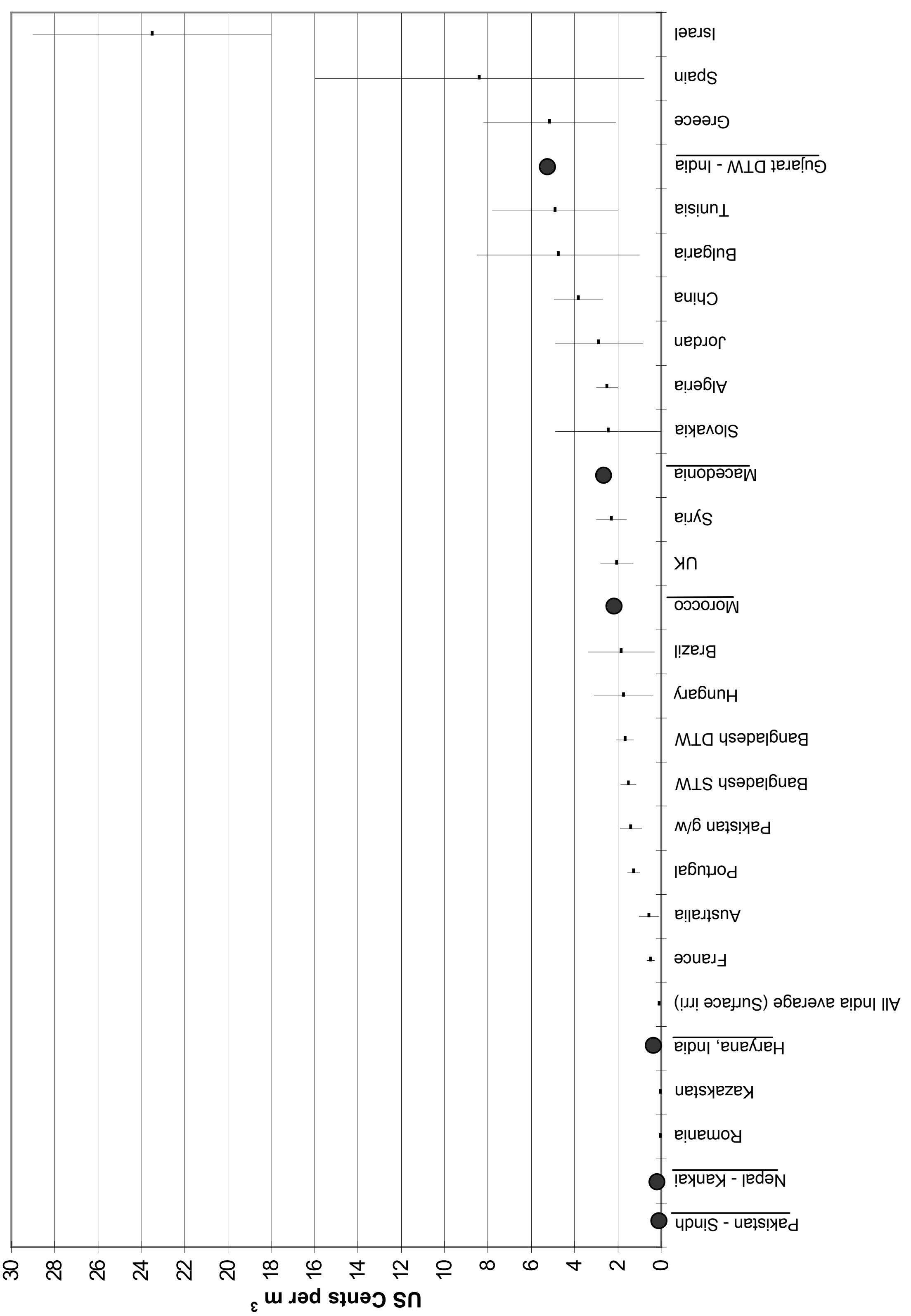

Figure 2 Case study data and the range of irrigation water prices in US cents per cubic metre

Table 1 Basic economic indicators from the five study countries

Country	Per capita income (US $/yr)	Rural population (%)	Agriculture in GDP (%)	Agriculture per capita income ($) [1]	Agricultural income as % of Average
Nepal	220	88	38	95	43
Pakistan	420	67	27	169	40
India	440	73	26	157	36
Morocco	1180	44	15	402	34
Macedonia	1685	41	11	491	29 [2]

Notes:

1. Agricultural per Capita Income computed as:
   (Average per capita income *Agriculture in GDP/Rural Population)
2. Rural incomes are actually similar to other sectors as many farmers have additional sources of income
   Data Source: World Bank (2003)

Table 1 shows that the case studies include a range of low- and middle-income countries, with the proportion of the population and GDP in agriculture declining as overall GDP increases. It also shows, based on the estimate of agricultural incomes as a percentage of average incomes, that while agricultural incomes increase with increasing per capita incomes, the divergence between agricultural and non-agricultural incomes widens as agriculture's role in the economy declines. However, these case studies will demonstrate that there is no simple or clear relationship between per capita income or levels of agricultural income and the fee rates charged or recovered.

The following sections present a brief synopsis of each country and the individual irrigation schemes where data have been collected. The full studies are set out in Annexes 1 to 5. In most of the field studies it proved impossible in the time available to obtain reliable data on the costs of fee collection, as this figure is seldom calculated as a separate budget item.

An analysis of the studies and the wider conclusions that they support concerning cost recovery, water management and livelihoods, are set out in Sections 3 and 4.

2.1 India - Gujarat

2.1.1 Importance of irrigated agriculture

In the study area of northern Gujarat, agriculture is the major economic activity. The climate is such that irrigation is essential for productive agriculture outside the monsoon season. However, the scope for irrigation using surface water is limited as there are few rivers in the area, and those that exist are short and highly erratic, with little storage capacity. Groundwater development is therefore extensive, and aquifers are declining rapidly and unsustainably.

2.1.2 Scheme characteristics

Unlike all the other case studies presented here, these schemes are privately owned and developed. Most are owned by a group of 3 to 10 farmers who have developed management systems that are financially sustainable under the current electricity rates. Water deliveries are through pipelines to individual farms, where fodder is commonly grown as an input to milk production – the major source of cash income in the area.

2.1.3 Objective of irrigation charging

Farmers set fees (charged by the hour of pump operation) so as to recover the costs of system operation and maintenance. The owners have made the capital investment collectively (usually as a function of area to be irrigated) and recover that cost from the profits on their agricultural operations rather than as part of the irrigation charge.

2.1.4 Case study scheme data

Table 2 Financial data for a typical deep tubewell, Gujarat

Parameter	
Water source	Deep tubewell
Nominal command area (ha)	20
Estimate of **required** annual O&M cost (US$ / ha)	300
Annual **actual** allocation from treasury (US$ / ha)	0
Current fee (US$ / ha)	300
Fees recovered (US$ / ha)	300
Net farm income (US$ / ha)	800
Average farm area (ha)	5
Water fee as % of net income[1]	37 %

Notes:

1. Net income before deduction of the water fee

2.1.5 Level of fee collection

All fees are collected and are proportionate to the volume of water pumped. Any user defaulting on payment is barred from access to water in the following season.

2.2 India – Haryana

2.2.1 Importance of irrigated agriculture

Haryana is a predominantly agricultural state, although other sectors are developing rapidly. Agriculture is virtually impossible without irrigation, and the development of large-scale surface irrigation has been a priority investment. Groundwater development, mostly within the surface irrigated areas, has recently been significant. Haryana (along with Punjab) is the major grain-surplus state in India.

2.2.2 Scheme characteristics

Haryana's surface irrigated area covers more than 2Mha and operates according to the "warabandi" system. Under this system, available water is divided equally over the entire command through a canal system that automatically divides the water down to the farmer groups (typically 300 ha or about 100 farmers), who share the supply based on rigidly fixed turns. Although originally designed as a "protective" irrigation system, to ensure some supplies to all farmers in times of water scarcity, the system has proved to be the most productive in India.

2.2.3 Objective of irrigation charging

The original objective of water charges was to recover full operational and part of capital costs. From 1970 to 1990, political pressures led to a decline (in real terms) in the value of recoveries and significant state subsidies. More recently, with advice from donors, a system of charging has been introduced that recovers charges from all sectors using water (domestic, industrial, supplies to Delhi, and agriculture) at rates that again fully cover O&M costs, though not sunk capital costs.

2.2.4 Case study data

Table 3 Financial data for surface irrigation in Haryana, India

	Data on the basis of "cost allocation" to the irrigation sector
Water source	Dams
Nominal command area (ha)	2.2 Mha
Estimate of **required** annual O&M cost (US$ / ha)	2.5 [1]
Annual **actual** allocation from treasury (US$ / ha)	0
Current fee (US$ / ha)	2.5
Fees recovered (US$ / ha)	2.2
Net farm income (US$ / ha)	500
Average farm area (ha)	2.7
Water fee as % of net income	0.5 %

1. This very low figure is a consequence of the state cross-subsidising the cost of infrastructure from the municipal and industrial sectors, which receive preferential treatment in terms of reliability and security of supplies. In addition, the overall costs of system operation to the state are exceptionally low because farmers bear full responsibility for O&M below the outlet serving some 300 hectares.

2.2.5 Level of Fee collection

Fee collection rates are high (85-95%). Collection is the responsibility of the State Revenue Department (Personal communication, Chief Engineer, Irrigation Department, Haryana, 2002).

2.3 Macedonia

2.3.1 Importance of irrigated agriculture

Macedonia officially has 163,000 ha of land equipped for irrigation, which is 25% of the country's arable land. However, much of this irrigation infrastructure is under-utilised or abandoned, with only 27,000 ha under irrigation in 1999.

2.3.2 Scheme characteristics

Most schemes are reservoir- backed. Much of the irrigation infrastructure is in very poor condition due to lack of maintenance since the break-up of the Yugoslav Federation. Average farm holding is very small – 1.3 ha – and farming is commonly a part-time activity and one of several sources of household income.

Cropping systems and farm incomes vary greatly between the drier east of the country and wetter west. In central and eastern regions, where irrigated horticulture and vineyards predominate, average annual net farm incomes lie between US$ 6,200 and US$ 11,900 and the contribution of off-farm income to the household budget is very small. In the west, net annual farm incomes are between US$ 800 to US$ 1,000 and off-farm incomes equal or exceed these values.

Most irrigation service provision falls under one of 20 Water Management Organisations (WMOs). As well as providing irrigation and drainage services, the WMOs can use their assets for other revenue-earning activities, such as sand and gravel mining and construction. In 1998 a single Public Water Management Enterprise was created to oversee the working of the WMOs, many of which had inherited large debts. However, confusion and disputes remain over the role and power of individual WMOs and the central PWME.

2.3.3 The objective of irrigation charging

The objective is to recover all annual operation and maintenance costs and capital depreciation.

Fee components

Water charges are made on a per irrigated hectare basis. On any given scheme, 10% of the charge is a fixed element, now set at 10% of predicted O&M + capital depreciation/ha. The remaining charge depends on the crop grown, reflecting water consumption of that crop. The charge levied varies substantially according to the scheme's O&M and capital costs. Table 4 shows the range of charges applied in 2000.

Table 4 Irrigation water charges applied in Macedonia in 2000 (US$ / ha)

Element	Lowest	Highest
Fixed charge	12	20
Maize	70	141
Wheat	33	94
Tomatoes	96	285
Rice	135	312
Vineyards	77	156
Alfalfa	79	238

Depending on the crop, the water price represents 6 to 8% of the total variable costs /ha. In the more productive systems of the east this represents about 2.5% of net income but in the west this may rise to as much as 20% of net income.

2.3.4 Case study scheme data

Referring to Table 5, if expenditure on past bad debt and capital depreciation is excluded, then income for that WMO exceeds expenditure on annual O&M by US$ 41 / ha. However, major provision for bad debt is essential, as levels of fee collection remain very low.

Table 5 Summary budget data for Tikvesko Pole Kavardaci Water Management Organisation, Macedonia

Parameter	Scheme
	Tikvesko Pole Kavardaci
Water source	Reservoir
Area irrigated in 1999 (ha)	2,862
Actual expenditure (US$ / ha) [1]	
Staff (irrigation sector)	131
Staff (Non core activities)	22
Energy, materials, insurance, etc	172
Capital depreciation	90
Bad debt provision	116
Total expenditure	**531**
Actual income (US$ / ha)	
Water fees	311
Other income [2]	55
Total income	**366**

Notes:

1 Macedonian Denars converted to $US at an exchange rate of D57 = US$1

2 This is income from individual farmers and the agrokombinats – previously, state farms.

2.3.5 Levels of fee collection

Nationally, rates of fee collection have declined from 89% in 1992 to 42% in 2000.

2.4 Morocco

2.4.1 Importance of irrigated agriculture

Morocco has just over 1 million hectares under irrigation, or 17% of its cultivated land. This irrigated sector produces 45% of the total value of agricultural produce in the country, which demonstrates the importance of irrigation to achieving high productivity. Agriculture as a sector accounts for just 15% of GDP in Morocco.

2.4.2 Scheme characteristics

Data were collected in two large irrigation schemes – Tadla (92,000 ha) and Haouz (310,000 ha). Each scheme is served by a reservoir, and water is distributed through overhead concrete channels with sophisticated division structures at all control points. The system was originally designed to serve a government-controlled cropping pattern, which has subsequently been relaxed. In both schemes, farmers rely heavily on private wells to provide an additional, flexible water supply when canal supplies are limited. Well-owners pay the full cost of well development, operation and maintenance, usually using diesel-driven pumps. Average farm size is about 6 ha.

2.4.3 The objective of irrigation charging

Irrigation charges in Morocco are designed to fully recover O&M costs, plus a proportion of capital charges. Charges are volumetric.

2.4.4 Case study scheme data:

Table 6 Financial data for Tadla and Haouz schemes, Morocco

	Tadla	**Haouz**
Water source	Dam	Dam
Nominal command area (ha)	92,000	310,000
Estimate of **required** annual O&M cost (US$ /ha)[1,2]	127 [5]	30
Annual **actual** expenditure (US$ / ha)	124	31
Current fee [3] (US$ / ha)	148	125
Fees recovered (US$ / ha)	111	81
Net farm income (US$ / ha)	994	1,706
Average farm area (ha)	6	6
Water fee as % of net income[4]	15 %	7 %

Notes:

1. Moroccan Dirham converted to US $ at an exchange rate of Dr10 = US$1.
2. Excludes cost of capital depreciation.
3. Values given are the averages of the sample farms on each scheme.
4. Net income before deduction of the water fee.
5. Higher annual O&M costs in Tadla as the scheme is much older and requires greater maintenance inputs.

2.4.5 Level of fee collection

Currently, the fee collection rate is 60-70% in Haouz and 70-80% in Tadla.

2.5 Nepal

2.5.1 Importance of irrigated agriculture

Agriculture generates 38% of Nepal's GDP, the highest amongst the countries studied. Only 13% of Nepal's cultivated area has access to year-round irrigation and an additional 17% receives supplemental irrigation during the monsoon. The approximate total area with some level of irrigation service is 783,000 ha.

2.5.2 Scheme characteristics

Irrigation schemes exist in both the Terai plains and in the hills. Most schemes are gravity fed from run-of-river diversions, but pumped irrigation, from both surface and groundwater, also occurs. Scheme size varies greatly: many have a command area of less than 1,000 ha and only nine schemes have command areas larger than 6,000 ha. The average irrigated holding is 1-3 ha.

Schemes are classified into three different management types:

Farmer managed – These schemes account for 70% of irrigation in Nepal. They are concentrated in the hill areas. The government does not levy any form of irrigation charge in these schemes.

Agency managed – Responsibility for all operation, maintenance and management lies with the Department of Irrigation (DoI). Irrigation fees are levied on these schemes and retained by the treasury. Total irrigated area under agency management is about 86,000 ha. Of this, 5,000 ha rely on pumped groundwater.

Jointly managed – Responsibility for O&M activities is shared between the Department of Irrigation (DoI) and water user associations (WUAs) established on the schemes. WUAs collect irrigation fees, retaining some proportion according to the level of responsibility assumed and passing the remainder on to the treasury.

2.5.3 The objective of irrigation charging

Irrigation charging is intended to meet annual O&M costs and, in theory, some part of the capital cost of the system.

2.5.4 Case study scheme data

Table 7 Financial data from four schemes in Nepal

Parameter	Scheme			
	Kankai	**Khageri**	**Tilawe**	**West Gandak**
Water source	Gravity, from run-of-river.	Gravity, from run-of-river.	Gravity, from run-of-river.	Gravity, from run-of-river.
Nominal command area (ha)	7,000	3,900	5,600	8,700
Estimate of **required** annual O&M cost (US$ / ha)	11	17.5	25	15.5
Annual **actual** allocation from treasury (US$ / ha) 1999/2000	6.3	9.1	3.3	2.6
Current fee (US$ / ha)	2.0	1.7	Effectively zero	Effectively zero
Fees recovered (US$ / ha)	0.56	1.0	0	0
Average annual net income (US$ / ha) [2]	242	226	223	197
Annual net incremental income (US$/ha) [3]	98	79	75	87
Average farm area (ha)	2.1	1.1	1.1	1.8
Range of farm sizes (ha)	1.6 - 6.0	0.03 – 0.7	-	-
Water fee as % of net income	4.5%	8%	11%	8%
Water fee as % of average net *incremental* income	11%	22%	33%	18%

Notes:
1. Nepalese Rupees converted to $US at an exchange rate of NPR70 = US$1 (rate applying June 2000)
2. O&M costs obtained by factoring assessed maintenance costs (HR 2001) by 1.20
3. Difference in income between rainfed and irrigated cropping

2.5.5 Levels of fee collection

The overall rate of fee collection in agency managed schemes is less than 30% of the assessed amount. In jointly managed schemes, collection rates average 58% of assessment. On average, fee income represents less than 2% of O&M costs.

2.6 Pakistan Sindh

2.6.1 Importance of irrigated agriculture

Irrigation is required for reliable agriculture, which is the main economic activity in rural areas.

2.6.2 Scheme characteristics

Sindh's surface system, which covers some 5Mha, was designed (like Haryana's) to be operated in accordance with the "warabandi" system, which divides the available water equally over the entire command, through infrastructure that divides the water proportionally down to farmer groups (typically 300 ha / 50 farmers) who share the supply based on rigidly fixed turns. Water management discipline has gradually declined over a long period. One example of this is the construction of outlets, without authorisation, directly from the main canals, which has led to difficulties in operating the system.

2.6.3 Objectives of irrigation charging

The original objective of charges was to recover at least O&M costs and part of capital costs. In recent years this objective has not been achieved, while the costs of O&M have increased. Reforms to the sector are on-going to address this problem.

2.6.4 Case study data

Table 8 Financial data for irrigation in Sindh Province, Pakistan

Parameter	
Water source	Barrage
Nominal command area (ha)	5Mha
Estimate of **required** annual O&M cost (US$ /ha) [1]	10.6
Annual **actual** allocation from treasury (US$ / ha)	
Current fee (US$ / ha)	2 - 8
Fees recovered (US$ / ha)	2.2
Net farm income (US$ / ha)	236
Average farm area (ha)	6
Water fee as % of net income	2 %

Notes:
1. This does not include any contribution to the high operation, maintenance and replacement costs of drainage, which Finney (1997) estimates to be as high as US$ 43 / ha. State expenditure on drainage is presently equivalent to US$ 2.44 / ha.

2.6.5 Level of fee collection

Collection rates are currently reported to be very poor – 30% or less of billings.

Table 9 Summary financial data from the case studies

	India		Macedonia	Morocco		Nepal				Pakistan
	Gujarat	**Haryana**		**Tadla**	**Haouz**	**Kankai**	**Khageri**	**Tilawe**	**West Gandak**	**Sindh**
Water source	Tubewell	Barrages		Dam	Dam	Gravity run of river	Gravity run of river	Gravity run of river	Gravity run of river	Barrage
Nominal command area (ha)	20	2.2 M		92,000	310,000	7,000	3,900	5,600	8,700	5M
Estimate of **required** annual O&M cost (US$ / ha)	300	2.5 [1]	200	127	54	11	17.5		15.5	10.6
Annual **actual** allocation from treasury (US$ / ha)	0	0	22	124	31	6.3	9.1	3.3	2.6	
Current fee (US$ /ha)	300	2.5	120	148	125	2	1.7	Effectively zero	Effectively zero	2 – 8
Fees recovered (US$ / ha)	300	2.2	50	111	81	0.56	1.0	0	0	2.2
Net farm income (US$ / ha)	800	500	600 – 9,000	865	1,705	242	226	223	197	236
Average farm area (ha)	5	2.7	1.3	6	6	2.1	1.1	1.1	1.8	6
Water fee as % of net income	37 %	0.5 %	1 – 20 %	17 %	7 %	4.5%	8%	11%	8%	2%

Notes:

1. Required O&M cost in Haryana is low due to cross-subsidy from municipal and industrial sectors

3. ANALYSIS OF THE CASE STUDIES

Findings and recommendations are only of value if they have relatively broad applicability. In view of this, the present discussion places emphasis on the identification of common factors that explain and characterise the situation across the spectrum of projects selected for study. We have given greater attention to drawing out generic lessons or conclusions rather than engaging in detailed analysis of each individual scheme. Specific conditions and some monetary values will change quickly between one season and another. However, the general trends concerning the extent to which different charging mechanisms come close to realising a given objective or objectives, and the preconditions that are present or lacking, can be identified.

Some of the charging objectives that were identified in the earlier literature review, such as taxation of beneficiaries, improvements to income distribution, or incorporating externalities such as environmental impact, did not feature in any of the case studies and thus are excluded from the discussion and analysis. Based on the authors' experiences elsewhere, this reflects reality and is not an oversight in the selection of the case study areas. This is, however, a significant finding: the dominant concerns of irrigation agencies around the world are financial sustainability and resource management; social objectives are not actively included in setting irrigation charging policies.

Table 10 presents an analysis of the case studies regarding the extent to which the objectives of cost recovery and demand management are addressed and achieved. The factors considered in relation to cost recovery are:

- Whether recovery of O&M costs is an objective
- Whether recovery of capital cost is an objective.

Achievement of these objectives depends on:

- An adequate level of charge for the service
- Collection of that charge.

The analysis of Table 10 considers two demand management 'tools' or mechanisms:

- Volumetric pricing of water, where the charge is directly related to the volume of water received, providing an incentive to reduce consumption and, in the extreme "market clearing price" case, allowing the price to find the level at which supply and demand are equalised
- Allocation of water, where the expected supply is allocated as specified volumes to users.

'Demand management' is used broadly in this analysis to include any action that reduces water consumption, increases the productivity of existing consumption or brings supply and demand into balance.

Whatever the objective of a water pricing policy – cost recovery or demand management – a number of important pre-conditions must be satisfied before irrigation pricing can be used to good effect in the field. Such pre-conditions include the establishing of an adequate legal framework defining allocation rules, the provision of institutional and administrative resources capable of implementing and enforcing the allocations and ensuring that the water distribution and control infrastructure can provide the level of measurement required. Many of the political, legal, institutional and administrative preconditions are common to any pricing tool but volumetrically-based, demand management tools require the provision of infrastructure capable of volumetric measurement at whatever level the allocation is specified (project, water users association, canal command, or farm). The lower in the system that the allocation is defined, the more demanding the management and infrastructural requirements. Equally, if a price is to be effective in significantly reducing demand, that price must represent a significant percentage of the income generated by the crop (see Box 1). For any irrigation charging system to work the methods of setting and updating the water price must be in place together with effective with effective means of assessment, billing and enforcement.

The summary analysis presented in Table 10 examines whether either cost recovery or demand management objectives are being realised in the different case studies. The left-hand side of the table considers cost recovery and the 'means' that contribute to it, i.e. whether the level of charge and the level of fee collection are sufficient to achieve the specified degree of cost recovery. The right-hand side of the table reviews whether demand management is also being pursued through volumetric pricing or the use of water allocation or rationing – this second approach being a non-monetary instrument that avoids some of the implementation problems associated with demand management through price. The analysis reviews whether selected preconditions, specific to that tool and objective, are in place in the country concerned. The table does not consider the more general preconditions such as the need for political will, the development of enforcement mechanisms or the allocation of sufficient resources, which are required for any water charging mechanism to succeed.

Table 10 Summary analysis of irrigation charging objectives and their realisation in the case studies

	Cost Recovery				Demand Management					
	Objective/ Achieved		Means		Tool	Precondition		Tool	Precondition	
Country	O & M	Capital	Charge level	Level of collection	Volumetric price	Infrastructure	Price level	Allocation	Water right	Measurement
India – Haryana	Y/Y [1]	N	Y	Y	N	N	N	Y[2]	Y	N [2]
India– Gujarat, private wells	Y/Y[3]	Y/Y	N	Y	Y[4]	Y	Y [5]	N [6]	N	N
Macedonia	Y/N [7]	Y/N	Y	N	N/A [8]					
Morocco	Y/Y	Y/N[9]	N[10]	Y	Y [11]	Y	N [12]	Y [13]	Y	Y
Nepal – Tubewells	Y/N	N	N	N	Y	Y	N	N	N	N
Nepal – Canal	Y/N	N	N	N	N	N	N	N	N	N
Pakistan	Y/N	N	N	N	N	N	N	N	N	N

Nomenclature:
Y means:
- An **objective** is *currently* part of policy/achieved
- A **means** is *currently* effective
- A **tool** is *currently* used
- A **precondition** is met (should the tool be applied).

Thus, for example, in Haryana, it is government policy to recover O&M costs (and this is achieved) but not capital costs. The level of current irrigation charges is adequate to meet this objective, and the level of collection of charges is satisfactory. Volumetric pricing is not practised, and the infrastructure is unable to provide individualised volumetric service. Current water charges (if converted to a volumetric equivalent) would have minimal effect on demand. Water allocation is in place, based on a system of proportional distribution.

Explanatory notes for Table 10:

India Haryana

1. Haryana achieves full recovery of O&M costs by allocating costs differentially among users (so that industrial users, for example, pay much higher charges per unit of water delivered than agricultural users). Such an approach depends upon an agency having a variety of non-agricultural customers.
2. The irrigation service in Haryana is achieved through fixed, proportional distribution of available water among farmer groups, with individuals entitled to a specified period of time each week. The water right is to a fixed proportion of the volume available and measurement is of the duration of delivery rather than of volume. Area and crop successfully irrigated are taken as proxy indicators of service, and are the basis for billing.

India Gujarat

1. Electricity charges to agriculture in Gujarat (and India generally) are based on a flat charge per month based on motor capacity, which results in substantial subsidy. This charge is fully paid by the farmers.
2. The farmers base their payments to the group on the electricity meter reading, which is a close proxy for water delivered. (Thus the state charges a flat rate for electricity, but the farmers in the group charge "volumetrically".)
3. If electricity prices were at levels required for financial sustainability of the power companies, irrigation of fodder crops (the highest value crop) would be unprofitable at present water table depths.
4. Under the Indian Constitution, land owners own the water resources beneath their land – so that control of overdraft is not generally possible.

Macedonia

1. Macedonia has the objective of full cost recovery (O&M plus capital, including past debts of irrigation projects). The Tikvesko Pole Kavardaci WMO's projected budget sets out a total income in excess of the O&M component of total costs. However, actual income is well below this as fee collection rates are very low.
2. The decline in irrigated area in Macedonia means that water availability currently exceeds demand.

Morocco

1. Morocco has a policy to recover all O&M costs plus a proportion (40%) of index-linked capital charges.
2. Current charges cover O&M costs, but do not fully meet the policy of recovering a significant capital element. The Haouz scheme does not levy fees on farmers in "traditional" irrigated areas and so has a budget shortfall.
3. Farmers are advised at the beginning of the season how much water is available per hectare. Deliveries are rationed to that level, and charges are based on quantity delivered – however, although charges are volumetric, the farmer can take either the full quota, or a lower amount, but not a higher amount.
4. Indications are that the current very high charges for water (and shortage of canal water) are inducing farmers to use groundwater. As this is unregulated (and elsewhere in Morocco, aquifers are substantially over-drafted), this requires attention to groundwater rights. Thus, price is causing farmers to change their source of water though probably not their overall consumption.
5. Morocco uses a combination of volumetric charges (to discourage waste and encourage productive use) and fixed allocations to ensure that use of surface water is commensurate with the available supply.

3.1 Achieving cost recovery

All the case studies report the objective of recovering O&M costs from beneficiaries, while three also report the objective of securing a substantial element of capital cost recovery. However, in only three of the studies – Haryana, Gujarat and the Tadla system in Morocco – do the fees recovered equal or exceed the O&M costs. In Morocco, the older and smaller Tadla system recovers its O&M costs. But in Haouz, where the O&M costs per hectare are less than half those at Tadla, fees are not levied in extensive "traditional" areas and the scheme receives large annual subsidies from central government in compensation.

In the case of the deep tubewells in Gujarat, farmers cover all O&M costs as they arise, but the state provides a large subsidy on the operating costs through the tariff structure applying to electricity for agriculture. If this subsidy were removed it would prove uneconomic for farmers to continue pumping water to irrigate alfalfa – or the price of that crop would rise.

Thus, although achieving cost recovery for annual operating and maintenance costs is an objective in all the cases considered here, less than half achieve that goal. Table 11 shows that the tubewell farmers in Gujarat and farmers on the Tadla and Haouz schemes in Morocco pay 37%, 15% and 7% respectively of their net income in water charges, (equivalent to prices of 5 and 2 US cents/m^3). In all three cases the recovery rates are high – 100% in the case of Gujarat. In these cases the fee collection process is transparent, farmers understand and are content with the service provided, and fees collected remain on the scheme.

In Haryana, if the present cross subsidy from other sectors were removed farmers would face a roughly threefold increase in the water fee to meet required O&M costs. However, this would still only represent 1.5% of net farm income per hectare. Here it would be likely to be farmers' *willingness* to accept such a price increase, were it imposed, rather than their *ability* to pay it, that would be at issue. In the Macedonian example farmers would face an approximate doubling of water price to US cents 4.2 /m^3 to meet estimated required O&M costs, equivalent to 21% of net income. Such a price would be very high by international standards. Given the weakness of the agricultural sector in Macedonia and the condition of irrigation infrastructure, the goal of recovering even annual O&M costs from irrigation charges appears unrealistic.

Table 11 Current fee levels and fees required to cover annual O&M costs

Country	Net farm income [1] (US$ /ha)	Assumed [2] water consumption (m^3/ha)	Net water value (US cents /m^3)	Present fee (US cents /m3)	Fee required to meet required O&M expenditure (US cents /m^3)	Required fee as a percentage of actual net income
India Haryana	500	7,000	7.1	0.04	0.11 [3]	1.5%
India Gujarat	800	6,000	13.3	5.0	5.00	37.5%
Macedonia	1,000	5,000	20.0	2.4	4.20	21.0%
Morocco Tadla	994	7,400	13.4	2.0	1.72	12.8%
Morocco Haouz	1,706	6,250	27.3	2.0	0.86	3.2%
Nepal	200-250	2,000 [4]	12.5	>0.01	0.55 – 1.25	4.5-11%
Pakistan, Sindh	236	8,000	3.0	0.06	0.13	4.5%

Notes:
1. Income per hectare after deduction of all production costs *except* the cost of water.
2. An assumed annual irrigation depth has been used for each case study where field data were not available.
3. Based on an estimate of O&M fees in Haryana if cross subsidy from other sectors was removed.
4. Water consumption based on supplementary irrigation to monsoon crop.

In Nepal, where agricultural productivity is low, the *ability* of farmers to pay fees at a level required to meet annual O&M may be in question. On Nepali schemes in better condition and delivering better service, the full O&M fee would be 4-5 % of net income per hectare but this rises to 11% for deteriorated surface schemes, where incomes are lower, and higher still for pumped schemes. In Sindh Province, Pakistan the fee would again represent about 4.5% of net income per hectare although price per cubic metre would remain very low in comparison with the other case studies. However, with existing fees currently well below even this low figure, and fee collection rates at less than 30%, irrigation in Sindh

Province remains entirely dependent on large, annual government subsidies. The detailed case study in the Annex presents information of the planned radical reform of this situation and predicted future budgets. One important point that sets farmers in Sindh Province apart from those in Nepal is the average size of irrigated holding. In the Sindh holdings average 6ha whilst on many Nepali schemes the average is no more than a hectare. Thus, although net income per hectare may be equal, the larger holdings in the Sindh provide a larger household income and a greater possibility that farmers could pay fees sufficient to cover annual O&M needs.

"Affordability" is not a simple criterion. In any situation, the charge must be a reasonable proportion of income, and where irrigation supplements rainfall it is important to assess the *incremental* return to irrigation from the holding, in excess of the income from rainfed farming. For schemes in arid areas (Morocco, Sindh, Pakistan), where meaningful agriculture cannot exist without irrigation, the net return is effectively the same as the net incremental return, for without irrigation there is no cropping. However, in supplementary irrigation, as in Nepal, incremental returns to irrigation are substantially less than net returns, because rainfed production gives significant yields. In the best surface scheme investigated in Nepal, the annual incremental net return to irrigation of the average farm (3 ha) was less than $US 300, of which O&M fees would take 11%. On the worst scheme (Tilawe), the incremental income was $US 225 for the same farm size but higher O&M costs represent 33% of this. The incremental income in unfavourable seasons, would be substantially less than this. For the smallest farmers, whose incomes are barely at the subsistence level, irrigation charges will be particularly difficult to meet. Both the ability and willingness of small farmers to pay must be doubted under these conditions. Thus, for the general run of schemes in Nepal, it seems that the returns to water would have to rise before recovery of full O&M costs could be considered as a general policy.

With the exception of the Nepali and Macedonian studies, the data in Table 11 suggest that full recovery of annual O&M costs from farmers is financially feasible. However, legal, political, social and administrative constraints may still prevent effective recovery of fees. Furthermore, it should be noted that whilst farm budget data demonstrate that the 'average' farmer on some schemes should be able to pay fees to cover full O&M costs, there will always be poorer farmers on any scheme generating lower net incomes per hectare. Careful analysis is therefore called for in any situation before drawing conclusions regarding affordability.

Of the three case studies – Gujarat, Macedonia and Morocco – that report the objective of securing a substantial element of capital cost recovery, only the small, user-funded and user-managed deep tubewells of Gujarat are successful in recovering capital expenditure. Of the Moroccan schemes, Tadla regularly recovers more than its O&M expenditure but the surplus does not amount to the target of 40% of capital costs. The case of Haouz is unusual in that the fee levels are sufficiently high that O&M plus capital costs could be recovered, except that they are only levied on a fraction of the total number of scheme beneficiaries. In Macedonia, the annual irrigated area is in decline and infrastructure is being abandoned. The factors behind this are complex but it seems apparent that passing the costs of historic bad debt and capital depreciation onto the Water Management Organisations is unsustainable.

It is difficult to generate reliable data on the magnitude of irrigation charges required for full financial cost recovery, including capital costs, on many schemes. However, it may well be that the steep fall in agricultural commodity prices in recent decades – which has been an enormous benefit to the non-agricultural poor – is such that the objective of full cost recovery, O&M plus capital costs, is seldom achievable.

3.2 Achieving demand management

The issue of water demand management is significant in the case studies in Gujarat, Haryana, Morocco, and Pakistan. In each of these locations water is scarce, agricultural demand continues to grow and there is increasing competition between sectors for a limited resource. Nonetheless, agencies in those countries have not explicitly identified water demand management as an objective of pricing.

Box 1 Pricing as an incentive for water saving

In the cases of Haryana and Pakistan Sindh, the current water fee is less than 1% of the net revenue from irrigated crops. Neither system cites demand management as an objective of water pricing but in both Haryana and Pakistan, competition for water is growing. In Morocco, farmers are willing to pay as much as 17% of their net income for a moderately inflexible, although reliable, surface water supply. In Gujarat, where farmers have complete flexibility of control over their own wells, they pay over 30% of their net income for water. If policy makers in Haryana and Pakistan were to consider using water price as an effective incentive to reduce agricultural consumption, they might need to consider raising current fee levels at least 20- or 30-fold even to set fees at 15% of net income. No agency or government would expect to implement such price increases rapidly: they would have to be brought in over time and would need to be matched by improvements in service delivery. Pakistan and Nepal also demonstrate that systems of fee collection and enforcement need to be greatly improved – their present systems achieve no more than 30 to 60% collection of very low fees.

In the study area in Gujarat, aquifers and groundwater quality are in decline and government has no mechanisms to address the issue other than through the price of electricity. However, since there is full flexibility and control over deliveries at farm level, volumetric pricing is feasible and indeed is practised by the farmer groups owning wells. Despite the state subsidy on power, current prices for irrigation water in Gujarat are high by international standards (see Figure 2). However, this has failed to control over-exploitation of the aquifer. Given the site-specific nature of farmers' crop selections, their market prices, varying depths to the water table and the variable yields of different aquifers, it is unlikely that an energy pricing policy can be developed that can bring the quantity demanded into line with sustainable aquifer yields. The problems of over-exploitation of aquifers and the near-bankruptcy of state electricity companies are linked. However, it seems unrealistic to expect that there is a pricing policy for electrical energy that will solve both problems simultaneously. Removal of flat rate tariffs for agriculture, such that farmers pay for the amount of energy consumed, may return the energy suppliers to solvency, assuming that billing according to energy consumption can be enforced. But it is unlikely that a single energy price can be defined that will achieve a balance between sustainable water supply and demand. Without the introduction and implementation of effective abstraction licensing laws, such a balance will continue to be achieved only by the draw-down of aquifers to a depth where further pumping becomes uneconomic for a given user, or the aquifer becomes too saline for agricultural use.

The state of Haryana addresses the issue of water scarcity by a system of water allocation. First, the demands on water for non-agricultural and agricultural use are prioritised at state level. Expected allocations to irrigation are then drawn up, based on reservoir storage levels and projected inflows. Finally, the water allocated to irrigation is distributed proportionally across all areas. This provides a transparent and easy to manage distribution system. However, control structures are located high up in the system, so that there is essentially no scope for moving towards more flexibility and volumetric delivery and pricing at the farm level. It can be argued that this system of water allocation, both between sectors and amongst farmers, is an economic instrument in that allocation decisions are taken based on the perceived value of a scarce resource. However, the system does not rely on the cost to the user of that resource either to control demand or achieve a given distribution. Allocation decisions between sectors are made at the political level, and allocation between farmers is based on well-established and fixed rules.

Morocco uses a combination of relatively high water charges, which discourage waste, and fixed seasonal allocations to ensure that supply and demand are in balance. It is important to note that it is the allocation system that constrains use, not the (relatively high) price. The vast majority of farmers would take more water at the prevailing price, and indeed development of more expensive groundwater within irrigated areas is progressing quickly. Increases in volumetric prices to discourage demand for surface water may lead to unsustainable groundwater use, which is a serious problem in many areas outside the irrigation schemes.

In Pakistan, water is scarce, and the underlying legal, administrative and system design is the same as in Haryana. Yet performance – in terms of cost recovery and implementation of allocation at the farm level - is far inferior. Water charges are lower and collection rates are poor; the physical system has been badly maintained (which leads to inequitable distribution), and tampered with, interfering with the design that ensured automatic distribution of the proper amounts of water to each area. Scarcity is "managed" by delivering what is available – those with best access take as much as they want, while those with poorer access get what is left, which may be nothing.

3.3 Irrigation fees and livelihoods

An important conclusion from the case studies regarding livelihoods is that, in most cases, the benefits of irrigation substantially exceed the basic costs of delivery. The information in Table 11 makes this clear. This means that where irrigation services are deteriorating for lack of proper maintenance, it is in the interests of all beneficiaries to ensure that services are continued, by paying the fees necessary for O&M. However, it may be necessary to bring about considerable political and institutional change to gain the confidence of those who are to pay for the service. Such pressures are encouraged by transparency in accounting: once the level of subsidy that currently prevails is made clear, politicians will be encouraged to increase charges to the beneficiaries of irrigation. From their side, farmers must perceive true benefits in paying for what they have often viewed as a 'free' government service.

It is clear that if water fees were increased to the levels required to bring about significant reductions in demand, there could be substantial, negative effects on the net incomes of smaller and poorer farmers. The case studies do not provide evidence on this point because none of the countries concerned has chosen to pursue such a policy. Nonetheless, it seems logical to conclude that water demand management through bulk water allocations or through a system of tradable water rights would better protect the interests of all farmers, especially the poorest. However, as with other economic instruments, these approaches also require significant and sustained political support, and the technical infrastructure to measure allocated volumes and permit their physical transfer between users.

4. ISSUES ARISING AND GENERAL CONCLUSIONS

4.1 The case studies

The state of Haryana is performing well on the major criteria applied here: cost recovery objectives are being met, scarcity of canal water is being managed transparently and equitably, and productivity is high. However, the physical infrastructure that underpins these objectives limits the prospects for more flexible irrigation scheduling (and hence the possibility to use pricing as a demand management tool).

Gujarat provides the clearest example of the use of volumetric charging. It meets all of the criteria required for the introduction of such a system: an acceptable basis for measuring how much water has been delivered; the potential to increase or decrease supplies at the farm level on the basis of requirements; a clear specification of the service to be provided (flow rate, duration, timing); the potential to enforce penalties for non-payment; and the possibility to set the price at a level that limits demand. Charges are high, yet demand is such that the aquifer on which irrigation depends is in severe and imminent danger of being irreversibly damaged.

Macedonia faces quite different problems: the objective here is to *encourage* demand for water and re-establish the viability of existing irrigation schemes. This may require incentives – certainly the present system of loading irrigation charges with past debts is a substantial disincentive to irrigation. However, wider uncertainties in the agriculture sector in general mean that water pricing is only one of several factors influencing the viability of irrigated production.

Morocco is the most sophisticated of the surface irrigation systems studied, but still uses water allocation to constrain demand. Pricing is used to achieve the objective of cost recovery, which is relatively high. Increasing the productivity of water will require that the present water delivery system becomes more flexible. Volumetric charging will continue to play a part in encouraging productive use of water – but volumetric allocations are likely to remain the dominant means of ensuring that demand is constrained to equal supply. It should be noted that to overcome the constraints of inflexibility and the quantity of surface water available, many farmers have invested in private tubewells where the unit price of water is more than double that of surface supplies.

The tubewell schemes in Nepal (like those in Gujarat) offer the potential to provide volumetric control to the farm level. However, the current low levels of management, indiscipline in charging for water, and low levels of recovery from farmers, constrain any possibility of using pricing as a tool for demand management. The situation in the canal systems is similar in terms of cost recovery but even worse in terms of control of water deliveries. Basic cost recovery is the first priority – and studies vary in their assessment of farmer ability to pay fully for O&M costs on surface irrigated schemes. Current fee levels are well below that required to cover all O&M costs but collection rates of even these low fees are very poor, reflecting farmer dissatisfaction with the current levels of service and financial accountability.

Pakistan suffers from severe indiscipline in how water is distributed and managed. Addressing this issue (which means reversing trends and practices that have become endemic) will require major political support and basic reforms in the means of enforcement. Once these difficult reforms are in place, recovering sufficient funds to cover the cost of proper O&M will be the priority issue. The managers of the large surface systems in Pakistan must also make a clear decision on whether the operational procedures to allocate water will be based on existing rules, that is, the warabandi principle, or whether a new approach will be adopted. Such a 'new approach' will require legal definition, because the present irrigation and drainage act defines procedures for allocating water. It must either be compatible with existing infrastructure, or the changes required to the infrastructure controlling a command area of 5 million hectares must be fully costed.

4.2 General conclusions

Many countries and areas face the problems of inadequate payment for water services, and demand for water that exceeds available supplies. The countries and schemes studied here cover a wide range of income levels and all exhibit one or both of these problems, which can be characterised as *financial* sustainability and *resource* sustainability.

The case studies show, first, that financial sustainability is often an issue – either because charges are too low, or are not collected. Where revenues are insufficient, either the Government must bridge the gap (Morocco, Tadla; Gujarat (electricity subsidy)) – or the irrigation scheme will deteriorate (Pakistan, Nepal, and Macedonia). Under-assessment of charges, or the failure to collect a large percentage of billed fees, is a significant problem in the latter three countries. Establishing an effective legal and administrative framework that ensures accurate billing, on whatever basis, and high levels of fee collection, are priority tasks in these and many other countries.

In addition, the case studies show that where charges are adequate to recover O&M costs (Haryana; Morocco, Haouz) demand for water may still exceed supply, so that *resource* sustainability must be ensured through other means. Even if charges were raised to a level adequate to meet O&M costs and applied volumetrically (for example in Pakistan, Morocco, Haryana), such charges would be unlikely to result in *resource* sustainability through significantly reduced consumption.

The Macedonia case is unusual – and perhaps a warning – in that the policy of full (O&M plus capital) financial cost recovery has led to sufficiently high charges to induce a substantial decline in demand, which in turn requires still higher prices to recover costs from the smaller "sales" base. Generally, if prices are increased to the level required to induce significant falls in demand, the impact upon small farmers' incomes may be substantial and damaging to their livelihoods; and Macedonia confirms this point.

In the poorest countries like Nepal, where over 40% of the population exists below the threshold of poverty and the productivity of agriculture is poor, the case for introducing a policy for recovery of full O&M costs from all farmers is difficult, and compounded by the poor performance of irrigation schemes. Those in the weakest position need to be identified, and interventions planned to prevent genuine hardship, on a scheme by scheme basis.

Turning to *resource* sustainability, if pricing is unlikely to produce the desired outcome, what tools are available? Straightforward, restricted allocation methods work in Haryana, Morocco and Pakistan. In Gujarat, the groundwater resource is under threat due to the absence of formal allocations, and in Haryana, Pakistan and Morocco, development of groundwater within surface irrigation systems is a present or future threat to the viability of the aquifer. The lesson appears clear. Formalisation of water rights, and the definition of sustainable quotas, are crucial to achieving the balance between supply and demand that *resource* sustainability requires.

Furthermore, as a basis for matching supply and demand, bulk allocations of water between sectors or tradable water rights are more transparent to the user and easier to apply than volumetric pricing.

Finally, volumetric pricing does provide a direct link between the volume delivered and cost, thereby providing an incentive to avoid waste, if the price is set high enough. However, the prerequisites for using volumetric pricing as a demand management tool are numerous and will often be expensive; the sophistication required in delivery, measurement and billing is clearly well beyond present capabilities in several of the case studies, where deliveries are not measured and charges are not collected.

5. ACKNOWLEDGEMENTS

Preparation of this report would not have been possible without the substantive contributions made by the authors of the original case studies on which it is based. These were: Macedonia and Sindh Province, Pakistan – Frank Van Steenbergen; Morocco – Nawal El Haouri; Nepal - Consolidated Management Services of Kathmandu and Chris Finney. The material for the two Indian case studies was prepared by Chris Perry, one of the joint authors of the report. Whilst these individuals prepared the original case studies and were involved in their various revisions, responsibility for the studies in their final form and for the more general analysis and conclusions lies with the authors.

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Annexes

Full Case Studies

Annex 1

India

Annex 1 India

1. INTRODUCTION

India is the second largest country in the world in population terms (over 1 billion) with 72% living in rural areas. Average per capita income is US$ 440, and agriculture accounts for 26% of GDP. Land resources are limited, at 0.33 ha/cap (World Bank, 2003). The national annual average available water resources are estimated at 1,880m^3/cap but there is great variation in this figure between states.

1.1 General policy for irrigated agriculture

India is a water-short country. In agriculture, the best available estimate of the utilisable water resource envisages a maximum of 150 Mha of irrigation[1], out of a total cropped area of about 180 Mha. Few places in India have adequate access to domestic water and some, including most of the major cities, are severely short of water for at least some part of the year. Industrial and commercial demands are increasing rapidly.

The expansion of irrigation has been a central element of successive Development Plans since Independence. The proportion of total Plan resources devoted to the sector was consistently about 10% until the mid-1980s. Self-sufficiency in foodgrain production was the primary motivation for this emphasis (the ratio of irrigated land to population worsened for India at partition, with the loss of the irrigated, and sparsely populated, Indus plains). Increased rural incomes and employment were important secondary objectives.

The extent of the deficit in food production, the sensitivity of total production to drought, and the rate of increase in demand due to population growth, made irrigation, and the introduction of modern agricultural technology, essential to India's development strategy.

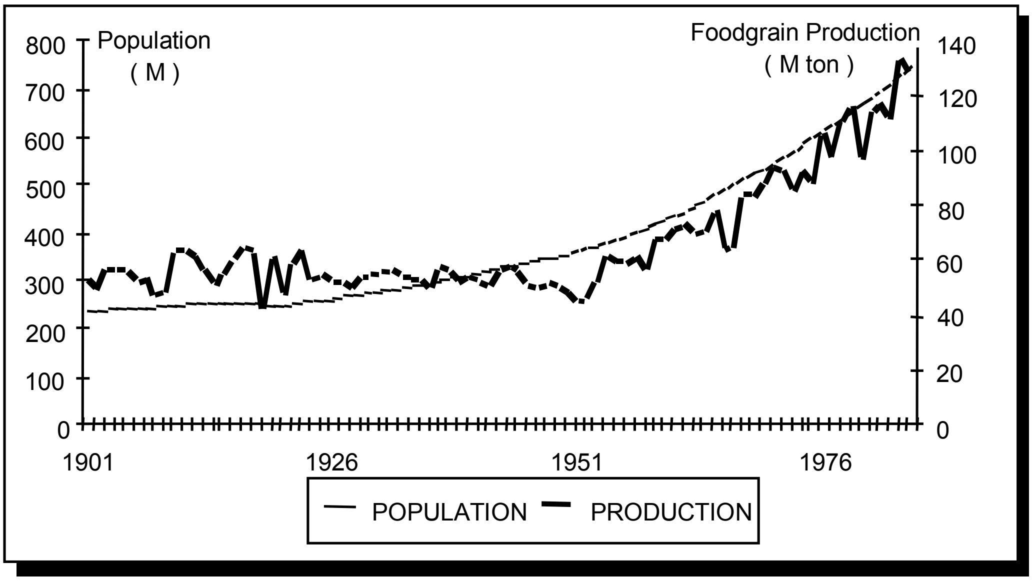

Figure 1.1 Increases in population and food grain production in India since 1900

Source: Dhawan (1988).

The precarious balance between population and foodgrain production is indicated in Figure 1.1.

[1] This figure includes development based on large-scale inter-basin transfers from surplus rivers to deficit rivers – the so-called "garland scheme" of canals. Without this development, the estimated potential for irrigation development is 113 Mha.

The upward trend after 1950 reflects the emphasis on surface irrigation, supported some years later by the new HYV seeds and fertilisers of the Green Revolution and subsequent groundwater development.

If judged by its success in feeding a huge and expanding population, despite a limited resource base and extremely low per capita incomes, India's agricultural performance and its investment in agriculture have been successful. Much of the incremental production comes from irrigated land, which expanded from 20 Mha at independence to 68 Mha today.

Foodgrain production, which is the dominant component of sectoral value added, has grown at a remarkably constant rate of 2.7%/yr. over the last 35 years - some 0.5% faster than the average rate of population increase, which has recently fallen to around 1.6%. The factors contributing to this growth have been increased area irrigated, and expanded use of fertilisers and HYVs. Over this period, the statistical analyses conducted by Seckler and Sampath (1985) indicate that "irrigation accounts for one half to two thirds of the increase in foodgrain production… and without the indirect effect of irrigation development enabling the use of HYVs and NPK, most of the remainder would not have occurred."

Although irrigation accounts for more than 90% of water use, the National Water Policy gives priority to domestic water supplies, followed by industry, agriculture and power. However, this policy is affected by the fact that water is a state issue in the Indian constitution: that is, the states decide independently how they wish to utilise their water resources. This independence is circumscribed by the fact that 85% of India's rivers are 'interstate', so the central government has a role in deciding on water allocation in the common event that states cannot agree on rules for sharing.

Irrigation charging objective

India's water policy provides, as an objective, that water charges in irrigated agriculture should cover all operation and maintenance costs, plus an unspecified proportion of investment costs.

1.2 Types of system management

Every system has its own unique features, and thus every "rule" has many exceptions. However, there are five, essentially regional, types of irrigation system, each with its own set of laws and infrastructure. These are:

- The *warabandi* system of northwest India, where water is shared strictly according to the farm area, and each farmer is free to grow the crops of his choice. Wheat, cotton, rice and pulses are the predominant crops, while high-value fruit and vegetables form a small but rapidly expanding proportion of total production. Privately financed supplementary irrigation has developed rapidly in commands where the groundwater is fresh. Yields are generally amongst the highest in India, and Punjab and Haryana are the major contributors to central government procurement of surplus foodgrains.
- The *shejpali* system of western India, where farmers must obtain official sanction, usually annually, for their proposed cropping pattern, and are then entitled to draw water according to loosely defined "crop needs". Cash crops - sugar cane, cotton, and tobacco - are important in these areas, as well as foodgrains. Yields are variable, but the high proportion of cash crops in the cropping pattern (for those farmers who obtain sanctions) leads to high incomes.
- The *localisation* system of southern India, under which the cropping pattern for the entire command (in terms of "wet" crops — rice and sugar cane — and "dry", upland crops) is legally defined as part of project design. Rice is the preferred crop in most of these areas, together with sugar cane. High value "dry" crops include cotton and tobacco, but tail-end farmers are usually only able to grow drought-tolerant coarse grains and pulses. Yields are highly variable, depending most importantly on access to water.
- The *field-to-field* pattern of rice irrigation used in eastern India and the delta areas of southern India. Kharif (summer monsoon) irrigation is obligatory (and charged for) over the entire irrigable area, while Rabi (winter) irrigation is organised annually, according to water availability. Rice yields are

generally moderate, constrained in the east by climatic factors, and more generally by the difficulty of achieving rapid transplantation of short-duration, high yielding crops to allow maturation before the onset of the second (northeast) monsoon. On the other hand, these projects were cheap to construct, having limited infrastructure and low maintenance requirements.

- The *tank* systems of southern India, which are a sub-set of the field-to-field systems, but have very limited water storage, and complex interactions within and between chains or “cascades” of tanks, where the spill from the upper tank is the primary inflow to the lower tank.
- *Groundwater* irrigation. There are essentially two technical forms of groundwater development – percolation wells (or open wells), which tend to be shallow and have relatively low yields, and tubewells, which are often deep and have higher capacities. The former are the only option where aquifers are limited, or water is to be extracted from fractured rock formations. There are many patterns of ownership and operation. Wells are predominantly privately owned – usually by a single farmer; selling of water is common.[2] A large proportion of the groundwater development in India is within the commands of surface irrigation systems, supplementing scarce and unreliable canal supplies. Such systems depend heavily on the recharge from the canal water to maintain the aquifers – but the general picture in India is of serious overdraft of aquifers for irrigation use. National figures for 1993 indicate that over half the irrigated area in India (53%) was then irrigated from groundwater sources (FAO, 1999). Controls over groundwater abstraction are minimal.

The overall performance of these six system types — in terms of productivity, equity, and achievements in relation to targets — is varied. Broadly, however, *localisation* and *shejpali* have failed to meet expected performance levels. The reasons are varied and complex: however, the common thread is that both systems commit the Irrigation Department to extremely complicated delivery schedules to meet the individual needs of thousands of farmers. In practice, these obligations are not met, because the infrastructure is inadequate, and farmers have no incentive to economise on water. Farmers rarely irrigate at night in *shejpali* systems, and the head-end farmers in *localised* systems prefer to grow rice rather than less water-demanding crops, which are more suited to the soils in their upper areas. Also, the power of control over water, which is given to the lowest level, lowest-paid departmental functionaries, inevitably leads to corruption. (In a *shejpali* system, the Irrigation Department controls gates at the 40 ha level).

By contrast, in the *warabandi* system departmental responsibilities are restricted to the larger channels. Control is at the 1,000 ha level or above, delivery schedules and priorities are made public, and the farmers have responsibility for operating the watercourses in accordance with transparently equitable rules. The power of lower level staff to favour individual farmers is minimal unless the physical system is (illegally) modified; they simply follow the published schedule of canal operations and the system automatically divides the water according to the rules. These factors, together with the relatively favourable soil, topography and farm sizes of northwest India have resulted in irrigation performance in excess of design expectations.

The *warabandi* system was designed to equitably allocate to all users, unreliable supplies derived from direct river diversions. Originally applied in colonial India through the Northern India Canal and Drainage Act of 1873, the laws and infrastructure of *warabandi* remain in place in the Punjab Province of Pakistan, and in India in the states of Punjab and Haryana, and parts of Rajasthan and Uttar Pradesh.

The system is designed to provide a rationed and equitable service (in proportion to land holding) to all farmers under conditions of extreme water scarcity – the average water available is adequate for full irrigation of about one-third of the command in each of two seasons. Rationing and equity are achieved through a three-stage process.

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[2] This is often, and erroneously, referred to as a “water market”. In fact, the market and the competition is directed towards the capacity and cost of *pumping*, so that the “market” clears on the pumping cost rather than the value of water. The case study of Gujarat is relevant to this issue.

First, the larger canals are designed for regulated operation, and are operated in accordance with the availability of water over a wide range of discharges. Off-taking canals are operated in a narrow range, close to full capacity, or are closed. Which canals are closed and which are run is determined by a published set of 'preferences' that rotate every eight days throughout the season, thus giving every off-taking canal equal probability of receiving water as supplies fluctuate in the parent channels.

Below the distributary canals, all channel capacities, and the stream flow in the individual watercourses serving each *chak* (the area within which farmers distribute the water – typically 100-400ha), are proportional to the area served. Thus, the water deliveries are uniformly and automatically allocated over the area.

Third, a unique time of the week (starting hour and minute, ending hour and minute) is defined for every farmer within each *chak* in strict proportion to the area of his holding, thus again giving equity of allocation per unit area.

The first stage in the process provides an equal probability for any part of the command of receiving or not receiving water in case of shortage. The second stage allocates water uniformly through proportionality of flows per unit service area, and the third stage allocates water uniformly through proportionality of time to farm area.

Field-to-field rice irrigation requires regular, annual co-operation amongst farmers, which has in turn provided a robust basis for many efficient and productive projects. However, in contrast to warabandi systems, shortages in rice systems are always concentrated, generally in tail-ends, and operation for non-rice crops during the dry season is inefficient due to the absence of field channels and the high canal capacities. Each of these factors makes the controlled and equitable distribution of scarce supplies difficult.

Similarly, and sometimes over periods of hundreds of years, the *tank* systems have reached a stable pattern of operation, with farmers within and (where tanks are part of a multi-tank system) between tanks following traditionally established rules for the distribution of water. Worryingly, there are now signs of decline in some tank systems, apparently due to over-exploitation of the limited water resource as upstream developments pre-empt inflows, and groundwater extractions restrict outflows to downstream tanks. However, in the longer term this trend is likely to improve both productivity and the stability of production, which is particularly poor in tank systems as long as they are entirely dependent on surface runoff from small catchments.

In general, successful groundwater development is privately owned and operated, the area served by dug wells and tubewells exceeds the surface-irrigated area, and it is generally more productive as a result of much greater flexibility of supply. This generalisation does not apply to publicly owned and operated tubewells, which have performed poorly, due to erratic power supplies, inadequate distribution systems, and dependence on easily-influenced, low-paid operators. Questions are increasingly being asked, however, about the extent of hidden subsidies to electric-powered wells (both private and public). Power is itself in very short supply in India, yet it is often supplied free to agricultural users, or at least at zero marginal cost. In addition, power connections and the cost of the well itself are subsidised, both explicitly and implicitly (through non-recovery of loans). When fully costed, the apparent 2:1 or 3:1 advantage of ground water development is far less obvious – as the bankrupt state of many State Electricity Boards clearly indicates.

Table 1.1 sets out the status of these five systems in relation to the legal, regulatory, and operational requirements for the introduction of volumetric water pricing. The table shows that before a volumetrically differentiated irrigation service could be introduced, providing the necessary basis for volumetric water pricing, substantial changes would be required in the legal and regulatory framework, along with large-scale infrastructural changes.

Table 1.1 Status of legal, regulatory and operational issues in Indian irrigation systems

System	Legal	Regulatory	Operational
Warabandi	Water right assures equitable share of total water, not quantity. Crop selection is free.	Rules are generally followed; distribution equitable and uniform.	Physical system not suitable for differentiated supply at farm level.
Shejpali	Water right assures "adequate" water for crop, not a specific volume.	Water distribution skewed.	Systems difficult to operate, but in principle suited to differentiated supply.
Localisation	Water right is for "enough" water for specified crop only.	Generally, rules are difficult to enforce.	Not possible to provide differentiated supply.
Field-to-field	No water rights at farm level.	Water distribution between farms not controlled.	Impossible to provide differentiated service.
Tank systems	Water rights hierarchical among tanks and farmers within tanks.	Rules are locally enforced.	Difficult to provide differentiated service.

Source: Perry, (2001)

1.3 Current levels of water charges in India

Water charges in the major irrigating states of India are levied on a crop-hectare basis, that is, rates vary across crops, and are charged according to the area irrigated (Ministry of Water Resources, 1999). There is no explicit volumetric charge, but the crop is used as a proxy for volume consumed. Paradoxically, rice, which is grown in the monsoon season and normally only requires a few irrigations to supplement rainfall, and that at times when water is generally plentiful, is normally charged at a higher rate than dry-season crops. Current charges per hectare range from zero (Punjab) to Rs 4,230 (approximately US$ 90) for sugar cane in Maharashtra. The following table lists important examples (in Rupees/hectare), with approximate per cubic metre volumetric equivalents (in US cents), assuming a dry-season *consumptive* (i.e. net of rainfall and with no account for conveyance and application inefficiencies[3]) requirement of 450mm; a monsoon season *consumptive* irrigation requirement of 250mm; and an annual consumptive requirement for sugar cane of 1500mm. For example, the rate for rice in Bihar is Rs 175/ha (equivalent to US$ 3.90). With estimated *consumptive* use from irrigation of 250mm, or 2500m^3/ha, the effective price per cubic meter is US$ 0.0016, or 0.16 US cents.

Table 1.2 shows that current water charges, expressed in volumetric terms, range from 0.02 - 0.26 US cent/m^3. The range of gross water productivity identified in IWMI's research (Molden *et al.*, 1998) is generally 10-20US cents/m^3 – some orders of magnitude higher. Thus, if current levels of charging were maintained, but converted from a per crop hectare basis to volumetric rates, the impact on consumption would be essentially zero as the value of water would be so many times greater than its price.

[3] By not accounting for the volume of water lost due to inefficiencies, this procedure arrives at the most conservative, i.e. expensive, estimate of water price per m^3. If losses were included, the use per hectare would be greater and the price per m^3 lower.

Table 1.2 Current water charges by crop and volumetric equivalents – major irrigating States in India

State	Crop					
	Rice		Wheat		Sugar cane	
	Rs/ha	US cent/m^3	Rs/ha	US cent/m^3	Rs/ha	US cent/m^3
Bihar	175	0.16	150	0.07	370	0.05
Gujarat	125	0.11	110	0.05	830	0.12
Haryana	113	0.10	91	0.04	148	0.02
Karnataka	86	0.08	54	0.03	370	0.05
Madhya Pradesh	197	0.18	247	0.12	742	0.11
Maharashtra	320	0.28	320	0.16	4230	0.63
Orissa	100	0.09	85	0.04	250	0.04
Rajasthan	99	0.09	74	0.04	143	0.02
Tamil Nadu	37	0.03	-	-	49	0.01
Uttar Pradesh	287	0.26	287	0.14	474	0.07
West Bengal	37	0.03	49	0.02	370	0.05

Source: Ministry of Water Resources, (1999).

1.4 Costs per hectare of irrigation services

As in most countries, it is difficult to assess the cost of irrigation services in India, but a number of estimates are available:

Dhawan (1988) estimated that full cost recovery (that is, properly funded O&M, plus recovery of investment costs) would average US$ 70/ha/yr, or US cents 4.7/m^3, assuming water consumption of 1,500mm. At the time of his writing, the average cost of surface irrigation development over the previous 30 years or so was less than US$ 2,000/ha. This figure rose rapidly during the 1990s as less convenient sites were developed and construction costs in general rose sharply.

Based on an extensive field exercise, the World Bank estimated O&M costs in Haryana at Rs 480/ha (US$ 15/ha[4] at the then-prevalent exchange rates, or US cents 1.0 / m^3 in the units of Table 1.2). The Haryana irrigation system is particularly simple and managed at a very high level in the system, with minimum gates and control structures. By contrast, ISPAN (1993) estimated the full O&M costs in Egypt at $50/ha – with much more low-level control as well as pumping costs for drainage facilities.

We conclude that average O&M in the Indian context would cost US$ 15-30 / ha (US cents 0.2-0.4 / m^3). Any estimate of the appropriate charge to include capital cost recovery will depend on the time when a system was built (costs prior to 1980 were often around US$ 1,500/ha; by 2000 the figure was 3-5 times higher); an appropriate interest rate; and the period for repayment. Dhawan's 1988 estimate of US$ 70 is indicative of the order of magnitude but today it might amount to as much as US$ 200 / ha.

2. CASE STUDY – HARYANA STATE

2.1 System characteristics

About 75% of the state's arable land is served by irrigation canals in three major areas: the Bhakra commands (1.2 Mha), the Western Yamuna commands (1.1 Mha), and the lift areas in southern Haryana (ultimately 0.5 Mha). Collectively, these three systems are served by over 12,000 km of major canals and 60,000 km of watercourses. Present surface water irrigation intensity averages about 60% – reflecting the

[4] Note that the actual annual cost of O&M for Haryana given in the case study in that state is only US$2.5 / ha. This is primarily because the state defrays the cost of the water conveyance infrastructure across municipal and industrial sectors.

government of Haryana's policy of providing limited supplies to all potential beneficiaries, and the highly efficient system of distribution. However, the state is reaching its limits of agricultural expansion: the earlier gains of the Green Revolution, in terms of yield increases and cropping pattern changes, are almost fully exhausted; scope for further development of irrigation is limited by the available water supply; and problems of water-logging and salinity are increasingly evident.

Haryana is mostly arid or semi-arid, with limited rainfall ranging from 300 mm in the south-west to 1,100 mm in the north-east. There are no perennial rivers running through the state, and two-thirds of the area is underlain with brackish water, with rising water tables and inadequate natural drainage. The state receives water from the Indus and from the Yamuna tributary of the Ganga. India and Pakistan are signatories to the Indus Waters Treaty (1960) which gives India unrestricted use of the Ravi, Beas and Sutlej rivers for irrigation and other uses, and the right to utilise the natural channels of the rivers to dispose of drainage effluent. Water is conveyed from these rivers into the state of Haryana.

The available surface and sub-surface water resources in Haryana (about 14bcm and 5bcm respectively) are almost fully developed, and correspond to only 6,000 m^3/ha – a depth of 600mm in an area where annual evapotranspiration is 1500mm. Groundwater development has progressed rapidly in the private sector and there is limited scope for further groundwater utilisation. Haryana will receive some additional waters from the Indus river system when the Sutlej-Yamuna Link Canal and the Thien dam in Punjab are completed.

The Irrigation Department estimates that Haryana has the potential to utilise some 30% more water than will eventually be available, so water shortage will remain the dominant constraint to agricultural production.

Farm sizes average 3-4ha, and are relatively stable because the rapid growth in non-farm activities is reducing the pressure to sub-divide holdings.

Along with Punjab, Haryana led India's Green Revolution, with the two states together contributing almost 70% of the total foodgrain procurement of GOI from surplus-producing areas. Yields of most major crops are high, and average foodgrain yields are 30-40% higher than the all-India average. The cropping intensity in Haryana is about 150% and is limited by irrigation supplies. Wheat, rice, mustard and cotton are the most important crops.

The existing system of irrigation management in Haryana has been in place for many years, and is commonly referred to as the *warabandi* (literally, "fixed turn") system – although *warabandi* is just one component of a complete system of water distribution. This has been fully described from a technical perspective by Malhotra (1982) and its underlying philosophy has been very thoroughly explored by Jurriens and Wester (1996).

The *warabandi* system has survived dramatic changes in farming and water resource conditions: in the Indian Punjab and Haryana, much of the surface irrigation supplies are now regulated through the construction of major reservoirs on the Beas and Sutlej. (However, the releases from these dams follow the needs of hydro-power demands and are not entirely suited to irrigation requirements). Groundwater development has reached a point where about one-third of water delivered to the fields is from this source (much of this being the recoverable fraction of surface deliveries and infiltration from rainfall). High yielding varieties predominate.

2.2 Institutions and governance

The *warabandi* system provides the framework for a comprehensive institutional system of governance, with clearly defined responsibilities. Allocation and scheduling of water among major canal commands is the responsibility of the Irrigation Department, and the list of priorities is a public document. Once the water reaches the *chak*, the farmers are fully responsible for operation (as well as maintenance of the facilities). The *warabandi* system provides very strong peer pressure governance – a farmer who steals the turn of another farmer threatens the stability of the entire allocation system and experiences pressures from all the farmers in the *chak*, not just the farmer whose water was stolen.

Failure to maintain facilities results in the government undertaking the work at the expense of the defaulting farmer, with charges recovered as arrears of Land Revenue (a very strong basis for recovery, providing the possibility of taking land away from defaulters).

2.3 Irrigation water pricing

Surface water is charged on the basis of area irrigated and crops grown, which provides a rough proxy for water delivered/consumed. Data are collected by staff of the Irrigation Department, and bills issued by the Revenue Department. There is therefore no close linkage, in this case, between levels of fee payment and the level of service delivery.

The Government makes no charge for groundwater use; farmers pay for the cost of their wells, and pay (as in the case of Gujarat) a flat rate per month for electricity, regardless of actual quantity used. Many farmers have diesel pumps as well as electric in case of failure of the electricity supplies.

Available statistics show the total cost of delivering water within Haryana to all users for the period 1996-2000 to have averaged US$ 18 M/year, while delivering 14bcm/yr – corresponding to an overall cost of water of US cents 0.13/m^3 (Personal communication, Chief Engineer, Department of Irrigation, Haryana, 2002).

The extensive network of interlinked canals of the two surface water systems distributes water to the main users as follows: irrigation (92%), municipalities (5%), fisheries (1%), industry (1%) and power (1%). The government of Haryana estimates that by 2040, the allocation of water to irrigation will fall to 26%, while municipal and livestock consumption will rise to 50%. Power is expected to account for 11% of consumption, with fisheries and industry claiming 8% and 4%. Over time, the demands on the state's water resources will far exceed any possible increases in water supply.

The Irrigation Department is able to almost fully recover total O&M costs by allocating approximately 33% of overall costs to irrigation, and the rest to the higher value uses. In consequence, the cost per cubic metre of irrigation water (92% of water, 33% of the cost) is less than one-twentieth the cost to other users (8% of water, 67% of costs). However, other users receive priority of supply in times of scarcity, and a more continuous and predefined service.

Cost recovery from irrigation thus amounts to approximately US$ 2.5/ha (Rs 70/ha) on the basis of its "allocated" cost share (equivalent to 0.05 US cents/m^3), and would amount to only $8 (Rs 250/ha, 0.13 US cents/m^3) if costs were allocated strictly in proportion to water delivered. This exceptionally low overall O&M cost is due to the highly centralised management system, limited staffing requirements, and substantial farmer participation in system operation (all management and operation and maintenance within the 200ha *chak* is by farmers).

2.4 Farm budget data

The data in Tables 1.3 and 1.4 are based on information derived from Aggarwal (2001) and the World Bank (1993).

Actual charges for water are very low in relation to returns. Table 1.3 shows that water charges, (assuming only canal water is available) at US cents 0.05/m^3, account for less than 1% of net income, and the returns to water average US cents 7 /m^3. This is more than one hundred times the cost of delivery on the basis of the allocated share of costs and more than 50 times the equivalent cost in volumetric terms, which was shown to be just US cents 0.13 /m^3.

Table 1.3 Farm budget for average 2.7ha farm – all canal water

Crop	Income per ha $	Area (ha)	Farm Income $	COSTS Inputs	Labour	Water	Net Income $	Family Labour Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
				- - - - - - - - $	- - - - - - - - -							
Rice	327	0.83	270	55	71	2	**142**	45	3	5.7	0.05	0.03
Wheat	449	2.00	899	165	82	4	**647**	76	9	4.9	0.18	0.13
Chickpea	161	0.34	55	11	23	1	**20**	17	1	0.8	0.07	0.03
Cotton	406	0.6	263	56	23	1	**183**	48	4	2.9	0.09	0.06
S Cane	1,000	0.2	162	43	20	1	**98**	19	5	2.1	0.08	0.05
Mustard	443	0.7	295	10	21	1	**263**	14	19	2.6	0.11	0.10
Total/Ave	418	4.6	1,944	339	241	10	**1,354**	219	6	19.1	0.10	0.07

If only groundwater is available, the cost of water rises to about US cents 0.5 /m^3 - the price paid by those who buy water from a well-owner - and accounts for close to 10% of net income, but the cost is still far below the return to water.

Table 1.4 Farm budget for average 2.7ha farm – all groundwater

Crop	Income per ha $	Area (ha)	Farm Income $	COSTS Inputs	Labour	Water	Net Income $	Family Labour Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
				- - - - - - - - $	- - - - - - - - -							
Rice	327	0.83	270	55	71	32	**113**	45	3	5.7	0.05	0.03
Wheat	449	2.00	899	165	82	29	**622**	76	8	4.9	0.18	0.13
Chickpea	161	0.34	55	11	23	5	**16**	17	1	0.8	0.07	0.03
Cotton	406	0.6	263	56	23	16	**169**	48	4	2.9	0.09	0.06
S Cane	1,000	0.2	162	43	20	11	**88**	19	5	2.1	0.08	0.05
Mustard	443	0.7	295	10	21	14	**250**	14	18	2.6	0.11	0.10
Total/Ave	418	4.6	1,944	339	241	107	**1,256**	219	6	19.1	0.10	0.07

These data fully explain why demand for water in Haryana is well in excess of available canal supplies, and why the water table continues to fall in areas where it can be used for irrigation. The "all groundwater" scenario also shows that increasing current canal water charges by a factor of ten, and charging volumetrically, would still fail to bring supply and demand into balance as the price would still be far below the value.

2.5 Mechanisms for fee collection

Irrigation charges are assessed by staff of the Irrigation Department, who record the area grown under each crop. This information is passed to the Revenue Department who bill farmers based on the area and the rate for each crop (this varies depending on the theoretical consumption of the crop in question). Because water charges are recovered as part of Land Revenue, the collection rate has always been very high – typically 90% or more – with shortfalls in the case of agricultural problems (floods, droughts, pest attacks) usually offset by collection of arrears in subsequent years.

3. CASE STUDY – GROUNDWATER IRRIGATION IN GUJARAT

Gujarat is situated in western India, with a population of 50 million (60% rural). Most of the potential for small and medium surface irrigation in the State has been developed. Development of the Narmada River command (2.1Mha) is ongoing. This case study focuses on groundwater development, which has proliferated in the northern parts of the state, where aquifer conditions were good, though they are now threatened by over-exploitation.

3.1 System characteristics with respect to charging

Where available, surface irrigation is cheaper than groundwater, but in the study area, groundwater is the only available irrigation source.

System sizes vary from a few hectares to 20 ha, depending on the number of farmers and their holding sizes. Irrigated areas are often not contiguous, but rather isolated patches within otherwise rainfed areas. Individual farm sizes vary widely from fractions of a hectare to 20 or 30ha. The farms are predominantly rainfed.

Northern Gujarat is a water short area (typical rainfall 400 mm; typical annual evapotranspiration 1,800 mm) with an expanding population and access to a good quality aquifer and productive farmland.

Groundwater exploitation has proliferated in recent decades. Open, dug wells were the original basis of this development, limiting the potential drawdown to ten metres or less. The aquifer was progressively (and competitively) developed by putting boreholes at the bottom of wells, then through tubewells – some of which now extend below 300m. The aquifer is falling everywhere – at varying rates – but clearly this level of use is unsustainable, and reports of deteriorating water quality are frequent.

Low-value, subsistence crops predominate on rainfed lands. Where irrigation is available, priority is given to fodder crops to support the livestock/milk industry which is well developed in the area (Gujarat was the home state of Operation Flood – a highly successful, now national, co-operative milk-marketing system).

In the study area, the control structures consist of deep tubewells, with a piped distribution system serving the owners' farms. Management is by agreement among the farmers as to who will take water at what time.

3.2 Institutions and governance

Management is co-operative among the farmer-owners, with occasional sales of water to other farmers. Most importantly, groundwater abstraction is uncontrolled, so that a competitive market in depletion has developed among the farmers in the area, with no interest in sustainable resource use.

3.3 Irrigation water pricing

Well-owners design the charges to cover the cost of electricity supplies – allocating costs on the basis of hours of use (which are recorded), then allocating any additional expenses for maintenance and repairs on the same basis.

The charge for fodder irrigation is based on reading the electricity meter, and is a direct, volumetric price for water at the rate of US cents 3.0 /kwh consumed. For a pumping height of 150m and a wire-to-plant efficiency of 25% the corresponding cost of water is US cents 5 /m^3. Assuming that alfalfa requires 1,500mm of irrigation, the irrigation charges would correspond to US$ 750 / ha. For less water-demanding crops, such as wheat, the gross revenues would be about US$ 600/ha (4t/ha at US$150/t), and the corresponding irrigation charge would be US$ 200/ha.

Farmers contribute to the capital costs of the well on the basis of the area they propose to irrigate. Thus, financial cost recovery is full – to the extent that electricity charges cover the cost of generating and distributing power. In fact they do not, and the situation is exacerbated by the structure of electricity charges for wells, which is based on a fixed amount per month related to the installed power, with no marginal cost.

Since 1989, the rate of charging for tubewell power has been Rs500/hp/yr – or approximately US$13 /kw/yr. If a pump is operated for 3 hours/day, this corresponds to an energy price of US cents 1.2 /kwh, which is about a third of the actual generating cost. (Confirming this, the Gujarat State Electricity Regulating Commission has advised that tariffs for tubewells should be increased by almost 400%).

Green fodder sells in the market for Rs25 per 10kg so that the gross revenue per hectare (with an average yield of 40t/ha) would be Rs100,000 (US$ 2,200). The irrigation charge (US$750) based on recovery of the present electricity tariff, plus pump maintenance costs, is very close to one-third of the gross crop value (US$2,200).

3.4 Mechanisms for fee collection

Farmers collect the charges from within the group, and use this to pay the electricity bill and other costs. Accounts are maintained, and the issue of non-payment does not arise as each farmer has a capital stake in the well, in addition to the need for water (which would be withheld in case of non-payment). Furthermore, the fodder crop is entirely cash-oriented: it is fed to cows producing milk, which is marketed through the local co-operative dairy, and paid for almost immediately.

3.5 Implications of full cost recovery for power

The present level of charges for electricity costs are 40% of the cost per cubic metre, and pump operation and maintenance are 60% of the cost. If power prices are raised by a factor of three to meet estimated full costs of generation, the cost of water to the farmers would increase by 80% from present levels, and would correspond to somewhat more than half of gross crop value – and a water cost of US cents 9 /m^3.

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Annex 2

Macedonia

Annex 2 Macedonia

1. INTRODUCTION

Prior to independence, Macedonia was the poorest of the six republics that made up the socialist Yugoslav Federation. That Federation offered a protected market for Macedonian agricultural products and an assured flow of subsidies to the agricultural sector. With the break-up of the Yugoslav Republic these supports were removed and farm incomes declined. In addition, Greece has applied an economic blockade over the name of the newly formed country and the wider military conflicts in the Balkans have destroyed markets and destabilised Macedonia itself. As a consequence the country's GDP has fallen by 25% since 1991 to its present level of US$ 1,685 / capita. The contribution of agriculture to GDP has fallen from 13.6% to 10.9%.

Charging for irrigation water is well established in Macedonia with the objective of recovering both annual O&M costs and depreciation on capital costs. However, the charging mechanisms and broader irrigation institutions have had to withstand the economic and political turmoil that has befallen Macedonia over the last ten years and the present situation is one of change and decline.

Much of the rural population are only part-time farmers, holding other jobs in addition. As a consequence, rural incomes appear to be similar to those in other sectors. Although the farming sector is not substantially poorer than others, there is a significant out-migration of young people from rural areas, in search of better livelihoods.

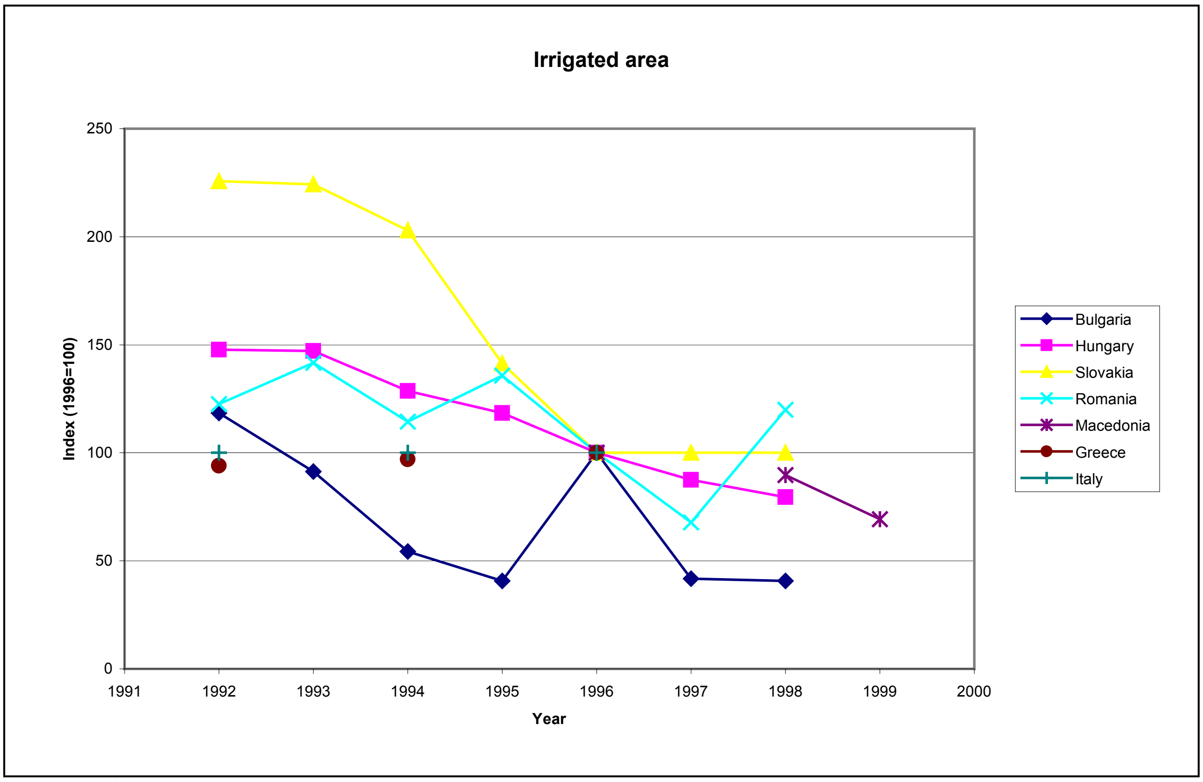
2. IRRIGATION AND DRAINAGE IN MACEDONIA

Average annual precipitation in Macedonia is 730 mm, but due to hilly topography there is great spatial variability. The western part of the country is wetter, and there is more rain-fed agriculture, than in the east. Irrigation schemes in the west mainly provide supplementary irrigation in dry years; in wet summers irrigation demand falls almost to zero. In the drier, eastern region demand for irrigation is less variable. The main irrigated crops are grapes, vegetables, tobacco, alfalfa, and until recently, paddy. Supplementary irrigation is provided to wheat.

With the exception of a few free river intakes, irrigation is mainly supplied from multi-purpose reservoirs. Of the 19 large dams in the country, 16 provide irrigation services to command areas of between 1,000 to 15,000 ha – usually in addition to hydropower. As returns from power generation are higher, irrigation supplies usually take second priority in these multi-purpose systems. There are over 120 small dams that provide water for irrigation, domestic supply, fish breeding or local industry.

Irrigation systems are often extensive and heavily engineered as a consequence of the mountain topography. The majority of farmers depend on these major systems as their single source of water. In a recent survey, only 24% of farmers used an additional source such as a small spring, well or river diversion, (MCG, 2002).

The total area 'equipped' for irrigation in Macedonia stands officially at 163,693 ha – close to 25% of the arable land in the country – but a large part of this area has never been irrigated and distribution networks were not constructed. The maximum area irrigated at one time has probably never exceeded 100,000 ha and, following the general trend in agriculture of the last ten years, the actual area under irrigation has declined. According to figures from the Public Water Management Enterprise, 27,000 ha, 16% of the official total, was irrigated in 1999. Such differences between actual and potential areas are common in other Eastern European countries. In Bulgaria only 8%, in Romania 14% and in Hungary 41% of the officially designated command area is irrigated. Whereas in several parts of the world the discussion in recent years has been how to accommodate increases in irrigated area, given limited freshwater supplies and ecological demands for water, Eastern Europe as a whole has moved in the opposite direction as Figure 2.1 illustrates.



Source: Oko, (2001)

Figure 2.1 Changes in irrigated area in Eastern European countries

During the period of theYugoslav Federation, Macedonia sold its agricultural commodities at premium prices to protected markets through collective marketing systems. High quality rice, for instance, used to get the equivalent of US$ 1.5/kg. The demise of many agriculture and food-processing conglomerates (agro-kombinats) eroded the market for irrigation produce. With reduced income damaged infrastructure went un-repaired. Non-functional pump stations, broken canals and collapsed canalettes, among others, reduced the area under irrigation. In this context water saving is not a priority in Macedonia, but survival of the public asset base and delivery of services at reasonable cost, is.

2.1 Farm types and income levels

Most farms in Macedonia are small. Data from 1994 show an average farm size of 1.29 ha, and this has subsequently declined. Land fragmentation is widespread – there are more than 7 plots on average per farm and part-time farming is common. In a sample of 125 farmers 32% indicated that they were part-time farmers and 61% had an additional source of income – from salaried employment, state social support or pensions (MCG, 2002).

There is wide variation in income between different irrigation schemes and prevailing cropping systems. Commercial horticulture is practised in the central and eastern part of the country (Tikves region). Here, net farm incomes are high and make up the main portion of household income. On mixed farms and predominantly rainfed farms (in the West), where wheat and maize are the dominant crops, or in the former rice growing areas (such as Bregalnica), net farm incomes are significantly lower and off-farm income becomes important. Table 2.1 shows the range of farm and household incomes related to different farming systems.

Table 2. 1 Annual household income (US$) for different cropping systems (based on sample of 125 farms)

Cropping system	Commercial vegetables	Commercial vineyard	Mixed system	Rice system in decline	Rainfed cereals	Average
Net farm income	11,910	3,625	790	1,000	290	4,050
Off-farm income	20	1,015	1,595	860	1,185	935
Household income	11,930	4,640	2,385	1,860	1,475	4,985

Values converted to US$ at an exchange rate of US$ 1 = 57 Denars
Based on: MCG (2002)

2.2 Institutions and governance in irrigation

Irrigation services in Macedonia are provided by financially autonomous irrigation agencies known as Water Management Organisations (WMO). Twenty WMOs nowadays provide irrigation and drainage services. A single irrigation system in Macedonia may have one WMO, but larger reservoirs typically supply water to several WMOs. One of the WMOs may look after the main reservoir, servicing others. In other cases the Public Electricity Company manages the reservoir. Apart from irrigation and drainage, the WMOs are engaged in other service activities such as river regulation, flood protection and erosion control, and in commercial activities such as construction, concrete works, gravel winning, operating hotels and the exploitation of fisheries in the reservoirs. This is not unlike other (former) socialist countries – including China. Table 2.2 gives an overview of the spread of activities of the WMOs. In some cases the commercial activities have become the main activity with irrigation cross-subsidised from these businesses. In other cases commercial activities have been poorly managed and have become financial liabilities rather than assets.

Table 2.2 Number of WMOs engaged in different activities

Water services	
Reservoir operation	4
Irrigation services only	10
Drainage services only	2
Irrigation and drainage services	8
Hydro-power	1
Other activities	
Sand and gravel mining	10
Fishery	9
Hotels	3
Construction works	11
Concrete works	5
Miscellaneous	6

Source: Arcadis 2001a

Under the Water Law of 1998 an effort was made to create a country-wide Public Water Management Enterprise (PWME) with a mandate to address the operational losses faced by most of the WMOs. The WMOs were to lose their autonomous status and become branch offices of the new organisation. However, several parties reneged at the planned time of transition of the WMOs to the PWME, at the end of 1999. The new PWME had begun to realise that the WMOs were saddled with substantial debts, arising from losses on operations in previous years and it feared that it would sink immediately, if it took over these liabilities. On the other hand, the few WMOs that were not facing debt, in particular Strecevo (earning substantial income from power supply) lobbied hard to have the planned transition undone. The resulting stalemate has caused considerable confusion over the legal position of the WMOs. According to the Water Law, the WMOs are part of the new central organisation, but in reality they were not registered as such. In the ensuing grey zone the PWME exercises some regulatory power over the WMOs – replacing directors of non-performing WMOs, co-ordinating lifeline subsidies and announcing cuts in the water prices.

From 1999 onwards water users associations – called Irrigation Water Communities – have been formed on a pilot basis with the support of the World Bank financed, Irrigation Improvement and Restructuring Project. By 2002 ten Irrigation Water Communities had been were formed, registered as voluntary foundations, and each in charge of a command area of approximately 80 ha. As voluntary foundations they only have leverage over those farmers who are registered as members; they have no power over other farmers in their command area. The Irrigation Water Communities contracted with the WMO to manage water distribution and maintenance in their area for a 40% discount on the water price.

3. IRRIGATION WATER PRICING

As financially autonomous organisations, the WMOs have to generate their own income from water fees and their other activities. In principle water fees should be calculated on the basis of all operating expenditures *and* the cost of capital depreciation. The system of calculating depreciation is regulated by law and is backward looking. The historical value of the infrastructure is re-valued and then depreciated over the assumed lifetime (usually fifty years) of the asset. Because investments in water infrastructure are bulky and irrigation infrastructure in Macedonia consists of the relatively costly, medium-sized, reservoir based systems, depreciation costs make up 40 to 70 % of the water price.

As a result of the high cost of depreciation, water charges in Macedonia are among the highest in the world. Table 2.3 shows the range of prices. Even though the full cost pricing formula has now been abandoned in most WMOs, agricultural water prices are significantly higher than they are in neighbouring countries.

The water price is made up of a fixed and variable portion. For a long time the fixed portion was equivalent to 50% of the total projected cost of O&M and depreciation charges for the coming year. The fixed portion ensured a basic income even in wet years when there was little or no irrigation demand. Given the high cost of depreciation charges such an assured income was particularly important. The variable charge was based on a per hectare price for the different crops with the price per crop loosely reflecting water consumption. Direct, volumetric charges have been considered in Macedonia on several occasions, but the cost of installing water meters was found to be prohibitive, particularly as most farmers only operate very small holdings. Moreover, with falling irrigation demand, there is little need for demand management and thus little rationale to introduce volumetric charging.

Table 2.3 Water charges in US $ / ha in Macedonia in 2000

Crop	Lowest	Highest
Maize	70	141
Wheat	33	94
Tomatoes	96	285
Rice	135	312
Vineyards	77	156
Alfalfa	79	238
Fixed charge	12	20

Waiving of payment after natural disasters is common – frost damage in 1993, hail in 1995 and floods in 1996 all resulted in lower fee collection. The cost of these waivers was borne by the WMOs as part of good customer relations.

As the prospect for agriculture in Macedonia deteriorated in the nineties and more and more irrigated land was abandoned, the imposition of high fixed charges became political untenable. In the new Water Law of 1998 the fixed proportion was lowered to 10% of the total water price. This particularly affected the self-financing ability of the irrigation systems in the wetter, western part of the country. Here the area irrigated fluctuates substantially from year to year and in a wet year no irrigation is required for maize or wheat. This lower demand translates into very low revenues. However, most of the expenditures in irrigation are fixed – not only the capital depreciation, but also much of the staff and the maintenance expenditures are made irrespective of the demand for water.

Table 2.4 Example of income statement of a WMO

Income Statement		
Tikvesko Pole Kavardaci WMO 1999	US $ '000	%
Revenue		
Agrokombinats	246	23
Individual farmers	285	27
Sales to other WMOs	174	17
Other water sales	107	10
Barter	78	7
Non water revenues	55	5
Other operating income		
Government grant	64	6
Other income/ insurance	38	4
Total revenue	1047	100
Expenditures		
Staff costs, irrigation sector	375	25
Staff costs, non-core activities	63	4
Depreciation	257	17
Materials, energy	125	8
Insurance/water damage	54	4
Contribution to PWME	34	2
Others[5]	280	18
Write off bad debts	331	22
Total expenditures	1519	100
Total net loss	- 472	
Area irrigated 1999	2,862 ha	
Revenue in US $ / irrigated ha	370	
Expenditure in US $/ irrigated ha	530	
Net loss in US $/ irrigated ha	161	

Based on: Boro and Ljupco (2000)

In most irrigation systems in Macedonia the formula used to calculate water fees has become opaque over time. A price once calculated became the basis for the prices in subsequent years – irrespective of changes in operating expenditures in those years. Officially, water prices continued to make provisions for

[5] Others consists of cost of entertainment and sponsoring and miscellaneous items

depreciation, but several WMOs had the value of their original assets largely written off, whereas others simply left depreciation costs out of the equation. This explains much of the large variation in water rates seen between WMOs in Table 2.3. Water prices no longer cover even the operational costs of several of the WMOs. Politicians have announced fee reductions over the past last two years, but there has been no parallel effort to control costs. As a result, several WMOs would be making a loss, even if they were able to recover all their dues – which they are not.

Table 2.4 shows the projected income and expenditure statement for one WMO, Tikvesko Pole Kavardaci WMO, for 1999. The largest expenditure item is on staff salaries. WMOs tend to be over-staffed; a legacy of the previous socialist policy and also a consequence of a reduction in irrigated area not being matched by a similar reduction in staff numbers. The second largest expenditure item is the writing off of bad debts, which include both historic debt and un-recovered irrigation fees from recent years. Maintenance expenditures – apart from field staff costs – are limited. The financial statement of this WMO is reasonably representative. There is a budgetary loss of US$ 462,000 driven largely by the allowance for depreciation, for which no provision is made. If fee recovery was higher, bad debt provision could be reduced and a balanced statement could be achieved. However, it is still the case that little maintenance would be funded under this scenario.

The newly created PWME sought to address the deficit in income seen in many of the WMOs by reducing water prices, in the belief that this would lead to much higher recovery rates. Thus, there was a 20% reduction in water pricing in 1999 and a further 10% reduction in 2000. Unfortunately, the reductions in price did not lead to any increase in rates of fee recovery, which continued to decline.

The PWME was also charged with developing a uniform methodology in water pricing. The method proposed using standard unit costs – adjusted from system to system – for required maintenance levels. These standard costs were derived from assessments of maintenance requirements by the different WMOs - which were subsequently compared. The final methodology was drafted in 2001 but has not yet been implemented. In the meantime water prices are based on historical rates – although reportedly there will be little difference between these and the newly calculated water prices.

Table 2.5 compares actual water costs (as paid), official water prices and gross margins. Although water prices in Macedonia are high by international standards they still represent less than 10% of total gross margin for commercial, horticultural crops. For farmers growing these crops water fees are still affordable. In recent years however some of the main grape growing areas in Macedonia have suffered severe frost damage, affecting water users' ability and willingness to pay.

Table 2.5 Comparison of water costs, other variable costs and gross margins/ha

	Actual water costs (US $/ha/yr)	Official variable water charges (US $/ha/yr)	Official fixed water charges (US $/ha/yr)	Gross margin (US $/ha/yr)
Grapes (red wine)	65	77-156	12-20	1757
Grapes (white wine)	111	77-156	12-20	1347
Onions	107	96-163	12-20	4373
Rice	156	135-312	12-20	1164
Maize	64	70-141	12-20	394
Wheat	12	33-94	12-20	266

Source: MCG (2002), sample

Similarly, vegetable prices have fluctuated heavily. In the case of staple grains the official water charges are equal to 15% or more of gross margins. Actual payment, however, is a lot less – but in case of rice and maize still a significant percentage. Actual payment for wheat is very low, as it is difficult to assess if the crop has been irrigated or not.

3.1 Mechanisms for fee collection

As in other countries, there is an official and an actual system of collecting water charges in Macedonia. The official system, described in several clauses of the Water Act (Box 2.1), is based on farmers' indents, used to prepare water management plans. The area under cultivation is recorded by water masters who are responsible for opening inlets and valves on the pipelines and have a close understanding of what goes on. Water users – individual farmers and agrokombinats – are expected to pay their dues before the end of the year. Those that do not pay can, in principle, be disconnected.

Actual practice differs from this. Farmers are often reluctant, or simply do not bother, to fill in indents. One WMO (Kocani) tried to popularise the indents by having them hand-delivered by the water masters to all 7,000 farmer-customers but only 30 were returned. In other systems more farmer indents are returned, but never for the entire area. Water management plans are actually based on past practice and on informal information obtained from local community leaders, who discuss their water requirements with the WMO.

Box 1 Billing and fee collection in the Water Law of the Republic of Macedonia 1998

Relevant sections for the billing and revenue collection procedures are given in the Water Law in article 101, 118, 119, 120, 141, 142, 146 and 147.

- Article 101 and 118 requires water users to submit crop plans/ water demands to the PWME for the following year by 30 October
- Article 119 commits the PWME to prepare an annual irrigation plan before 30 November - which in case of unexpected dry conditions can be adjusted by 1 March
- Article 120 commits water users to follow the annual irrigation plan
- Article 141 - 142 instructs the calculation of a fixed fee (charged on all irrigable land) and variable fees (dependent on the acreage under different crops). The norm for the fixed fee is 10% of the expected total charge
- Article 146 obliges the PWME to deliver to each water user the water quantity allocated in the annual irrigation plan, but makes an exception in the case of farmers who do not submit an indent
- Article 147 gives the PWME the power to stop supplies to water users who do not pay their charges.

Bills are prepared at the end of the season based on crop area data recorded by the water masters. However, not all systems have reliable cadastral mapping and in addition the WMOs are making greater and greater use of temporary staff, as they can only offer full employment during the 5 months of irrigation from May to September. These temporary staff are not familiar with the area and are prone to make mistakes in reporting cultivated areas. Nonetheless, the WMOs have the impression that the water masters are relatively accurate in their assessments, as differences would show from a comparison of previous bills and from farmers objecting to the bills. Farmer interviews confirm that billing is reasonably fair.

The water master delivers bills to farmers. Trials to send bills by post failed, as this was unreliable. Farmers have the right to challenge the bill within 8 days. In Kocani WMO 20% of the 5,000 bills issued in 1999 were challenged. The objections usually concern plots that were not irrigated or where there was crop failure. Whilst areas where crops fail are not automatically exempt from fees, negotiation of a reduced fee may be possible. In general, the farmers who make the effort to object are those who are willing to pay.

A very recent development is the inclusion of value-added tax on the water bills. VAT at 17.5% was introduced in 2000 in Macedonia and irrigation water charges were not exempted. As WMOs are taxed on the amount billed, rather than amounts received, non-recovery of bills leads to huge losses. Some WMOs have responded by excluding notorious defaulters from the billing process. In some cases this has resulted in a reduction of 10% in billed amount. Although pragmatic, the 'moral hazard' in this development is obvious.

3.2 Fee recovery and enforcement

Non payment of bills is a growing problem. Countrywide, recovery rates have dropped from 89% in 1992 to 42% in 2000.

As the culture of non-payment grows those who continue to pay appear "odd". Furthermore, politicians, including the Minister, have made sweeping public gestures in which they announced the waiver of water charges – a gesture that could not be carried through, but the suggestion fuels non-payment.

The WMOs have two possible sanctions against non-payment:

- Taking defaulters to court.
- Suspending water supplies.

Up to 1993 all defaulters were taken to court but with increasing levels of non-payment, court costs have become so high that they endangered the financial position of the WMOs. In recent years only groups of larger defaulters have been taken to court. Cases have to be initiated within three years of non-payment but there are long delays of 3 to 5 years in processing cases. By the time a decision is taken, inflation has reduced the value of the dues. Many defaulters still refuse to pay – even when summoned by court. There are then not many effective sanctions unless the defaulter has a permanent source of income to confiscate. To illustrate the difficulty with the 'court route' one WMO spent US $ 200,000 in court fees in 2000 and was able to retrieve US $ 250,000.

The alternative sanction is to suspend the supply. The 1998 Water Law permits this but in the case of individual defaulters this sanction is difficult to enforce as both farmers that pay and those that do not are on the same outlet, valve or sprinkler system. Furthermore, political pressure exists not to enforce this measure.

Where Irrigation Water Communities exist it is, in theory, easier to suspend supplies. But as there is no legislation that gives the Irrigation Water Community authority over the entire command area and as membership is still voluntary, there are still farmers who do not come under the control of the Irrigation Water Community. The Irrigation Water Communities have been relatively successful in collecting dues – with recovery in several Irrigation Water Communities close to 100%. However, recovery among non-members remains very low. Draft legislation has been prepared which would give the Irrigation Water Communities a separate legal status. The plan is that in the medium-term the Irrigation Water Communities would become the single bulk users, which by contract rather than by law would give them leverage over all water users within their area of jurisdiction.

4. CONCLUSIONS

4.1 Effects of low fee recovery

The declining revenue from water fees, coupled with low revenues from non-core activities has seriously reduced the operational capability of the WMOs. Despite falling revenues, the WMOs did not make serious efforts to reduce fixed costs. Although the areas effectively irrigated fell sharply, staff numbers remained the same. Some savings were made by deferring major repairs and replacements. In a few cases WMOs have compensated their losses by defaulting on loans and in most cases they have ceased to make provisions for replacement and are no longer paying 'compulsory' contributions to pension schemes, medical insurance and providence funds. By 2001 the combined debt of the twenty WMOs had reached over US$ 8 M, more than twice their annual turnover in a normal year.

Due to such debt, the majority of the WMOs have had their bank accounts blocked and as a result they are only operating on a petty cash basis. Furthermore, because they have not paid contributions to pension funds, no employee is interested in taking early retirement.

As water prices continue to be based on full cost recovery, including an amount for capital replacement, the minority of water users who continue to pay are paying for capital replacement that will never happen. In addition, as the number of defaulters passes a certain threshold it makes those who continue to pay appear foolish and thus the rate of non-payment spirals upward.

The total of fees outstanding is equivalent to US $ 396/irrigated ha, which is approximately three times the average annual water fee per hectare. The fees owed to nine WMOs investigated in detail were US $ 8.9 M, whereas the money owed by these WMOs to social funds and banks was US$ 4.9 M (Arcadis 2001b). Almost 70% of unpaid fees are owed by individual farmers rather than the agrokombinats. Much of this money cannot be recovered, because the time to do so has lapsed or because the original billing was disputed.

4.2 Lessons

1. Mechanisms for revenue collection are equally or more important than the means of setting the water price. Documents such as the Ministerial Declaration at the Hague World Water Forum and the WorldWater Vision ('Move to full-cost pricing of water services for all human uses') pin much hope on full cost pricing but without effective revenue collection any pricing strategy is naïve. In addition, when revenue collection starts to falter, a small group of users, those who continue to pay, find themselves bearing a large part of the costs, but without adequate services in return.

2. Water users, or an independent regulator, must be able to exercise some control over the service provider. The WMOs did not adjust their staffing and expenditure in response to declining demand and income. As self-regulating, monopoly suppliers, the WMOs were unstoppable – the only options water users had was to pay an inflated price, default on payment or pull out.

3. The experience of several of the WMOs illustrates the dangers of making too large a part of a service provider's income dependent on the volume of water provided. In a semi-humid climate the demand for water can vary greatly from season to season generating a highly variable income stream, whilst much of the cost base is constant. A similar situation can occur in semi-arid climates where the volume available for release can vary greatly. The lesson is to ensure that a large part of the provider's fixed costs are met by a fixed fee element.

4. The huge debts that the autonomous WMOs have incurred need to be resolved. As long as they are there it is hard to see how the irrigation sector can move forwards. In the meantime, no proper financial management is possible, because the WMOs can no longer maintain bank accounts, but have to operate all their financial transactions on a petty cash basis.

5. A final lesson is that when agriculture is in decline, it is hard to maintain the irrigation infrastructure. However, the risk is that gravely deteriorated infrastructure may present a serious bottleneck as and when the agriculture sector moves towards recovery.

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Annex 3

Morocco

Annex 3 Morocco: Tadla and Haouz Irrigation Schemes

1. INTRODUCTION

1.1 Relevant characteristics of the country

Morocco has a population of 29 million of which 44% live in rural areas. Average per capita income is US$1,180, and agriculture contributes 16% of GDP. The availability of arable land is only 1.5 ha/capita and water is scarce, at only 1,045m^3 /person/year (World Bank 2003).

1.2 General policy for irrigated agriculture

Water availability is the primary factor constraining agricultural production in Morocco. Rainfed agriculture is uncertain and generally of low productivity, especially in southern areas where rainfall is highly variable and on average far less than potential evapotranspiration. On average, one year in three is a drought and production from the unirrigated arable land (6Mha) varies widely (e.g. 10 million metric tonnes in 1994/95; 2Mmt in 1996/97).

Development of irrigated agriculture has therefore been a high priority, accounting for about 7% of total developmental expenditure and 60% of government expenditure on agricultural development (World Bank, 1995). The broad objectives of this investment policy and the irrigation it has supported are to:

- Improve food security for the population as a whole
- Promote rural development and incomes
- Contribute to the economy through domestic value-added, import substitution and exports.

The irrigated areas (1.3 Mha or 20% of arable land) contribute 45% of agricultural value-added and 75% of agricultural exports. Despite this, agricultural imports, at US$1.6bn in 1996, were approximately double the value of agricultural exports. Irrigation currently accounts for 88% of water use (domestic and industrial use accounting for 8% and 4% respectively).

Morocco receives an annual average of 150 billion cubic metres (bm^3) of rainfall, although this figure is highly variable. Of this total, 21 bm^3 (17 surface, 4 groundwater) is utilisable. Approximately 14 bm^3 of surface water is already controlled through more than 90 large dams. The remainder will be controlled by 2020. Groundwater use is already extensive, with significant over-exploitation in some basins and coastal areas. Renewable water resources per capita are estimated at 1,045 m^3/yr.

The estimated national water balance in 1990 showed an availability of 11bm^3, with demand at 10.9bm^3. By 2020, the supply of water (as a result of construction of more dams and development of additional aquifers) is planned to rise to 16.8bm^3, while demand is expected to be marginally higher at 17.6bm^3. Of this increase in demand from 10.9 to 16.8bm^3, additional irrigation demand will contribute about 5bm^3, or about 85% of the total.

The precision of such estimates is always open to question – especially given the high variability of rainfall. The important conclusion is that Morocco's currently developed water resources are fully utilised and future surpluses are unlikely as infrastructure developments may not keep pace with demand. The trend in water table depth in nine of the ten major aquifers has been negative over recent decades, suggesting that the 1990 estimate of a marginal surplus of supply over demand is optimistic. Deteriorating water quality strengthens these concerns: in the Sebou basin, where current exploitation is only 40% of the anticipated supply at full development in 2020 (i.e. 60% of the water in the average year is currently available to flush and dilute pollution loads), potable water supplies are already suspended occasionally due to poor quality.

In 1993 the National Irrigation Program was launched, aimed at:

- Horizontal expansion – dam development was 250,000 ha ahead of command area development, a gap that has now been halved.
- Improving the “performance” of irrigated agriculture – through improved water use efficiencies and increased crop yields – and improving the managerial capacity of the ORMVAs (Office Régional de Mise en Valeur Agricole) – organisations responsible for agricultural development, both irrigated and unirrigated, which have substantial responsibility in the operation of irrigation projects).

Reduction in losses and increases in water productivity are to be achieved through:

- Rehabilitation (200,000 ha planned, mostly in small/medium sector).
- Improving water delivery to farmers – better O&M, more modern management; strengthening the relationship between ORMVAs and farmers.
- Establishing Water User Associations (WUAs) – the objective is NOT transfer, but rather organising farmers to participate in management.
- Improved on-farm water management.

Competition for water within and between sectors is already evident in some areas. In this competition, it is clear that:

- Agriculture will remain the dominant consumer for the foreseeable future.
- Supplying the demands of other sectors is a relatively minor challenge compared to meeting future irrigation demands.
- Pollution control has an important role in ensuring maximum beneficial use of limited quantities of water.

1.3 Extent of irrigation and types

Surface irrigation development in Morocco can be classified into informal irrigation systems, which tend to be smaller and older, and formal systems, developed over the last 40 years or so, which are larger and government-planned and -financed. The informal systems include community developed systems that exploit local surface water resources through traditional groups, and more recent private developments of groundwater, which is theoretically licensed but actually subject to very few controls.

Modern, large-scale irrigation, which is the subject of this study, has been the centrepiece of irrigation development in Morocco, accounting for about 0.5Mha to date[6] with an estimated future potential of 0.85 Mha.

There are nine such schemes in the country, each overseen by an ORMVA responsible for design, O&M, and fee collection within the irrigated zone. ORMVAs also have responsibility for rainfed agriculture within their areas of responsibility. The nine ORMVAs are semi-autonomous, public agencies, with a common Board chaired by the Minister of Agriculture, and including representatives of farmer organisations, and the Finance, Commerce, Interior and other ministries. There are also regional 'Technical Committees' chaired by District Governors, which include local representatives. At the local level (3,000-4,000 ha) Agricultural Development Commissions are responsible for the details of irrigation planning.

Large-scale irrigation systems in Morocco follow the French “rational” layout. In the case of surface deliveries, water is pumped from the distribution canals into suspended “canalettes”. These are of standard dimensions – typically carrying 120 litres/second (l/s) which is successively divided and delivered to the 30l/s earthen watercourse channels from which the farmers take water. The original concept was that the cropping plan was set by the government, and farmers were obliged to grow the specified rotation of crops on their land. Since the water demand schedule for the various crops was different, the watercourses are

[6] Source: Irrigation Water Pricing Policy in Morocco’s Large Scale Irrigation Projects, Md. Ait Kadi

arranged to run at right angles to the ownership boundaries, so that each watercourse can be operated to serve the needs of a specific crop (see Figure 3.1).

Since a farmer has land in each watercourse, his schedule will include deliveries at several times in each channel rotation. In Figure 3.1, the bold line at the top represents the channel while vertical lines represent the watercourses.

Channel>>					
Farm 1 Plot A	Farm 1 Plot B	Farm 1 Plot C	Farm 1 Plot D	Farm 1 Plot E	Farm 1 Plot F
Farm 2 Plot A	Farm 2 Plot B	Farm 2 Plot C	Farm 2 Plot D	Farm 2 Plot E	Farm 2 Plot F
Farm 3 Plot A	Farm 3 Plot B	Farm 3 Plot C	Farm 3 Plot D	Farm 3 Plot E	Farm 3 Plot F
Farm 4 Plot A	Farm 4 Plot B	Farm 4 Plot C	Farm 4 Plot D	Farm 4 Plot E	Farm 4 Plot F
Farm 5 Plot A	Farm 5 Plot B	Farm 5 Plot C	Farm 5 Plot D	Farm 5 Plot E	Farm 5 Plot F

Figure 3.1 Schematic of watercourse and farm plot layout

Each farm is in 6 plots, arranged horizontally. The left-most watercourse would first serve Farm 1 Plot A, followed by Farm 2 Plot A, through to Farm 5 Plot A. Irrigation would then begin to Farm 1 Plot B on to Farm 5 Plot B, through watercourse 2, and so on.

This means that in an irrigation turn a farmer may have to come back up to six times to irrigate his farm (the average size of a farm is around 5ha). This operating pattern is closely matched by the design of the infrastructure, which has division structures at each level to ensure accurate provision of the proper discharge to each area. The whole system was logical when cropping patterns were enforced so that all 'Plot A' areas would have the same crop (and hence irrigation schedule) and could be provided with an irrigation schedule suited to that crop, while all the 'B' areas had another crop, supplied by a suitable schedule for that crop.

Today, however, the enforcement of cropping patterns has been abandoned, even though the ORMVA management gives clear "guidance" as to the feasible cropping plan prior to each season, especially when water is scarce. Under these new circumstances, it is difficult to fix irrigation schedules. However, farmers are familiar with this system and they probably consolidate their turns fairly effectively on an informal basis.

In sprinkler systems, delivery is (in normal years) purely on demand. Water is pumped into pressurised pipes and farmers operate valves to take water, and are then billed for the volume taken.

Both these systems are sophisticated by any standards. Water delivery is well controlled, and system losses between the source and the farm turnout are low in the case of the surface systems (where all channels except the watercourses are concrete) and minimised in the case of the sprinkler systems where delivery is through pipes to the field level.

Despite this, analysts suggest that system efficiency is below 50% – that is, of the water diverted to an irrigation system, less than 50% is actually beneficially used by the crop. This claim is surprising in terms of physical losses, because the system is fully lined, well constructed and well maintained. It may well be that operational losses (that is, the mismatch between delivery schedule and the pattern of demand) account for much of the measured "inefficiency", and that such losses are returning to drains and hence reused elsewhere. The fact that aquifers are generally declining and large-scale waterlogging is not reported suggests that where there are losses, these are already being substantially exploited through local reuse (by pumping from drains or the aquifer).

The issue is important as much weight is given to expectations of reducing losses to improve water availability. This is only true if the “losses” are *not* already recaptured.

1.4 Moroccan approach to water pricing

In 1969, a Code was issued specifying a complex and comprehensive approach to cost recovery, including full recovery of operational and maintenance costs and partial (40%) recovery of capital costs, indexed over time to inflation. These basic costs were to be further increased by the cost of pumping, as applicable, on a scheme by scheme basis. Charges were linked to the water supplied; a basic allocation of 3,000m^3/ha was obligatory, and additional water was charged volumetrically. The price of water, based on this Code, varied from US cents 1 - 7.5 /m^3, with most charges close to US cents 2 /m^3. Such charges – corresponding to US$ 100 or more per hectare for typical field crops – were (and are) substantial by international standards.

However, most of the farmers in the new schemes were unaccustomed to irrigated agriculture and these high water prices were a substantial disincentive to irrigation, especially when combined with government-prescribed cropping patterns and controls on domestic pricing policy. In consequence, the full water charges implied by the Code have never been enforced.

Current charges range from US cents 2 – 6 /m^3, whereas the charges implied by the Code would be about double these figures. With the actual level of collection at less than 100%, ORMVAs that have pumping as a significant element of total operational costs[7] need an annual transfer of funds from the central government to meet operational expenses, let alone to meet capital cost recovery objectives. However, it should be noted that the *objectives* of water charging policy in Morocco – in terms of aiming to recover 40% of capital costs, in addition to all annual O& M costs – are far more ambitious than in most countries. While these objectives have not yet fully been met, water charges are:

- relatively high by international standards
- directly and volumetrically linked to the water provided
- seen by government as a mechanism to promote appropriate resource allocation through discouraging unproductive use.

Morocco therefore presents an interesting case study of the potential to use economic instruments, and particularly water charges, as a means to control demand in line with limited resource availability.

2. TADLA AND HAOUZ CASE STUDIES

Morocco's Tadla and Haouz schemes are both gravity-fed systems, with similar design and management features. However, Tadla is an older scheme and covers an area of about 100,000ha; Haouz was constructed more recently and covers 310,000ha.

2.1 System characteristics with respect to charging

The major source of water in both projects is the canals, although development of authorised and unauthorised private wells is widespread – there are at least 10,000 private wells in Tadla.

Canal water is priced in accordance with the general regulations summarised in the introduction, and varies in relation to the cost of operation and any pumping costs (neither the Tadla nor Haouz canal systems involve lifts, but there is pumping for areas served with sprinklers). The government does not charge for

[7] Electricity is charged to ORMVAs at 20% below the commercial rate – around US cents 8 / kwh.

groundwater, but well-owners pay the full cost of development and operation and maintenance – often preferring diesel because of the high cost of electricity.

Water demand exceeds available supplies, and in consequence is rationed in accordance with a schedule set out at the beginning of the irrigation season when supplies (available in storage dams) are reasonably well known.

The main crops grown include wheat, fodder crops (lucerne, berseem) and olives. The irrigation infrastructure is relatively sophisticated: delivery is through concrete "canaletti" – channels suspended on pillars – of standardised sizes, branching eventually to the 30 l/s channels delivering to earthen channels serving individual farmers in accordance with the layout described in the introduction. At each branching point "modules" are constructed, which provide accurate supplies to each off-taking channel, more or less independent of the driving head. The net result of this system is that all mismatches between supply and off-taking capacity are concentrated at the final off-take, and field observations indicate that while individual modules can be adjusted to various flow rates (30, 60, 90 l/s) most seem to be fixed at specific rates allowing a routine of deliveries to be maintained at a known operating level.

While surface deliveries are the norm, these schemes also include large areas served by pressurised systems, with water available in accordance with prescribed schedules, and metered volumetrically.

2.2 Institutions and Governance

System operation is dominated by the ORMVA, which sets schedules, approves cropping patterns and manages the system down to the tertiary level, from which the farmers take water.

2.3 Irrigation Water Pricing

Water charges are designed to recover all O&M costs plus a proportion of capital investment. They are uniform for any scheme, except that remissions are given if the farmers undertake cleaning of the tertiary canals (20%), or both the tertiary and secondary canals (40%). Charges are also different (because a pumping charge is involved, and the capital investment is higher) in the areas served by pressurised systems.

The basis for charging is the quantity of water received – which is metered in the case of the pressurised systems and calculated on the basis of time and the nominal flow rate for surface areas.

Tables 3.2 to 3.5 show the results of a farm survey for three farms each in Tadla and Haouz. The farms are of 5-8 ha, and include a variety of cropping patterns. Tables 3.2 and 3.3 show farm incomes for Haouz on the assumption that irrigation is fully from canal water (Table 3.2) and fully from groundwater (Table 3.3). Similar results are presented for Tadla in Tables 3.4 and 3.5. In fact, farms use a mixture of sources, but the results show the two possible extremes.

The tables contain a great deal of detailed information and are based on additional data sets. The returns to various crops seem reasonable, with fodder crops uniformly showing a loss, because the crop is grown as an input into more valuable, animal husbandry activities, and higher returns to cash crops such as paprika and olives. Key data for this report are gross income per hectare, net income (before water charges), and the proportion of net income accounted for by water charges, assuming charges are paid in full. All data are presented in US dollars to facilitate comparison across case studies.

Table 3.1 Summary data from case study farms

Farm	Haouz 1	Haouz 2	Haouz 3	Tadla 1	Tadla 2	Tadla 3
Size (ha)	6	5.5	6.2	4.8	6	7.7
Gross Income US$/ha	1,622	1,865	2,600	1,453	1,582	318
Net Income [1] US$/ha	1,338	1,568	2,209	901	1,470	612
Canal Charge [2] US$/ha (%)	128 (9%)	123 (8%)	123 (6%)	156 (17%)	145 (13%)	145 (23%)
Well Charge[3] US$/ha (%)	205 (16%)	197 (13%)	198 (9%)	320 (35%)	297 (27%)	298 (49%)

1. Net income before deduction of water costs
2. Surface water charge US cents 2 /m^3
3. Groundwater charge US cents 3 - 4 /m^3

These summary data indicate that farmers, particularly in Tadla, pay a substantial proportion of their income for canal irrigation services, and even more for groundwater. Most farmers in fact use a mixture, but in the year of this study (2002) the three Tadla farmers drew an average of 83% of their water from their own wells, while in Haouz the figure was 66%.

Data on the cost of providing irrigation services, summarised in Tables 3.6-3.9, require some interpretation. The situation in Tadla (Tables 3.8 and 3.9) is relatively straightforward: the cost of full O&M is Dh 115M/yr (approximately $127/ha). The full cost, including depreciation in accordance with the official formula, is $150/ha. Official statistics indicate that recoveries exceed O&M (see Table 3.9), despite farmers' heavy reliance on pumped groundwater, which does not generate returns to the ORMVAs.

In the newer Haouz scheme, the cost of full O&M is only $30/ha/yr, while the full cost including depreciation is almost double this figure at $54/ha/yr (see Tables 3.6 and 3.7). These figures are quite different from Tadla, where the annual O&M cost is much higher, but the difference between O&M and full costs is much smaller. The reasons for this are that Tadla, the first irrigation project in Morocco, is older and therefore requires much more ongoing maintenance. However, because the scheme was cheaper at the time of construction, the full cost (including amortisation) of the Tadla project is not much more than basic O&M.

An additional difficulty with the analysis is that while the farm budgets indicate that charges in Haouz are more than sufficient to cover the full costs of the irrigation service, data at the project level indicate substantial annual subsidy. This is because Haouz includes extensive "traditional" areas that do not pay the level of charges indicated in the farm budgets, and because many farmers in Haouz opt to undertake cleaning of secondary and tertiary channels, reducing the payment of water charges by up to 40%. Thus despite the much lower costs of the irrigation service in Haouz and the fact that full charges would more than cover these costs, actual recoveries fail to meet costs and overall operation is therefore subsidised.

Average water use in Tadla is 7400 m^3/ha and the full service cost is US$ 150 / ha; average use in Haouz is 6200 m^3/ha and the full service cost is US$ 54 /ha. Thus, the full cost of water per cubic metre delivered at the field is US cents 2/m^3 in Tadla, and US cents 0.8/m^3 in Haouz. Returns to water range from US cents10-40/m^3, indicating that the charges required for full cost recovery are substantially less than the value of water in this water-constrained environment.

2.4 Billing and collection

Bills are prepared by the local ORMVA service ("La Subdivisions de Gestion" in the Haouz scheme and "Arrondissement de Gestion" in the Tadla Scheme) and are generally issued to individuals (except in some sectors of the Haouz scheme where bills are issued in the name of traditional water users associations, which are responsible for collecting water fees from members). The bills are established and delivered each quarter by the ditch-rider (Aiguadier) and payment is due twice a year.

If a farmer contests a bill, he can request the ORMVA to review it. The ORMVA holds a meeting with the farmer, the ditch rider, other farmers using the same tertiary canal and the president of the WUA, if one exists. The monthly water delivery document, which is jointly signed by the ditch-rider and the farmer, is examined and the farmer's water consumption is recalculated in order to check if the bill is correct or not.

In the case of Tadla, every farmer has a "chequebook" to help track water consumption: at each water turn, the farmer gives a "cheque" to the ditch rider detailing the volume of water consumed, keeping a copy for himself. The farmer can then calculate the total volume of water consumed and the related cost -- and has proof for the ORMVA in the event of any error in billing.

This approach is an innovative means of combining rationing with flexibility. The total water available for the season is defined in the chequebook, but the schedule of deliveries is variable, based on demand from the individual farmer (within reason, and subject to competing demands).

Compensation (in case of failure to deliver) is based on the water tariff, and roughly estimated – usually to exceed the actual volume of water needed in compensation. Water charges are based on actual deliveries, so that losses in the main and secondary canals and in case of damage to a canal are not billed. These are absorbed in the general budget.

Fee collection rates are moderate, 70-80% on average in Tadla, and 60-70% in Haouz. However, system delivery losses (between diversion and measured supply to farmers) must be relatively low, because the volume of water billed is typically 80% of water available to the scheme.

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Table 3.2 Haouz farm budgets – canal irrigated

Farm 1 -- 6 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs	Labor	Water	Net Income $	Family Labor Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
				—— $ ——								
Wheat	1.545	2,7	4.172	704		311	**3.156**	81	39	15,6	0,3	0,2
Lucerne	700	0,6	420	325	4	160	**-70**	30	-2	8,0	0,1	-0,0
Feves	1.568	0,8	1.223	87		63	**1.073**	34	31	3,2	0,4	0,3
Olive 1	1.925	1,6	3.003	253	64	167	**2.520**	55	46	8,3	0,4	0,3
Berseem	585	1,6	913	230	33	67	**582**	23	26	3,4	0,3	0,2
Totals		7,2	9.730	1.600	101	768	**7.261**	223	33	38,4	**0,3**	**0,2**

Cropping Intensity = 120% Utilization of Available Family Labor =46% Proportion of Family Labor in Total Used = 91%

Farm 2 -- 5,5 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs	Labor	Water	Net Income $	Family Labor Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
				—— $ ——								
Wheat	1.326	1,7	2.187	396		190	**1.601**	66	24	9,5	0,2	0,2
Lucerne	800	0,6	440	293		147	**-0**	31	-0	7,3	0,1	-0,0
Berseem	540	1,0	558	118		45	**396**			2,2	0,3	0,2
Broadbean	1.960	0,7	1.401	112		54	**1.235**	30	41	2,7	0,5	0,5
Olive 2	1.908	1,0	1.973	173		79	**1.721**	43	40	3,9	0,5	0,4
Paprika	3.360	1,1	3.696	530		164	**3.002**	15	195	8,2	0,5	0,4
Totals		6,1	10.256	1.623		678	**7.954**	186	43	33,9	**0,3**	**0,2**

Cropping Intensity = 111% Utilization of Available Family Labor =19% Proportion of Family Labor in Total Used = 100%

Farm 3 -- 6,2 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs	Labor	Water	Net Income $	Family Labor Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
				—— $ ——								
Wheat	1.467	2,5	3.638	737	112	286	**2.504**	72	35	14,3	0,3	0,2
Olive 1	2.750	0,6	1.705	91	3	66	**1.545**	16	95	3,3	0,5	0,5
Broadbean	1.715	0,6	1.063	242	38	47	**736**	20	38	2,4	0,5	0,3
Paprika	3.840	2,5	9.523	985	24	369	**8.145**	62	131	18,5	0,5	0,4
Totals		6,2	15.930	2.055	176	768	**12.930**	170	76	38,4	**0,4**	**0,3**

Cropping Intensity = 100% Utilization of Available Family Labor =35% Proportion of Family Labor in Total Used = 83%

Table 3.3 Haouz farm budgets – groundwater irrigated

Farm 1 -- 6 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs $	Labor $	Water $	Net Income $	Family Labor Use (days)	Family Labor Return $/day	Water Use 000 m3	Water Return $/m3 Gross	Net
Wheat	1,545	2.7	4,172	704		498	**2,970**	81	37	15.6	0.3	0.2
Lucerne	700	0.6	420	325	4	257	**-166**	30	-6	8.0	0.1	-0.0
Feves	1,568	0.8	1,223	87		101	**1,035**	34	30	3.2	0.4	0.3
Olive 1	1,925	1.6	3,003	253	64	267	**2,420**	55	44	8.3	0.4	0.3
Berseem	585	1.6	913	230	33	108	**541**	23	24	3.4	0.3	0.2
	Totals	7.2	9,730	1,600	101	1,229	**6,800**	223	31	38.4	**0.3**	**0.2**

Cropping Intensity = 120% Utilization of Available Family Labor = 46% Proportion of Family Labor in Total Used = 91%

Farm 2 -- 5.5 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs $	Labor $	Water $	Net Income $	Family Labor Use (days)	Family Labor Return $/day	Water Use 000 m3	Water Return $/m3 Gross	Net
Wheat	1,326	1.7	2,187	396		304	**1,487**	66	23	9.5	0.2	0.2
Lucerne	800	0.6	440	293		235	**-88**	31	-3	7.3	0.1	-0.0
Berseem	540	1.0	558	118		71	**369**			2.2	0.3	0.2
Broadbean	1,960	0.7	1,401	112		87	**1,202**	30	40	2.7	0.5	0.4
Olive 2	1,908	1.0	1,973	173		126	**1,674**	43	39	3.9	0.5	0.4
Paprika	3,360	1.1	3,696	530		262	**2,904**	15	189	8.2	0.5	0.4
	Totals	6.1	10,256	1,623		1,085	**7,547**	186	41	33.9	**0.3**	**0.2**

Cropping Intensity = 111% Utilization of Available Family Labor = 19% Proportion of Family Labor in Total Used = 100%

Farm 3 -- 6.2 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs $	Labor $	Water $	Net Income $	Family Labor Use (days)	Family Labor Return $/day	Water Use 000 m3	Water Return $/m3 Gross	Net
Wheat	1,467	2.5	3,638	737	112	457	**2,332**	72	33	14.3	0.3	0.2
Olive 1	2,750	0.6	1,705	91	3	106	**1,506**	16	93	3.3	0.5	0.5
Broadbean	1,715	0.6	1,063	242	38	75	**708**	20	36	2.4	0.5	0.3
Paprika	3,840	2.5	9,523	985	24	590	**7,924**	62	128	18.5	0.5	0.4
	Totals	6.2	15,930	2,055	176	1,229	**12,470**	170	74	38.4	**0.4**	**0.3**

Cropping Intensity = 100% Utilization of Available Family Labor = 35% Proportion of Family Labor in Total Used = 83%

Table 3.4 Tadla farm budgets – canal irrigated

Farm 1 -- 4.8 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs ($)	COSTS Labor ($)	COSTS Water ($)	**Net Income $**	Family Labor Use (days)	Family Labor Return $/day	Water Use 000 m3	Water Return $/m3 Gross	Water Return $/m3 Net
Sugarbeet	1,060	1.0	1,058	443	165	155	**295**	59	5	7.8	0.1363	0.0580
Wheat	2,680	0.8	2,135	195	25	64	**1,851**	22	83	3.2	0.7	0.6
Lucerne	1,080	1.8	1,944	1,466	48	415	**15**	53	0	20.7	0.1	0.0
Broadbean	1,645	0.6	987	60	6	43	**878**	27	33	2.2	0.5	0.4
Olive 1	920	0.6	552	68	86	52	**345**	21	16	2.6	0.2	0.2
Berseem	498	0.6	299	69	21	21	**189**	5	35	1.0	0.3	0.2
Totals		5.4	6,976	2,301	352	750	**3,573**	188	19	37.5	**0.2**	**0.1**

Cropping Intensity = 112% Utilization of Available Family Labor = 78% Proportion of Family Labor in Total Used = 70%

Farm 2 -- 6 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs ($)	COSTS Labor ($)	COSTS Water ($)	**Net Income $**	Family Labor Use (days)	Family Labor Return $/day	Water Use 000 m3	Water Return $/m3 Gross	Water Return $/m3 Net
Sugarbeet	1,400	2.0	2,772	1,062	506	308	**895**	74	12	15.4	0.2	0.1
Wheat	2,033	2.0	4,025	421	147	160	**3,298**	34	97	8.0	0.5	0.4
Broadbean	1,410	1.0	1,404	102	60	72	**1,170**	47	25	3.6	0.4	0.3
Paprika	2,600	1.0	2,590	442	9	203	**1,936**	3	565	10.1	0.3	0.2
Olive 2	1,040	1.0	1,036	83	178	127	**648**	26	25	6.4	0.2	0.1
Totals		6.9	11,827	2,110	900	870	**7,947**	184	43	43.5	**0.3**	**0.2**

Cropping Intensity = 116% Utilization of Available Family Labor = 77% Proportion of Family Labor in Total Used = 46%

Farm 3 -- 7.7 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs ($)	COSTS Labor ($)	COSTS Water ($)	**Net Income $**	Family Labor Use (days)	Family Labor Return $/day	Water Use 000 m3	Water Return $/m3 Gross	Water Return $/m3 Net
Sugarbeet	600	1.5	901	672	4	234	**-8**	118	-0	11.7	0.1	0.0
Wheat	1,550	3.4	5,251	664	28	273	**4,286**	84	51	13.7	0.4	0.3
Lucerne	480	2.6	1,246	1,543	14	598	**-909**	245	-4	29.9	0.0	-0.0
Broadbean	1,410	0.2	271	26	0	14	**231**	9	25	0.7	0.4	0.4
Totals		7.7	7,669	2,905	46	1,118	**3,600**	456	8	55.9	**0.1**	**0.1**

Cropping Intensity = 100% Utilization of Available Family Labor = 63% Proportion of Family Labor in Total Used = 97%

Table 3.5 Tadla farm budgets – groundwater irrigated

Farm 1 -- 4.8 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs ($)	Labor ($)	Water ($)	**Net Income $**	Family Labor Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
Sugarbeet	1,060	1.0	1,058	443	165	318	**132**	59	2	7.8	0.1	0.1
Wheat	2,680	0.8	2,135	195	25	132	**1,784**	22	80	3.2	0.7	0.6
Lucerne	1,080	1.8	1,944	1,466	48	850	**-420**	53	-8	20.7	0.1	0.0
Broadbean	1,645	0.6	987	60	6	89	**832**	27	31	2.2	0.5	0.4
Olive 1	920	0.6	552	68	86	106	**291**	21	14	2.6	0.2	0.2
Berseem	498	0.6	299	69	21	43	**167**	5	31	1.0	0.3	0.2
Totals		5.4	6,976	2,301	352	1,538	**2,785**	188	15	37.5	**0.2**	**0.1**

Cropping Intensity = 112% Utilization of Available Family Labor =78% Proportion of Family Labor in Total Used = 70%

Farm 2 -- 6 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs ($)	Labor ($)	Water ($)	**Net Income $**	Family Labor Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
Sugarbeet	1,400	2.0	2,772	1,062	506	631	**572**	74	8	15.4	0.2	0.1
Wheat	2,033	2.0	4,025	421	147	327	**3,130**	34	92	8.0	0.5	0.4
Broadbean	1,410	1.0	1,404	102	60	147	**1,095**	47	23	3.6	0.4	0.3
Paprika	2,600	1.0	2,590	442	9	416	**1,723**	3	503	10.1	0.3	0.2
Olive 2	1,040	1.0	1,036	83	178	261	**514**	26	20	6.4	0.2	0.1
Totals		6.9	11,827	2,110	900	1,783	**7,034**	184	38	43.5	**0.3**	**0.2**

Cropping Intensity = 116% Utilization of Available Family Labor =77% Proportion of Family Labor in Total Used = 46%

Farm 3 -- 7.7 ha

	Income per ha $	Crop Area ha	Farm Income $	COSTS Inputs ($)	Labor ($)	Water ($)	**Net Income $**	Family Labor Use (days)	Return $/day	Water Use 000 m3	Return $/m3 Gross	Net
Sugarbeet	600	1.5	901	672	4	479	**-253**	118	-2	11.7	0.1	0.0
Wheat	1,550	3.4	5,251	664	28	560	**3,999**	84	48	13.7	0.4	0.3
Lucerne	480	2.6	1,246	1,543	14	1,226	**-1,537**	245	-6	29.9	0.0	-0.0
Broadbean	1,410	0.2	271	26	0	28	**216**	9	23	0.7	0.4	0.4
Totals		7.7	7,669	2,905	46	2,293	**2,425**	456	5	55.9	**0.1**	**0.1**

Cropping Intensity = 100% Utilization of Available Family Labor =63% Proportion of Family Labor in Total Used = 97%

Table 3.6 ORMVA of Haouz : water service costs

(a) Staff + annual O&M costs (No allowance for capital depreciation) US$ millions

Haouz	Dept of Irrigation and Drainage		Dept of Construction		Dept of Ag. Development + Extension		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
Direct costs	2.6	71	0.8	84	3.3	71	6.7	73
Indirect costs	1.0	29	0.1	16	1.3	29	2.5	27
Total costs	3.6	100	0.9	100	4.7	100	9.2	100

Project Area: 310,000ha
Cost/ha/yr: US$ 30

(b) Structure of costs with capital depreciation US$ millions

Haouz	Dept of Irrigation and Drainage		Dept of Construction		Dept of Ag. Development + Extension		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
Direct costs	9.1	87	1.4	88	3.5	68	14.0	82
Indirect costs	1.3	13	2.0	12	1.7	32	3.2	18
Total costs	10.4	100	1.6	100	5.2	100	17.2	100

Cost/ha/yr: US$ 54

Table 3.7 Haouz O&M and investment budget 1993 to 1999 (US$)

US$	1993	1994	1995	Sem 1 96	96/97	97/98	98/99
Provisional Budget	6,259,897	9,276,413	8,375,595	4,738,140	9,292,841	8,629,278	8,403,125
Actual expenditure on operations	5,841,134	6,524,674	7,574,643	3,844,767	7,781,250	7,462,784	7,566,771
Pumping costs	0	0	0	0	0	0	0
Maintenance	0	0	0	0	0	0	0
Personnel	4,850,722	5,406,848	6,167,738	2,920,465	6,612,045	6,337,423	6,525,000
Other ops costs	990,412	1,117,826	1,406,905	924,302	1,169,205	1,125,361	1,041,771
Actual expenditure on new works/investment	943,196	1,692,717	1,962,738	1,127,093	1,719,091	1,697,526	1,919,688
Total actual expenditure	**6,784,330**	**8,217,391**	**9,537,381**	**4,971,860**	**9,500,341**	**9,160,309**	**9,486,458**
Income	**2,122,165**	**2,912,935**	**4,941,667**	**898,023**	**5,376,250**	**3,884,845**	**5,325,000**
Level of subsidy	4,662,165	5,304,457	4,595,714	4,073,837	4,124,091	5,275,464	4,161,458

Table 3.8 ORMVA of Tadla: water service costs

(a) Staff + annual O&M costs (No allowance for capital depreciation) US$ million

Tadla	Dept of Irrigation and Drainage		Dept of Construction		Dept of Ag. Development + Extension		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
Direct costs	4.1	70	0.5	68	3.3	69	8.0	69
Indirect costs	1.8	30	0.2	32	1.5	31	3.5	31
Total costs	5.9	100	0.8	100	4.8	100	11.5	100

Project Area: 92,000ha
Cost/ha/yr: US$127

(b) Structure of costs with capital depreciation US$ million

Tadla	**Dept of Irrigation and Drainage**		**Dept of Construction**		**Dept of Ag. Development + Extension**		**Total**	
	Amount	%	Amount	%	Amount	%	Amount	%
Direct costs	5.4	71	6.0	69	3.5	70	9.5	71
Indirect costs	2.2	29	3.0	31	1.5	30	4.0	29
Total costs	7.6	100	9.0	100	5.0	100	13.5	100

Cost/ha/yr: US$150

Table 3.9 Tadla O&M and investment budget 1993 to 1999 (US$)

US$	1993	1994	1995	Sem 1 96	96/97	97/98	98/99
Provisional Budget	12,261,340	12,881,848	12,784,643	5,736,744	11,954,205	10,493,814	10,218,438
Actual expenditure on operations	8,330,825	9,226,196	10,378,333	4,526,163	10,355,227	9,089,175	9,040,417
Pumping costs	136,392	117,609	148,690	28,605	161,250	135,361	138,854
Maintenance	239,794	235,435	162,738	40,349	58,182	100,206	86,563
Personnel	5,165,670	5,621,848	6,532,381	3,093,140	6,325,682	5,567,629	5,584,896
Other ops costs	2,788,969	3,251,196	3,534,524	1,364,070	3,810,227	3,286,082	3,230,104
Actual expenditure on new works/investment	1,159,691	1,538,478	870,238	768,953	901,136	2,342,474	2,401,667
Total actual expenditure	**9,490,515**	**10,764,674**	**11,248,571**	**5,295,116**	**11,256,364**	**11,431,649**	**11,442,083**
Income	**10,058,763**	**10,631,196**	**13,084,405**	**4,299,302**	**13,322,500**	**12,264,948**	**14,293,125**
Level of subsidy	-568,247	133,478	-1,835,833	995,814	-2,066,136	-833,299	-2,851,042

Annex 4

Nepal

Annex 4 Nepal

1. INTRODUCTION

1.1 Country Background

Nepal has a population of roughly 23.5 million, of whom 88% live in rural areas. The overall average annual per capita income is US$ 220 but in the agricultural sector, annual per capita incomes may be as low as US$ 95. Annual water resources per capita, based on internal renewable water resources, are estimated to be 8,400m^3/capita/yr, indicating that water is relatively abundant over the year, but the supply is highly seasonal with much of the annual surface flow occurring during the monsoon.

1.2 Agriculture and the Nepalese economy

Nepal is one of the poorest countries in the world and the poorest in South Asia (World Bank, 2002). Agriculture is the backbone of the Nepalese economy. Although its contribution to gross national product (GDP) has declined over time, it is still the largest sector of the economy, contributing 38% in 1999/2000. Food crops, principally paddy, maize, wheat, millet and barley, accounted for nearly 78% of total cropped area in 1999/2000. Cash crops – oilseeds, potato, sugarcane, tobacco and jute – are grown mostly in the Terai and occupy about 9% of the total cultivated area, accounting for about 8% of the agricultural sector's contribution. Other crops include fruit and vegetables.

Agriculture has received high priority in all government development plans, programmes and policies, yet performance in the sector has been unsatisfactory. Agricultural production has barely kept pace with population growth and the productivity of most crops over the past four decades has at best increased marginally. Despite efforts to extend the area under irrigation, agriculture in Nepal remains largely dependent on the vagaries of the weather. Of the 2.6 million ha under cultivation, only 346,000 ha (13%) have perennial irrigation while a further 437,000 ha (17%) receives supplemental irrigation during the monsoon, from June to August.

The government has adopted a policy of integrating programmes for agriculture and irrigation, enlisting the active participation of farmers in the selection, execution, maintenance and management of irrigation projects. However, the results have not been encouraging, with government investment in irrigation development actually declining over the past decade (Pariyar, 2002).

1.2.1 Agricultural trade

India is the major trade partner of Nepal. Agriculture is a substantial, but declining component of this trade: over the last two decades, agricultural exports to India, as a share of total agricultural exports, have declined from 94% to 72%, while agricultural imports from India have decreased from 69% to 55%. Most agricultural inputs (e.g. fertilisers, pesticides and irrigation equipment) are procured from India. These inputs are subsidised in India, reducing production costs and prices. The same inputs are sold at higher prices in Nepal, increasing production costs, while farmers are forced to sell their produce at lower prices in order to compete with Indian produce. The extent of cross-border trade between India and Nepal therefore greatly influences production costs and the financial viability of agriculture in Nepal.

1.2.2 Agricultural productivity

Winter cropping of wheat, legumes, potatoes and vegetables has become possible with the increased availability of irrigation. An impact study of Mahakali Irrigation Project (Department of Irrigation (DoI), 1999) reported that cropping intensity increased from 160% before regulated and assured irrigation, to 195% in 1999.

A summary of the impact of irrigation on crop yield and farm income for major crops under Hill and Terai conditions is given in Tables 4.1 and 4.2. In the Hills, improvements in crop yield after irrigation were 19% in paddy, 29% in maize, 16% in wheat, 20% in legumes (pulses) and 20% in oilseeds. Income per hectare improved by 26% for maize and 24% for oilseeds. In the Terai, the improvement in yields ranged from 19% (wheat) to 100% (lentils). The improvement in net returns over rainfed conditions varied from 14% (wheat) to 105% (lentils). Generally, irrigated crop yields in the Terai are higher than in the Hills owing to greater availability of quality seeds, increased use of chemical fertilisers, and better management practices.

Table 4.1 Difference in crop yield and net farm incomes between rainfed and irrigated conditions in the Hills

	Paddy	Maize	Wheat	Oilseed	Pulses	Potato
Status under rainfed conditions						
Yield, kg/ha	2,100	1,160	1,900	500	500	-
Net Farm Income, US$ /ha	136	85	149	111	129	-
Status under irrigated conditions						
Yield, kg/ha	2,500	1,500	2,200	600	600	10,000
Net Farm Income, US$ /ha	128	107	166	138	158	217
Percentage change in yield over rainfed conditions	19	29	16	20	20	-
Percentage change in net farm income over rainfed conditions	-6	26	11	24	23	-

Source: Siddiq (1999).
Nepalese Rupees converted to US$ at NRs 62 = US$1 (August 1998)

Table 4.2 Difference in crop yield and net farm income between rainfed and irrigated conditions in the Terai

	Paddy	Wheat	Oilseed	Sugarcane	Lentil	Potato
Status under Rainfed Conditions						
Yield, Kg/ha	2,200	2,100	(1,900)*	(600)*	700	9,000
Net Farm Income, US$ ha	223	213	(155)*	(143)*	223	447
Status under Irrigated Conditions						
Yield, Kg/ha	3,400	2,500	(3,000)*	(1,100)*	1,400	16,000
Net Farm Income, US$/ha	336	242	(264)*	(281)*	459	778
Percentage change in yield over rainfed conditions	55	19	58	83	100	78
Percentage change in net farm income over rainfed conditions	50	14	70	96	105	74

Source: Siddiq (1999).
Nepalese Rupees converted to US$ at NRs 62 = US$1 (August 1998)

Note:
* Figures appear doubtful. Oilseed yields are normally 500-600 kg and sugar cane 20-40t/ha in the Terai.

1.3 Characteristics of irrigated agriculture

1.3.1 Physical types

Surface irrigation

National policies have strongly affirmed farmer-controlled, year-round irrigation as a key precondition to achieving the level of agricultural production envisaged in the Agriculture Perspective Plan (APP). However, almost all surface irrigation facilities developed in the past, by farmers as well as by government, were designed only to provide supplementary irrigation for the main monsoon crop.

UNDESD/UNDP (1993) estimated that overall, only 50% of the command area of Agency-Managed Irrigation Systems (AMIS) is irrigated in summers and 25% in winters.

Many medium-sized to large irrigation schemes have failed to deliver anticipated benefits. The major causes for poor performance are considered to be:

- Unsatisfactory management of irrigation systems
- Inadequate water supply in designed command areas during dry seasons
- Low efficiency of water utilisation
- Weak linkages between the agricultural and irrigation sectors
- Weak institutional capacity.

Groundwater irrigation

Officially, the potential command area of groundwater irrigation facilities developed up to mid-2000 is 220,750 ha. This comprises 38,814 ha covered by deep tubewells (DTW) and 181,936 ha by shallow tubewells (STWs). Most STWs are privately owned and operated, whereas DTWs are normally installed and owned by the Department of Irrigation. DoI estimates that the actual areas irrigated are 131,330 ha in the wet season, 139,360 ha in winter and 48,600 ha in spring. However, a better analysis based on the realities of land fragmentation, small land parcels and low average operating hours, indicates that the actual command area is 25-30% of the theoretical potential for STWs and about 50% for DTWs. The low level of utilisation of groundwater installations adds another dimension to the cost of pumped water, because it increases the unit water charges borne by users.

In most cases, shallow tubewells are used only as supplementary irrigation for nursery bed preparation, and for paddy cultivation in compensation for late rainfall. Shallow tubewells are also used where wheat and some other winter crops need additional water during dry periods. Even at these low levels, it is apparent that farmers using STWs practise more intensive cultivation than those around DTWs.

1.3.2 Governance types

Existing irrigation systems can be broadly separated into Farmer-Managed Irrigation Systems (FMIS), Agency-Managed Irrigation Systems (AMIS), and Jointly-Managed Irrigation Systems (JMIS).

Farmer-Managed Irrigation Systems (FMIS)

In FMIS, farmers are responsible for all management activities, including resource mobilisation and management of resources for operation and maintenance (O&M). The FMIS mainly comprise:

(i) Surface irrigation schemes – traditional run-of-river type with temporary structures, and run-of-river type with permanent/semi-permanent structures constructed mostly with external assistance.
(ii) Groundwater irrigation systems – STWs.

Recent statistics indicate that FMIS account for nearly 70% of irrigation development in the country and supply over 20% of cultivated land (Pradhan, 2001b). Outside the Terai, roughly 90% of irrigated areas, in the Hills and mountains, are farmer-managed.

Farmers have traditionally operated and maintained their systems by co-operative action, contributing both labour and cash. Since the 1980s, the government has assisted FMIS in improvement programmes that now cover 2,460 schemes serving a total of 286,000 ha (Karki, 2001). As stipulated in the Irrigation Policy, the government does not levy irrigation service fees (ISF) on systems fully managed by farmers.

Agency-Managed Irrigation Systems (AMIS)

AMIS include all irrigation systems constructed by the government, where operation, maintenance and management of the system are the responsibility of the Department of Irrigation. AMIS include:

(i) Surface irrigation systems – run-of-river
(ii) Lift irrigation systems
(iii) Deep tubewell systems (DTWs)

The government has constructed some 210 schemes covering 339,000 ha. However, only 35 systems receive regular funding from the DoI for operation, maintenance and management. Most AMIS provide supplemental irrigation in summer, rather than year-round.

Jointly-Managed Irrigation Systems (JMIS)
JMIS are systems constructed by the government, in which government and the water user associations (WUA) share management responsibilities. Current government policy is to share the operation and maintenance responsibilities of large irrigation systems between WUAs and the irrigation agency, leading to joint management programmes at a number of medium/large schemes. WUAs are usually responsible for secondary canals and below, whilst participating in planning for the main canal. They are mandated to collect the irrigation service fee (ISF) for those parts of the system under their control, retaining a part of the collection proportionate to their responsibility, and depositing the balance in the government treasury.

1.3.3 Costs, charges and subsidies

Estimates of irrigation O&M costs
Table 4.3 summarises estimates of *target* and actual O&M budgets for a number of schemes or scheme types, drawn from different sources.

Table 4.3 Estimates of annual O&M costs in different schemes ($US/ha)

Item					
AMIS	Terai generally	Tilawe (Terai)	Hills generally	Rampurphant	Hyangja (Hills)
Actual	9.4-10.7 (1)	-	28.5-35.3 (1)	-	7.8
Target	-	14.3+	-	31.5	21.3
JMIS	Kankai	Khageri			
Actual	6.8 (3)	-	-	-	-
Target	9.3 (3)	7.1 (4)			
FMIS	Chatis Mauja				
Actual	10.6 (2)	-	-	-	-
Target	-				
Tubewells	General	Narayani			
Actual	24.2-42.8	8.6 (3)	-	-	-
Target		23.6-31.1			

Notes
a). Sources:
1). NISP (2001 b)
2). Gautam et al. (2001)
3). NISP (2001 c)
4). HR Wallingford (2001)

b). Target = estimate of the annual charge needed to do all required O&M tasks
Actual = O&M budget allocated by DoI

c). Costs converted from Nepalese Rupees at an exchange rate of NRs80 = US$1

The overall rate of ISF collection in AMIS is extremely low, less than 30% of the assessed amount (Shrestha *et al.,* 1984), and the recovery of O&M costs from ISF collection is less than 2% (NPC, 1994; Pradhan *et al*., 1998; NISP, 2001a). Hence, 98% of O&M costs in agency schemes are borne by the government.

FMIS have traditionally been maintained by the collective action of farmers. Increasingly, there is a trend to seek cash contributions for maintenance. According to HR Wallingford (2001), the contribution in kind by farmers on hill systems may be as high as 1,000 NRs/ha/year (approximately US$ 14).

Water charges
The water charge varies significantly between different government irrigation schemes, reflecting both the cost of O&M on different schemes and whether the scheme supports a single crop or multiple crops per year. Table 4.4 indicates the charges for various schemes.

Table 4.4 Water charges applying on different schemes

Name of System	Rate US $/ha	Charging Basis
Kankai	1.25	By area under rice
Narayani Zone	1.25	By area per year
Sunsari – Morang	2.5	By area per year
Chitwan Lift	0.75	By area per year
Bhairahwa-Lumbini DTWs	5.0	By volume
West Gandak	0.75	By area per year
Khageri	1.6	By area per year
Panchkanya	2.0	By area per crop
Mahakali	2.5	By area per year
Narayani Tubewell	4.8 – 8	Per application
Narayani Tubewell	0.02-0.04	Per unit of electricity consumed

Note: Costs converted from Nepalese Rupees at an exchange rate of NRs 80 = US$1, (rate applying in 2002.)

Irrigation subsidy
Two different forms of subsidy exist – capital and O&M. Surface irrigation schemes and deep tubewells constructed under government initiatives are almost fully financed by the government. However, in a recent step towards the participatory management of AMIS, a small proportion of capital repayment by beneficiaries has been stipulated[8]. The government also provides annual budgets for operation, maintenance and management of the systems. Although irrigation service fees (ISF) have been introduced, collection efficiency is extremely low, and the government bears virtually all O&M costs – comparison of the figures in tables 4.3 and 4.4 illustrates this point. In order to reduce the O&M burden, the government has initiated Turnover and Joint Management programmes, but without great success to date. About 90% of the cost of surface irrigation is subsidised by the government. The annual DoI budget is approximately NRs 4.9 billion for regular and development expenditure (US$ 61 million).

[8] The Irrigation Policy 1992 (Amendment 1997) gives details on the cost sharing arrangement for different sections of the irrigation system.

1.4 Experience with irrigation charging

1.4.1 Objectives of irrigation charging

In Nepal, irrigation charging is intended to meet annual O&M costs and, in theory, some proportion of capital costs. However, no capital costs are ever recovered, as the amounts collected are too small even to meet the cost of O&M, as the figures above demonstrate.

1.4.2 Initiatives and legislation supporting irrigation charging

On AMIS, the government has a policy of collecting water charges from farmers receiving irrigation services. Water charges were introduced in the 1950s in systems fully financed by the government, but such charges were not formalised or given statutory recognition on either surface or groundwater schemes until the promulgation of the Canal, Electricity and related Water Resources Act of 1967.

In 1974, the Canal Operation Regulation made provisions to collect water tax as government revenue and to punish defaulters. Water tax (*panipot*), which was historically levied by landowners on tenants, thereby became a government tax. Until 1975, the tax was levied at an annual rate of NRs. 9/ha per crop, subsequently rising to NRs. 60/ha per crop – a rate that has remained unchanged in surface irrigation schemes, except for those managed by development boards where the charge is now NRs. 200/ha/year (US$2.5/ha/year). The water charge for groundwater irrigation is higher. At Bhairahwa-Lumbini Project, the charge has recently been increased from NRs. 200/ha to NRs. 400/ha (that is, from US$ 2.5 to US$ 5/ha/year).

In FMIS, beneficiaries are required to contribute directly to annual O&M costs. There is no fixed rate, but each system has its own mechanism for collecting revenue.

The 1990s saw several policy announcements aimed at promoting user participation and cost-sharing by beneficiaries, including the National Irrigation Policy (1992) (First Amendment 1997), the Water Resources Act (1992), the Water Regulation (1993) and the Irrigation Regulation (2000).

The National Irrigation Policy aims to decrease the government's direct involvement in the construction and O&M of irrigation systems. Under the Policy, small and medium-scale schemes are to be turned over to WUAs, and large-scale irrigation schemes brought under joint management. For turned-over schemes, the ISF is to be collected and retained by the WUAs to meet the costs of scheme operation, maintenance and management. In jointly-managed schemes, water charges are to be collected by the WUA and shared between the agency and the WUA according to the division of work between the two. The proportion of the collection due to each is presented in Table 4.5.

Table 4.5 Shares of Irrigation Service Fee to HMGN and WUA under Irrigation Policy 1992 (First Amendment 1997)

Details of Participation:	ISF Collection Shares	
	% passed to DoI	% kept by WUA
1. O&M of water courses and below by WUA, and the rest by DoI	75	25
2. O&M of irrigation blocks by WUA, and the rest by DoI	50	50
3. O&M of all canals and command area except the main canal by WUA, and the rest by DoI	25	75
4. Main canal and the total command area except the headworks by WUA, headworks managed by DoI	10	90

Pradhan *et al*. (1998) analysed the water charge collected from various AMIS during the period 1994/95 to 1996/97, and compared O&M costs and ISF collection. ISF collection fell far below the assessed amount. The recovery of O&M costs in various AMIS ranged from 0.1% to 15 %, with an average recovery of 1.3%.

Even transferred projects have not yet succeeded in collecting the full ISF. Table 4.6 shows that in 1997/98, collection efficiency was highest (94%) in the Panchkanya irrigated system, and lowest (21%) in the Paparapati irrigation system. Collection of ISF is difficult, even on transferred irrigation systems, and is central to the problem of cost recovery.

Explaining the reasons for poor fee collection, Shakya (1994) argues that irrigation projects have inadequate institutional mechanisms to administer the collection of fees. Agency staff are not motivated to collect fees, as they would then face greater pressure to provide an assured supply to farmers.

Table 4.6 ISF Collection Efficiency, 1997/98

Irrigation system	Collection target NRs (US $)	Collection progress NRs (US $)	Collection efficiency (%)
NGWCS	369,600 (6,480)	201,292 (3,530)	54
Piparapati	207,450 (3,640)	43,714 (770)	21
Khageri	161,487 (2,830)	105,316 (1,850)	65
Panchkanya	45,095 (790)	42,297 (740)	94

Source: Water Pricing and Cost Recovery, (2001)
Converted at an exchange rate of NRs 57 = US$1 current in June 1997

1.4.3 The scope for fee recovery

Many studies show that the incremental increase in farmers' income due to irrigation is much higher than the tariffs imposed by an irrigation system. However, farmers are reluctant to pay even operating costs because they have come to feel that the construction, operation and maintenance of projects are the responsibility of the government. Table 4.7 indicates incremental annual net returns to farming as a result of irrigation, according to the farm budget analysis presented in the Project Completion Report for the Mahakali Irrigation Project.

Table 4.7 Incremental net returns per farm household and family members in the Mahakali irrigation project area

Farm Size	Incremental Net Returns NRs. ($US)	
	Per farm household	Per family member
Small	16,258 (285)	2,323 (41)
Medium	49,820 (874)	4,684 (82)
Large	119,524 (2,096)	7,559 (133)
Overall Average	27,961 (490)	3,148 (55)

Source: DoI (1997).
Conversion at an exchange rate of NRs57 to US$1 current in June 1997

The present water charge in the Mahakali Irrigation Project is NRs 200 per ha per annum (US$2.5, at a rate of NRs 80 to US$1), which is expected to rise to NRs 400 (US$5) in future. Present and future charges are equivalent to 0.7% and 1.4 % of the overall average incremental net returns per farm household, respectively, and are therefore quite affordable. Another study (NISP, 2001b) supports these conclusions.

Stage II of the Mahakali scheme is still relatively new, so that these relatively low charges may be sufficient to stem gross deterioration of the system in the immediate future. However, in other areas of

Nepal, the relative value of returns to irrigation and the costs of O&M make full cost recovery much more problematic.

1.4.4 Constraints to fee recovery

A number of constraints can be identified that may contribute to the low levels of ISF recovery. These include:

(a) Lack of ownership

The low rate of ISF collection is attributable to users' lack of identification with their scheme. Lack of ownership leads to poor maintenance and, for example, damage to canal banks by free-grazing livestock.

(b) Lack of motivation to pay

In systems that are fully managed by the government, the irrigation office deputes its staff to collect irrigation charges, to be handed over to the general treasury of HMGN in Kathmandu. Farmers therefore see DoI as a revenue-collecting arm of the government. In the case of WUA-managed branches, some 50% of the ISF collected is supposed to be sent to HMGN with the remainder kept by the WUA. There is therefore no linkage between rates of ISF collection and O&M services delivered.

(c) Weak institutional mechanisms

In almost all systems, the institutional mechanisms required to administer the ISF are weak. Contractual bonds between the DoI and farmers are lacking and support services to augment production are either unavailable or ineffective.

(d) Limited impact of irrigation

The impact of irrigation tends to be less than anticipated. Most sites are characterised by O&M problems because of poor funding and procedures. Farmers achieve less than potential output and income, in part because of deficiencies in supply, but also because of the relatively low level of agricultural development compared with other parts of South Asia.

(e) Water as a free good

Farmers on government schemes consider water to be a free good because sanctions for misuse are not imposed.

(f) Poor management

The DoI's post-construction, project management and O&M procedures are inadequate. Problems of supply at the tail end extend to the middle reaches of some systems. Problems of waterlogging in the wet season are exacerbated by a lack of attention to drainage.

(g) Lack of reliable information and inefficient legal and regulatory measures

The information available on most systems is very limited. Neither the WUAs nor the DoI know the actual area irrigated, although the water charge is based on a "per ha per year" assessment to facilitate administration of the charge. In practice, the assessment of ISF appears to be determined principally by reference to statistics available in the maintenance survey office. These statistics are defective in many respects and are commonly based on out-of-date information. For example, land may be subject to payment because it was once recorded as taxable despite being currently fallow or affected by flood.

(h) Evading payment and 'free riders'

In the absence of effective enforcement mechanisms and the virtual absence of mechanisms to exclude non-payers from irrigation service use, free riders enjoy equal or (if they are powerful) greater services than those paying ISF. A mechanism capable of imposing strong sanctions on defaulters is lacking.

(i) Alternative uses of water

At present, the charge does not differentiate between alternative uses of system water. For instance, there may be fishponds in the command area. These farmers use sizeable volumes of irrigation water but pay (the comparatively low) ISF equivalent to paddy irrigation. Similarly, winter vegetable growers use water more than wheat growers, but they pay the same rates as the latter.

(j) Land tenure system and absentee landlords

Existing land tenancy arrangements, consisting mainly of fixed tenancies and sharecropping, do not encourage increased ISF collection. Tenants are charged rather than landowners. Some absentee landlords thereby obtain irrigation services without paying ISF.

(k) Staged turnover of systems

Within most systems falling under the turnover programme, some branches have been turned over to WUAs while others have not. Most users of turned-over systems pay ISF reasonably regularly, while users on branches that have not been turned over do not pay, which leads to a sense of injustice.

1.4.5 Pre-conditions for increased cost recovery

It is considered unrealistic to increase the value of the ISF without first achieving great improvements in the collection of existing fees and in the quality of irrigation service provided. Actions that may improve the present levels of recovery include:

a) Turned-over branches and systems

Field investigations indicate that WUAs are more efficient at collecting ISF than is the DoI or other government agencies. The process of handing over branches or systems needs to be speeded up if O&M cost recovery is to be realised. Unless users are intimately involved in the process, improved ISF recovery is unlikely.

b) Change farmers' perceptions of ISF

Farmers generally perceive no obvious link between the ISF and O&M services, and therefore view the fee as little more than a source of revenue for the DoI. It is therefore important to create an environment in which users perceive the ISF to be payment for services received from the DoI.

c) Transparency of allocation and use of ISF

Even on turned-over systems, users resent what they perceive as an unsystematic assessment of the ISF payable by each farmer and the fact that they have little say in the use of funds collected. The system therefore requires greater transparency, including means of ensuring that revenue collected is spent on irrigation services.

d) Institutional strengthening

Programmes aimed at strengthening institutions such as the DoI, WUAs and other relevant authorities should be introduced, including measures to improve data collection and record-keeping so as to reinforce the link between water use (normally based on crop and area) and the charge levied.

e) Creation of a framework of social conditions

Until WUAs are able to enforce sanctions agreed by all their members, free riders are likely to remain a problem. WUA constitutions provide for such measures but implementation is often ineffective.

Before raising the level of present ISF tariffs the following issues should be addressed:

1) Improved quality of service.

Unless the water delivery performance is improved, users are unlikely to be disposed to pay higher fees.

2) Improved awareness
Many problems are linked to a general lack of awareness about the operation of an irrigation system. Public awareness campaigns could improve knowledge of irrigation issues, particularly amongst the elite, public sector bureaucrats and farmers, as well as international donors.

3) Incentives
Incentives for those who pay and sanctions for those who do not should be developed. ISF payments could be linked to irrigation service performance.

4) Institutional changes
Involving WUAs in the collection of irrigation fees has proved quite effective. It is therefore important to extend turnover to other branches and systems.

5) Revision of ISF
To date, the ISF has been fixed on an ad hoc basis. However, the fee needs to be raised. Users should be consulted and convinced of current constraints and the consequences for their livelihoods if the fee is not increased. A systematic approach should be introduced that considers what farmers can afford to pay as well as local socio-economic circumstances. The following factors should be considered in reviewing the existing ISF rate:

- Reliability of the water supply
- Level of production, especially from early paddy
- Cropping intensities
- Cost of production
- Marketing facilities and networks
- Required O&M costs
- Inflation and increase in price of major commodities.

Revision of the ISF should be made a regular process, and should take account of inflation. Since farmers may have difficulties understanding the national inflation rate, a more practical starting point could be to use increases in the price of paddy and wheat. There should also be meaningful representation of monsoon and winter crops. A two-year transition to a new ISF structure is considered realistic.

6) Raising farmers' confidence in DoI O&M activities
The DoI's performance in O&M needs to be improved. Until farmers perceive that the DoI's performance is better and more responsive, they are unlikely to co-operate in the ISF revision process. An assured supply of water is a prerequisite to getting farmers to pay a higher ISF.

7) Ownership
Unless farmers feel that the irrigation system is basically under their control, attempts to raise the ISF are unlikely to be very successful.

Government actions needed to support these different policy measures are summarised in Table 4.8.

Table 4.8 Necessary Government Support/Action/Legislation

Policy measure	Necessary government support/action/legislation
Turnover of branches and irrigation systems	Initiate repair and maintenance works in branches and irrigation systems, to upgrade them to an adequate standard for turnover. Improve the capacity of WUAs to take over branch or irrigation system management. Hand over works and assign ISF collection and management responsibilities to WUAs.
Change perceptions of ISF collection	Assign full responsibility for ISF collection and allocation to WUAs on turned-over systems. Initiate on-site awareness campaigns to clarify that the ISF pays for ongoing costs of the irrigation system and for services received, and is not simply a means for the DoI to collect revenue.
Transparency in use and allocation of ISF	Devise policy and procedural guidelines for the systematic use of the ISF. Involve WUAs in the ISF allocation and management process. Introduce a system of public auditing to collect and use the ISF.
Institutional changes and strengthening	Improve WUA procedures for irrigation charge collection, for transparent accounting and for maintenance identification/execution.
Minimising problems of 'free riders' and payment evasion	Promote the message that water is an economic good and is not free. Encourage WUAs to introduce and enforce a system of penalties for transgressors, particularly denying the use of irrigation services, if feasible.
Incentives for timely payers	Consider making ISF payment one of the criteria for participation in training and study visits. Devise financial incentives for ISF payers and enforce penalties for non-payers.
Basis for increasing ISF rate	Establish ISF revision as a regular and scheduled process. Use inflation of commodity prices over the periods under consideration for ISF adjustments, with proper representation of monsoon and winter crops. Consult users.
Raising farmers' confidence in O&M activities	Train WUAs to participate actively in jointly managed schemes and to make the link between ISF collection and O&M activities on turned-over schemes.
Improve water supply	Improve the quality of irrigation services, particularly for early paddy. Implement users' awareness programmes.

2. CASE STUDIES

2.1 Selected schemes

Table 4.9 below shows leading details of four large, surface irrigation schemes on the Terai constructed by HMG, for which maintenance issues were investigated in detail (HRW, 2001).

Table 4.9 Characteristics of four large surface irrigation schemes on the Terai

Scheme	Nom. gross ha	Avge land Holdng ha	Crops: Monsoon	Crops: Winter	Crops: Spring	Notes
Kankai	7,000	2.1	Paddy	Wheat	Maize/ Paddy	Spring water shortage. Farmers get water only alternate years.
Khageri	3,900	1.1	Paddy	Wheat	Wheat/pulse /oilseed	Recently rehabilitated. System condition good. Joint managed.
Tilawe	5,600	1.1	Paddy	Wheat	Pulse/oilseed /maize	Poor condition generally.
West Gandak	8,700	1.8	Paddy	Wheat/pulse/ oilseed	Perennial: Some sugarcane	Fully turned-over. Poor conditions throughout.

Kankai scheme, management of which has now been partially turned over to farmers (Joint Management), is generally considered to perform above the average. Like many schemes, water is short following supplementary irrigation to paddy in the monsoon season. The Department of Irrigation manages a rotational supply pattern under which farmers only receive water in the winter and dry seasons in alternate years. In their "on" years, farmers may grow irrigated wheat or spring paddy. Otherwise, wheat is rain-fed, or land is left fallow. Farmers' annual incomes will reflect the constraint.

Khageri Irrigation System is situated in Chitwan District. The mean annual rainfall is about 2,000 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 settled land of the Chitwan valley. Original plans to develop 6,000 ha of land were abandoned due to shortage of water. 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.

Tilawe Irrigation Scheme is located in Parsa District. The scheme has an average annual rainfall of about 1,400 mm. Monthly rainfall varies from 4 mm in November to 470 mm in July. The project started in the late 1950s. During the 1960s, the Indian Government assisted Nepal to construct the Nepal Eastern Canal (NEC) for 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.

West Gandak Irrigation System is located in Nawalparasi District in the Western Development Region of the Nepal Terai. Mean annual rainfall is 1,500 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 8,700 ha of land in Nepal 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.

Other analysis of O&M was carried out under the Nepal Irrigation Sector project O&M Study (NISP, 2000 and NISP, 2001 a, b and c). Data from 3 schemes of different types and in different areas were subsequently reviewed in 2002 by consultants Consolidated Management Services based in Katmandu (CMS) for this study, (CMS, 2002).

Kankai (KIS) is considered a surface scheme of above average performance by CMS.

Hyangja (HIS), is a small, agency-managed (AMIS) surface scheme (300 ha) in the Hills, constructed under the Hill Irrigation Project in 1987/88. River flow is intermittent. The soils in HIS are extremely fertile. The scheme was rated Below Average by CMS.

Narayani Tubewell Scheme (NTS) is a groundwater scheme, also agency managed. NTS consists of 29 deep tubewells with a total command area of about 2,790 ha. It came into operation in 1968. Since then a number of tubewells have failed because of damage, mainly to the screen or casing pipes, and have been abandoned. Currently 7 tubewells are non-functional. The major crop grown during summer is paddy. During the winter, wheat, potato, oilseed, pulses and vegetables are grown, and during spring, paddy and maize are grown. Sugarcane is grown as a perennial crop. NTIS was recently rated to be of Average performance.

2.2 Operation and Maintenance

2.2.1 Required (target) O&M expenditures

Table 4.10 illustrates the variation in target maintenance expenditures on the four Terai schemes, as derived from a needs-based assessment (HR Wallingford, 2001). Costs depend, amongst other factors, on scheme age, characteristics and condition (the last of which is, in turn, affected by the date of any rehabilitation). Much wider variation in basic maintenance costs could be expected, for example, on smaller schemes, groundwater schemes and those in more difficult soils and topography (e.g. hilly areas). The costs, which do not allow for major restoration works, reflect the fact that the general condition of the systems varies considerably, ranging from relatively good at Kankai to severe neglect at Tilawe.

Target O&M costs would be higher than for maintenance alone. Without making a detailed study of current staffing levels, a broad estimate of required O&M costs could be made by factoring the maintenance costs by 1.20.

The figure of $US 9 /ha for maintenance in Kankai seems somewhat low. The system appears in relatively good condition and includes a sediment extraction device at the head. The main canal is steep, so there is little sedimentation, but its condition has deteriorated owing to a backlog of deferred maintenance. The average figure for the four schemes on the Terai is $US 14.5 /ha.

Table 4.10 Cost of required maintenance. NRs ($US) per ha

Scheme/system level	Cost of required annual structure maintenance/ha	Cost of required annual canal maintenance/ha	Total cost of maintenance/ha	Capital cost of required structural improvements/ha
Kankai				
Main	270	252	523	3,571
Branches	56	54	110	173
			Total **633 (9)**	Total 3,744
Khageri				
Main	85	285	370	5
Branches	143	504	647	0
			Total **1,017 (14.5)**	Total 5
Tilawe				
Main	621	287	908	170
Branches	289	245	534	50
			Total **1,442 (21)**	Total 220
West Gandak				
Main	111	148	259	291
Branches	228	420	648	272
			Total **907 (13)**	Total 563

Note: The figures are averages derived from the canals and structures surveyed on the four schemes
Source: HR, 2001

Estimates of the required (target) costs of O&M in the three schemes reported by CMS (2002) are shown in Table 4.11. The figure for Kankai is comparable with that obtained for maintenance only in Table 4.10.

Table 4.11 Estimated annual required (target) O&M costs. US$ / ha

Scheme	Estimate of full O&M/ha (US$)	Notes
KIS	10 [1]	Surface scheme, Terrai. "Good" condition. (NISP, 2001c)
NTIS	37 [1]	Average of 5 wells. Includes O&M of well and canal system. Data collected by CMS study team
HIS	21 [1]	CMS interviews with WUA chairman & DoI staff

1. Based on an exchange rate of 70 NRs = $US 1.
Source: CMS, 2002.

The substantially higher figure for the tubewell scheme (Narayani) reflects the energy costs for pumping.

2.2.2 Actual O&M expenditures

Identification of the actual amount spent on O&M is complicated by the fact that salaries and part of general establishment costs may be separately listed in typical agency records. To further complicate the issue, programmes of major repairs are being carried out on some systems, so it is difficult to separate out recurrent from one-off costs.

There is considerable annual variation in the budget allocated to each scheme. There appears to have been a trend to reduce the allocations to most schemes in the years leading up to the millennium, both in terms of the rupee and the dollar. The backlog of maintenance work evident at many locations bears out the fact.

On the Terrai schemes in table 4.10, approximate figures for maintenance derived from the total annual works budget on the different schemes, divided by the effective command areas, vary from: $US 3 /ha (Tilawe) to $US 7 /ha (Khageri) for 1999/2000. Much of the expenditure at Khageri was needed to restore the downstream protection to the barrage.

For the remaining schemes in Table 4.11, the average figures for annual repair and maintenance for the six years prior to the millennium were $US 9 /ha (HIS) and $US 11 /ha NTIS, falling to $US 7 /ha and $US 3 /ha in 1998/99. The budgets allocated fall far short of the amount needed.

2.3 Representative farm budgets

Table 4.12 Estimated financial returns from Irrigation. Prices in NRs ($US [1]).

Item	Kankai	Khageri	Tilawe	W. Gandak
Net Returns/ Crop Hectare				
Paddy:				
- Irrigated	10,711 (153)	13,016 (186)	12,378 (177)	10,882 (155)
- Unirrigated	7,378 (105)	9,671 (138)	9,167 (131)	7,378 (105)
Wheat:				
- Irrigated	7,277 (104)	5,368 (77)	3,403 (49)	4,671 (67)
- Unirrigated	3,405 (49)	1,746 (25)	1,281 (18)	1,206 (17)
Net Returns per Farm Hectare				
(a) Irrigated Cropping				
Paddy:				
- Crop area (ha)	0.90	0.95	1.00	0.90
- Net returns	9,640 (138)	12,366 (177)	12,378 (177)	9,794 (140)
Wheat:				
- Crop area (ha)	1.00	0.65	0.95	0.85
- Net returns	7,277 (104)	3,489 (50)	3,233 (46)	3,971 (57)
Total net returns	**16,917 (242)**	**15,855 (226)**	**15,610 (223)**	**13,764 (197)**
(b) Rainfed Cropping				
Paddy:				
- Crop area (ha)	0.90	0.95	1.00	0.90
- Net returns	6,640 (95)	9,188 (131)	9,167 (131)	6,640 (95)
Wheat:				
- Crop area (ha)	1.00	0.65	0.95	0.85
- Net returns	3,405 (49)	1,135 (16)	1,217 (17)	1,025 (15)
Total net returns	10,045 (143)	10,322 (147)	10,384 (148)	7,665 (109)
Incremental Returns from Irrigation/ha	**6,872 (98)**	**5,532 (79)**	**5,226 (75)**	**6,099 (87)**
Household income				
- Assumed area (ha)	2.1	1.1	1.1	1.8
- Income/month [2]	2,960	1,453	1,431	2,065
- % poverty line	104%	51%	51%	73%
Estd. Maintenance costs/ha [3]	633 (9)	1,017 (14.5)	1,442 (21)	907 (13)
Estd. O&M costs/ha (maint. x 1.2)	760 (11)	1220 (17.5)	1730 (25)	1090 (15.5)
O&M Cost as % Incremental returns from irrigation	11	22%	33%	18%

Source: HR Wallingford (2001).

Notes 1. Assumed conversion rate, mid 2000: $1US = NRs 70
2. Income per month = net irrigated return per farm hectare per year, multiplied by farm area, divided by 12.
3. Maintenance costs are those needed to deal with the system as is, owing to delayed maintenance, rather than the somewhat lower costs once backlog has been removed.

The per hectare crop yields taken for the four Terai schemes shown in Table 4.9 are broadly comparable with those obtained in studies elsewhere on the Terai in Nepal. Table 4.12 summarises the data. The analysis considered a monsoon paddy-wheat cropping pattern. Despite its higher yield potential, investigation showed that the actual yields from spring paddy were not much higher than those of wheat. As market prices for paddy (NRs 8/kg) and wheat (NRs 9/kg) were comparable at the time, the net returns from irrigated wheat were taken to be similar to those from spring paddy. It is a simplification, since spring paddy is a strongly preferred crop, but it is considered sufficiently accurate for the purposes of the present analysis. Other minor irrigated crops such as pulses are planted on small areas only.

Irrigation benefits per farm hectare are fairly similar on the four schemes, ranging from NRs 6,900 / ha at Kankai to NRs 5,200 / ha at Tilawe. 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, irrigation increases farmers' crop net income per hectare by between 50% and 80%.

Data on the maintenance costs needed to sustain the system were obtained in the same study (HR, 2001). For Kankai they were found to be comparable with estimates made under other projects/studies. They correspond to some 9% of farmers' *incremental* annual net returns to irrigation. In "off" years, and in otherwise unfavourable seasons, O&M costs can be expected to represent a higher proportion of farmers' income, since annual regular O&M costs will not vary much year by year, even though parts of the system may only be operating in every second dry season. It is considered that 9% is towards the upper limit of acceptability for a surface system operating reasonably well, in contrast to a groundwater supply, for which farmers may be disposed to pay higher charges in return for a more readily available and manageable supply. The figures for the remaining schemes correspond to 15% upwards of a farmer's incremental net returns, which appears too high for a marginal farmer (income already below the poverty threshold) to afford.

2.4 Levels of fee recovery

Table 4.13 shows actual incomes from irrigation fees in the three schemes reported by CMS for the period 1994 to 1997.

Table 4.13 Fee recovery 1994 to 1997

Scheme	Total income from fees (US $)			Average income US$ / ha
	1994/95	1995/96	1996/97	
KIS	3,714	5,463	4,250	0.56
NTIS	No data	1,390	No data	0.5
HIS	0	0	0	0

Source: CMS (2002)

At Kankai, the fees are set at NRs 150 /ha, equivalent to about US$ 2.7 /ha using the prevailing exchange rate for the period. Thus, the level of fee recovery at KIS is about 20%. However, given that the actual cost of O&M on the scheme is above US$ 9/ha, it is evident that even with 100% fee recovery the scheme would still rely on government funds for about 70% of its budget each year. In practice, setting a higher fee would have little effect when the rate of recovery is so low.

There is no fixed rate per hectare at Narayani deep tubewell scheme, as farmers pay per irrigation and according to hours of pumping. However, the lack of data for two of the three years of record and the very low rate of recovery, equivalent to just US$ 0.50 /ha in 1995/96 indicates that the total fee recovery is extremely low.

In Hyangja Hill scheme there is no formal fee system in place, as farmers contribute their labour, plus some cash, on an ad hoc basis to meet maintenance or emergency repair needs. However, as a consequence of this the scheme is highly dependent on government subsidy to meet routine O&M costs.

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Annex 5

Pakistan: Sindh Province

Annex 5 Pakistan: Sindh Province

1. INTRODUCTION

1.1 Relevant characteristics of the country

Pakistan has a population of about 141 million, of whom 67% are rural dwellers. National average per capita income (GDP / head) in 2001 was US$ 420 and agriculture accounted for about 27% of GDP, (World Bank, 2003). Total annual renewable water resources were estimated to be about 418 km^3 in 1995 (FAO, 1997) equivalent to a water availability of about 2,960 m^3 /head /year.

1.2 Agriculture in Sindh Province

Of the four Provinces in Pakistan, Sindh, located along the lower Indus, is the second largest. Almost all cropping in the province relies on irrigation. Table 5.1 lists the main crops grown and their average yields, which are low for irrigated production.

Table 5.1 Main irrigated crops and yields in Sindh Province

	Area '000 ha		Yield (t/ha)	
Major Crops	***1998-99***	***1999-2000***	***1998-99***	***1999-2000***
Wheat	1,124	1,144	2.38	2.62
Rice	704	690	2.74	3.08
Cotton ('000 Bales)	630	633	3.39	3.75
Sugarcane	271	230	62.96	61.97
Sorghum	110	91	0.58	0.61
Bajra	175	18	0.42	0.49
Maize	10	9	0.52	0.53
Rape Seed & Mustard	92	78	0.80	0.82
Gram	90	86	0.85	0.81

The major crops are wheat, rice and cotton. High value horticulture is mainly limited to mango orchards. Over the last fifteen years agricultural production in Sindh has increased roughly in line with the rate of population increase, at 2-3% a year.

Large farm holdings, cultivated with the help of tenants, landless labourers and mechanised equipment, are the norm. Only 33% of farms are officially classified as 'small', meaning less than 8 ha.

In the last three years a number of steps have been taken to reform the management of irrigation in Sindh Province, which includes changes to the water charging system. The reforms are still in progress and were driven in part by the recognition that historic levels of government subsidy required to operate and maintain irrigation in the Province could no longer be sustained.

2. THE IRRIGATION SYSTEM AND ITS MANAGEMENT

The irrigated area in the Province, irrigated by fourteen main canals from three barrages on the Indus River, is about 5 Mha. The main canals serve distributaries (secondary canals) and minors which in turn supply individual water courses. A typical distributary provides water to between 15 to 30 watercourses but a large distributary may serve more than 100 watercourses. Table 5.2 sets out the number of distributaries and the command areas served by each main canal and barrage.

The main canals are officially designated as perennial, or non-perennial. Perennial canals provide year round water supply with the exception of the canal maintenance period in January. Non-perennial canals traditionally carried larger flows but only in the winter season, when the flow in the Indus was greater. However, since the completion of the Tarbella dam, which regulates flows in the Indus, the non-perennial, main canals have also provided year-round irrigation. Nonetheless, the water allocations both for main canals and distributaries/minors have never been formally adjusted to take account of this major change in the water control system.

Table 5.2 Canal commands in Sindh Province

Barrage	Main canal	No. of Distributaries	Cultivable command area (ha)
Sukkur	Dadu	120	226,120
	Rice	90	210,097
	NW	127	432,183
	Khaipur Feeder East	55	152,711
	Rohri	283	960,275
	Nara	163	894,840
	Khaipur Feeder West	68	161,343
		906	3,037,569
Kotri	Akram Wah	49	227,323
	Fulleli	74	402,957
	Kalri Baghar Feeder	110	294,074
	Piyari Feeder	113	340,828
		346	1,265,182
Guddu	Begari Sindh Feeder	85	232,059
	Desert Pat Feeder	45	174,809
	Ghotki Feeder	64	303,332
		194	710,200
Total Sindh		**1,446**	5,012,948

An exception to this pattern of barrage – canal – distributary – watercourse are the direct outlets. These are watercourses directly connected to the main canals. They are very popular with the landowners served by them because being directly on the main canal assures virtually continuous supply. Data from the Nara canal illustrates this point. Direct outlets now serve nearly 29% of the command area, up from less than 5% at the time of system commissioning in 1932. Direct outlets make it difficult to control canal hydraulics and manage water levels between head regulators and contribute to unreliability in the system.

Other features of the canal system in Sindh include:

- Most of the command area in Sindh is underlain by saline groundwater. As a result, conjunctive use of groundwater and surface water has not developed as it has in the upstream Punjab Province where groundwater is estimated to supply more than 40% of on-farm demand. According to official statistics there are only 16,000 tubewells in Sindh Province, against 550,000 in Punjab. Conjunctive use is also less popular because sanctioned water supplies per area are relatively high in several canal commands in Sindh, making additional groundwater supplies unnecessary.

- Drainage problems are widespread in Sindh. They are typically attributed to over-irrigation although the turning of natural depressions into irrigation commands and distorting natural drainage paths by the construction of roads and canals have also played a role. The major investments in drainage include surface drains and vertical drainage well fields, installed under the Salinity Control and Reclamation Projects (SCARPs) and the Left Bank Outfall Drain, (LBOD). The LBOD provides surface and subsurface drainage to an area of 550,000 ha in the Districts of Nawabshah, Sanghar and Mirpurkhas on the Left Bank of the Indus. Under the project a 'spinal' surface drain was constructed, discharging to the Arabian Sea. The spinal drain is supplied by a network of tributary surface drains as well as 1,600 deep tubewells, scavenger wells and sub-surface field drainage. Construction costs were approximately US$ 1 Billion and the annual operation and maintenance costs are estimated to be US $ 21 /ha in 2001/2 or US $ 31 /ha, if equipment replacement[9] is included as well (MMD/PDC 1998). This is significantly higher than the costs of irrigation operation, maintenance and replacement, reflecting the heavy reliance on pumped drainage. The estimate above is based on the assumption that all drainage pumps would run, but at 75% of the design pumping time. In reality, the pumps have run at far less than 75% of the design pumping time since their commissioning, due to the prolonged absence of rain in Sindh. This made it possible to control water-logging whilst only 75% of the pumps were running at less than 25% of their capacity. This has brought O&M costs, minus equipment replacement, closer to US $ 15/ha[10].
- Because of the salinity of groundwater, surface irrigation is also a source of domestic water supply. Direct abstraction from irrigation canals and shallow, hand tubewells drawing fresh seepage water from canals are widely used. Official statistics report that 26% of the Province population use canal water for their domestic supply but this does not include those relying on canal seepage and shallow wells.
- Sindh is the tail-end province in the Indus irrigation system and there is constant concern that the Province does not get its agreed share of water. Water is distributed between the intakes at the various barrages with a base flow passed to the Indus Delta. However, the base flow has practically dried up in a number of consecutive years. Given the inter-provincial sensitivities over water allocation it is difficult to get accurate data on the actual intakes into the canals.

2.1 Management and recent reform

Since its construction in the late nineteenth century until very recently, the Sindh irrigation system has been managed by the Irrigation and Power Department (IPD) of the Government of Sindh. The IPD operated the main barrages, canals and drains in the Province, initiated smaller construction work and undertook emergency management and routine repairs. It managed water distribution down to the outlets to watercourses and was responsible for sanctioning changes to the watercourses such as the size of outlets, and the location and use of pumpsets.

The IPD had no distinctive role in water resource management in the Province, and its performance was not supervised. Most importantly, in the context of water pricing, it did not have to generate its own revenue or collect water charges, apart from checking assessment records, as fee collection was the responsibility of the State Revenue Department.

The system was administered with a very small number of professional staff, with one senior executive engineer, assisted by two or three assistant engineers, typically in charge of an area as large as 2-300,000 hectares. Below this very small, professional, civil engineering cadre, the IPD has a large field-based staff. The main group consisted of linesmen (*daroghas*) and maintenance workers (*beldar*). The total staff

[9] The equipment replacement costs mainly concern the replacement of the pumping equipment. The figure of $ 31/ha is lower than an earlier estimate of Finney (1992) of $ 42/ha for operation and maintenance and full replacement costs.
[10] This period of low intensity pumping probably came to an end in 2003, which saw extremely heavy rainfall in July.

strength is 33,000. A comparison with official staffing norms suggests that total staff strength exceeds requirements by a factor of 2.

In 1997 a major program of reform was initiated to address the following types of management shortfall:

- Income from water-related tax (*abiana*) in the Province in 2002 was just 20% of the actual establishment and operation and maintenance expenditures.
- 57% of expenditure was on overheads and un-metered electricity supplies to public irrigation pumps and drainage systems. Levels of expenditure on other O&M budget lines were less than 50% of the government 'norm' and no provision was being made for capital replacement.
- International loans intended for capital works were used to pay for part of the maintenance costs.
- Water charges in Sindh are among the lowest in the world at US $ 2-8 / ha. In spite of the low rates, there is considerable opposition to significant increases in water charges.

The Sindh Irrigation and Drainage Authority (SIDA) was established by act of parliament in 1997 and came into being in 1998. The Act transformed the Irrigation and Power Department into a financially autonomous authority and laid the basis for the formation of ultimately self-financing Area Water Boards (AWB) on the canal commands. Financial self-sufficiency – defined as paying for the full O&M costs of the irrigation infrastructure – is to be achieved over a 10 year period. In parallel with the creation of these institutions, O&M responsibility at distributary and minor level is to be transferred to Farmer Organisations (FOs), serving an average area of 3,000 hectares. Thus, they are much larger than the watercourse-based Water Users Associations that were formed earlier under the On-Farm Water Management Program. These earlier associations played a short-lived role in the lining of watercourses, but subsequently disappeared into informal arrangements.

The first Area Water Board, on the Nara canal, was established in 1998 and by 2003 150 FOs had been established, with varying degree of operational capability. Approximately forty percent of these have signed transfer agreements giving them responsibility for the operation and maintenance of the distributary or minor and authorising them to collect their own source of income and suspend supplies to non-paying customers. The agreements also commit the FOs to pay the AWB for their services.

The IPD continues to exist alongside the SIDA and is still in charge of all non-AWB areas. Several of the newly announced AWBs still follow IPD procedures and almost all personnel in the new organisations are formally 'on loan' from the IPD, so there is considerable crossover of ideas and methods from the old to the new.

3. WATER PRICING AND FEE COLLECTION

The water pricing strategy under the new AWBs still follows, by and large, the pattern set in the first half of the twentieth century with the price being determined politically by the Provincial Government. It is essentially regarded as a provincial tax, with the service provider, (IPD or SIDA) having no control over the price level. Until the 1960's, income from water 'taxes' exceeded expenditure on the irrigation system and thus irrigation effectively cross-subsidised other state government activities. However, water pricing did not keep pace with inflation and both assessment and collection rates fell such that now irrigation and drainage services are a drain on the Provincial budget.

Farmers pay the water tax (*abiana*), together with other taxes – land revenue, local funds and ushr – as a single bill. *Abiana* is assessed on the basis of the area under cultivation with different rates applying for different crops. The prices range between US $2-8/ha, (See Table 5.3) which are low in comparison with other large-scale systems in South Asia. Different rates apply for gravity systems and lift channels, the latter subject to double rates. The prices of the different crops bear a relation – although not completely straightforward – to the notional water consumption of that crop. In areas where drainage systems are in place, the irrigation price is surcharged. This so-called drainage cess varies but may be up to the equivalent of the *abiana*. However, given the estimate of US $15 to 31 /ha for operation, maintenance and equipment replacement costs of the drainage systems, (MMD/PDC, op cit) it is clear that income would be well below costs, even if 100% collection of fees was achieved.

Table 5.3 Water rates in Sindh in 2002

Crop	**Current (2002) In PAR/acre**	**Current (2002) in US $/ha**
Garden, banana, vegetable	142.14	6.12
Sugarcane	181.87	8.07
Kharif crops		
Rice	88.78	3.83
Cotton	93.09	4.02
Fodder, maize, jowar, pulses	39.85	1.72
Other Kharif Crops	75.33	3.25
Rabi crops		
Wheat and other Rabi Crops	53.30	2.30

Note: Prices converted at an exchange rate of 57.3 PAR = US$ 1

3.1 Ability and willingness to pay

It has proved difficult to obtain information on irrigated farm incomes in Sindh Province. However, the material that is available indicates that current water charges are equivalent to approximately 2% of net income.

One indication of farm incomes comes from work by IIMI on three distributaries in the Nara Canal Command, (Pirzada *et al.,* 1997; and Khanzada *et al.,* 1997). The figures – based on farmers' recall – were calculated on the basis of land cultivated, including crop areas destroyed prior to the harvest. They give a weighted average of kharif and rabi crops and vary between US $ 145 / ha for Heran Distributory to US $ 328 / ha for Bareji Distributary.

In 1995 the Sindh Development Studies Centre (SDSC) made an assessment of farmers' ability to pay for the operation and maintenance of irrigation and drainage facilities based on fieldwork on Amergi Branch Canal (in Nawabshah). The study included an opportunity cost for land of US $40/ha per year and a notional charge for a farm manager, and thus the net income figures appear low (See Table 5.4). Nonetheless, the SDSC study concluded that farmers were able to pay for the irrigation services. It appears however that the main bottleneck in payment is not *ability* to pay but *willingness* to do so. This in turn is related to the confidence of water users in the quality of services and the integrity of the revenue collection system. On both scores confidence is low. As the chairman of the Sindh Abadgar Board explained in an interview – "farmers are willing to pay for services but not for someone else's wife's jewellery". He suggested that if quality and transparency of services improved, farmers would have no objection to even drastic increases in abiana.

Table 5.4 Crop wise returns (pre-tax) for land owners on Amerji Branch, Sindh

Crop	**Per hectare returns**	**Crop**	**Per hectare returns**
Wheat	US $ 69	Sugarcane	US $ 183
Cotton	US $ 61	Oil seeds	US $ 40
Rice	US $ 52	Fodder	US $ 175

Source: SDSC (1995)

More anecdotal, but important in indicating the value of water, is a comparison between land lease prices and water charges. Land leases prices vary from place to place but are in the order of US $ 50/ ha per year. However, land that is located in the upstream section of a minor will attract a lease price that is more than double that of a similar plot in a downstream area. The reason is that through a variety of informal devices (widening outlets, using pumps or siphons) upstream farmers are better placed to obtain additional water for their land. The cost of this and the bribes paid in the process are modest; estimates differ from US $ 6-15. Although by their nature, these figures cannot be precise, they indicate an order of magnitude. This order of magnitude is much less than the value of additional water supplies that are secured. The true value of the water thus secured is not expressed in the water price but in the price paid to rent the land.

3.2 Water price and service costs

Table 5.5 gives an overview of the present (2001/02) O&M costs associated with one of the largest canals in the Province, the Nara Canal, as well as a forward projection of plans to balance expenditure and revenue by 2007. Current total expenditure is US $ 9.5 million, or US $ 10.6 / ha, while revenue from abiana is just US $ 2.01 million, equivalent to US$ 2.2 /ha. Revenue from non-abiana sources (municipal water charges, fishery rights) is negligible.

The single largest cost item is the salary and wage bill at US$ 2.88 million (US$ 3.2 / ha) . High energy costs result from the use of pump stations in the upper reach of the canal system and the drainage tubewells and scavenger wells. For a long time this expenditure item was invisible as the federal energy company deducted its charges at source from the provincial financial allocation, a practice that gave rise to inflated billing. Metering of energy consumption continues to be problematic and electricity theft from public facilities is widespread.

Table 5.5 Financial projections Nara AWB (Million US $)

	2001/2	2002/3	2003/4	2004/5	2005/6	2006/7
Expenditures						
Salaries and wages	2.88	2.84	2.09	1.33	1.26	1.15
Establishment costs and general overheads		0.40	0.44	0.49	0.54	0.59
Retrenchment costs		0.80	0.80	0.80	0.80	0.80
Service charges to SIDA		0.02	0.02	0.23	0.26	0.37
Maintenance costs surface irrigation systems	1.27	1.41	1.55	1.69	1.87	2.06
Electricity costs irrigation pumping systems	0.52	0.58	0.63	0.70	0.77	0.84
LBOD performance contracts	1.13	1.17	1.29	1.29	1.31	1.50
Electricity costs LBOD pumps	1.05	1.15	1.22	1.33	1.41	1.50
Costs for revenue collection (5% in 2002)	0.10	0.12	0.12	0.14	0.16	0.17
Provision for bad debts/ non recovery	1.31	0.70	0.65	0.61	0.70	0.84
(assumed percentage non recovery)	*65*	*25*	*20*	*15*	*15*	*15*
Depreciation of assets	0.19	0.21	0.23	0.26	0.28	0.31
Total expenditures	**9.60**	**9.83**	**9.41**	**9.13**	**9.62**	**10.38**
Income						
Abiana (current rates plus 10% inflation a year)	2.01	2.22	2.43	2.67	2.93	3.23
Drainage cess		0.56	0.79	1.43	1.73	2.36
Abiana increase		0.00	0.77	1.54	2.30	3.07
Non abiana income	0.09	0.19	0.21	0.21	0.23	0.23
Government contribution to drainage	2.18	2.09	2.01	1.83	1.64	1.50
(as % of costs)	*100*	*90*	*80*	*70*	*60*	*50*
Government balance subsidy	5.32	4.78	3.19	1.45	0.79	0.00

Source: IRC SIDA (2002)

Table 5.5 indicates the following actions planned to move towards the elimination of government subsidy for irrigation O&M by 2007. (Note that drainage costs will still receive a 50% subsidy). Wage and salary costs will be reduced by 60%, following the transfer of responsibilities to FO's. There will be a modest increase in the budget for main canal maintenance but responsibility for the maintenance of distributaries and minors will be assumed by FO's. On the revenue side, collection rates are assumed to increase from the current level of 35 % to 85%. A separate drainage cess will be introduced and the water price (*abiana*) increased. Income from sources other than irrigation pricing is assumed to increase by 160% although its contribution would still be only US cents 25 / ha.

3.3 Fee collection

With the exception of the command area of the Nara Area Water Board, crop area assessment and fee collection continue to be the responsibility of the Revenue Department, represented by a Deputy Commissioner in each district. In each sub-district there is a patwari, who supervises the tapedars and muktiadars, who actually carry out the assessment of irrigated area and crop type and collect the *abiana*. *Abiana* is collected with a number of other Provincial taxes, in particular the land revenue, local funds and *ushr* – a religious tax notionally equivalent to one tenth of production.

3.3.1 Assessment

Irrigation water charging is based on the area cultivated and the crops grown. Collecting information on these two parameters for an area as large as Sindh is highly labour intensive.

The basic unit of assessment is the revenue village (*deh*). Assessment is carried out after each cropping season by tapedars or muktiadars in each *deh*, theoretically on the basis of field walkthroughs. Farm areas and owners are identified, based on the often outdated area maps. Each farm is then divided into cropped acreage plots and the assessment of each plot is carried out by applying the rate of *abiana* for that crop. Under this method, the revenue official uses his skill and experience, and sometimes arbitrary judgement, to determine whether an acre of plot has produced a full yield of crop or some other percentage. This percentage is used to calculate the *abiana* charges. The whole method, however, is open to manipulation and leads to under-assessment of *abiana*. There are nine main rates of *abiana* including variations for kharif and rabi crops. Furthermore, rates for government and private lift schemes are double and half the gravity rates, respectively. This increases the opportunities for misreporting.

For several years the assessment by the Revenue Department was double-checked by “abdars” of the Irrigation Department. The assessments by the abdars were generally as much as 50% higher than those of the Revenue Department.

Among farmers there is considerable ill feeling towards the *abiana* assessment by the Revenue staff, which translates into a very low willingness to pay. The main complaint concerns the arbitrary assessment of the area under cultivation. A common grudge is that, as they are forced to be lenient on big landlords, revenue staff try to achieve revenue targets by overcharging smaller landlords.

Overall, there is considerable underassessment. A second point of concern are the dispensations due to crop failure. In 1992-3 and 1994-5 kharif seasons the entire *abiana* was waived, because of floods and adverse weather. In other years particular areas receive dispensations but the dispensations are open to abuse. Officially the *abiana* is charged and then returned to the landowner. In reality many provisions are booked under this heading, but not returned to the farmer concerned.

The total loss of income due to underassessment and the abuse of dispensations is very significant. Euroconsult/ACE (1998) compared crop area data with *abiana* assessments and estimated a shortfall in assessment of 60% - half due to misclassification and half due to unjustified compensations for calamities. This is substantially higher than the losses due to non-payment.

3.3.2 Billing and payment

In the traditional system, bills are issued twice a year by the revenue staff and payment is made to them in cash. At present, customers are expected to pay in January and July at a time when they are relatively short of cash. It has been proposed to shift the billing dates to March and September to make the payment more convenient and avoid repeated reminders.

Of greater concern to landowners than the timing of payment is the failure to issue receipts for payment. This makes it questionable how the money is booked and increases opportunities for not accounting for special dispensations (see above).

3.3.3 Enforcement

Non-payment of *abiana* ranges from 5-10%. This is not high, because the assessment is the main arena for ‘negotiation’ for those not willing to pay. Under the traditional system the sanctions for defaulters are financial penalties and the threat of imprisonment.

Cutting off the supply has not, in the past, been a potential sanction, partly due to the problem of singling out a single defaulter if a watercourse supplies several farmers. In the past, however, it was not uncommon for IPD staff to use the pretext of maintenance to close water to an area with a notorious payment record. Under the reforms of 1998 the sanction of cutting off the supply to an entire Farmer Organisation has been introduced.

3.4 Changes under the reforms

The Nara Area Water Board, and 24 Farmer Organisations, that existed at that time, carried out their own collection of *abiana* for the first time in the 2001/2002 season. The AWB deployed 122 of its existing cadre of 136 abdars to undertake the labour-intensive field assessment work. In the past, the Revenue Department, which simultaneously collected three other local taxes, used four times this number of staff. The average salary of an abdar is Rs 3,570 per month (US$ 63 / month). With 136 abdars the total annual salary bill amounts to Rs 5.83 million (US$ 101,700). Had the AWB employed four times the number of field staff, in accord with the practice of the Revenue Department, the wage bill would have risen to Rs 21.08 million (US$ 367,800) or 19% of the total fee collection of Rs 115 million for 2000/2001.

The assessment done by the AWB abdars was of the same order of magnitude as the previous assessment by the Revenue Department. Crops were assessed on 607,000 acres, which is low, given a command area of 2,211,000 acres, although drought conditions may partly explain this. Nonetheless, the practice of systematic under-assessment appears to have carried across from the Revenue Department to the new AWB structure and their abdars.

The *abiana* rates remained unchanged. The proposed introduction of drainage cess was not implemented in this first year and the final fee collection rate reached 82%; again similar, but slightly worse, than the collection rates achieved by the Revenue Department.

4. CONCLUSIONS

- Farmers do pay a substantial price for water - not in the official and non-official transactions to the Revenue and Irrigation Departments - but in land transactions where the value of land for lease reflects the availability of water.

- The major issue in water charging in Sindh is the underassessment of the land area that should be paying for water. Until this is resolved it will be difficult to achieve the policy objective of O&M cost recovery.

- In restoring the finances of the irrigation service provider a multi-pronged approach is preferable, which will include reducing establishment costs, making water charge collection more efficient, increasing tariffs and exploiting other, non-water charge related sources of income.

- In payment, effective sanctions, in particular the threat of suspending supplies, is effective. Next, transparency and stakeholder control are important in restoring the confidence in the integrity of the system.

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Annex 6

Details of Contract

Contract - Research

This is an output of the Department for International Development's (DFID) Knowledge and Research contract R 8027, Irrigation Charging, Water Saving and Sustainable Livelihoods, carried out by HR Wallingford Ltd. The HR Wallingford job number was MDS 0541.

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