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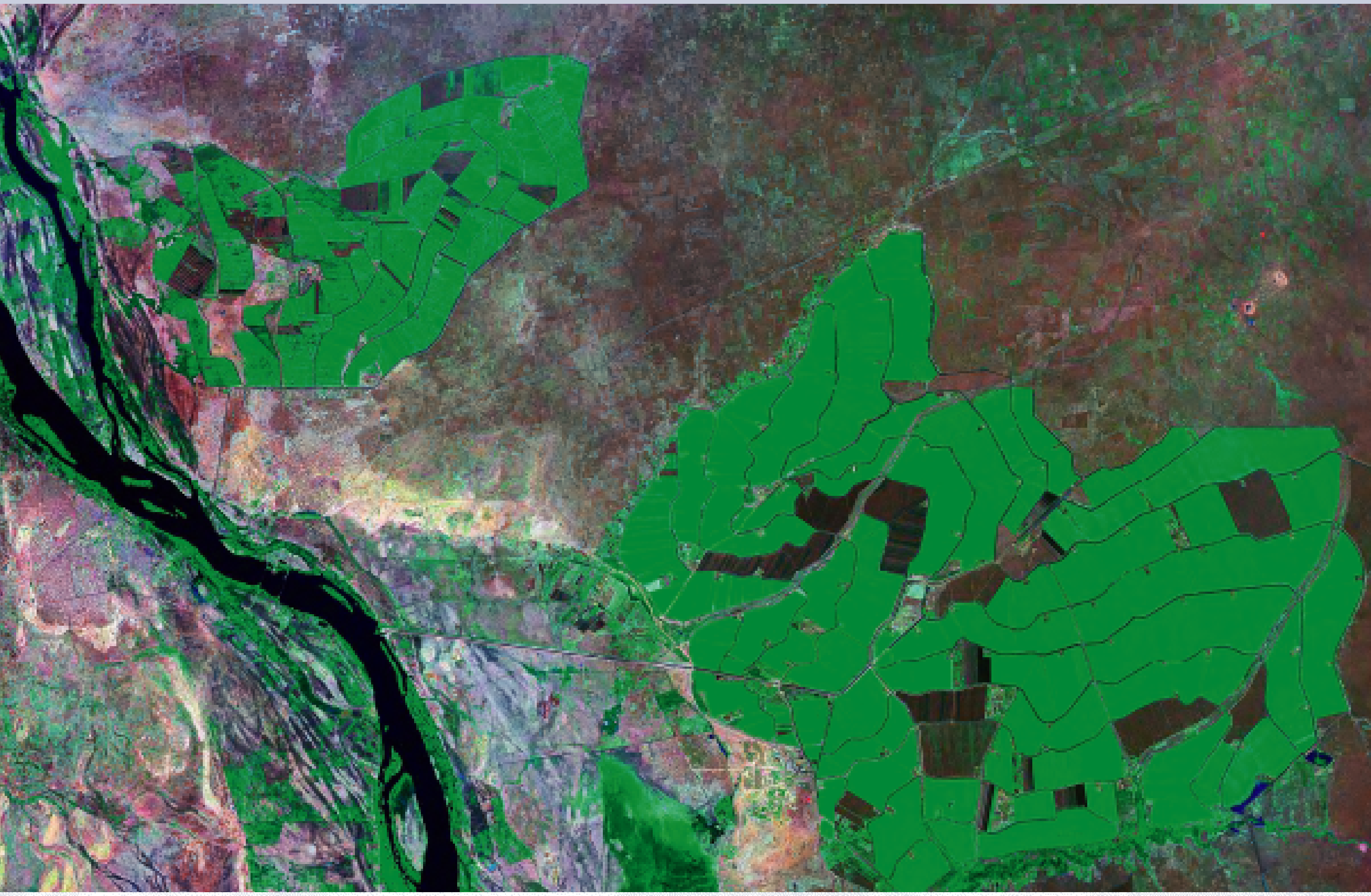
Water charging in irrigated agriculture

An analysis of international experience



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by

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Acronyms

EU	European Union
GWP	Global Water Partnership
ICID	International Commission on Irrigation and Drainage
IMT	Irrigation management transfer
ISF	Irrigation service fee
IWMI	International Water Management Institute
M&I	Municipal and industrial
NISP	Nepal Irrigation Sector Project
O&M	Operation and maintenance
OECD	Organisation for Economic Co-operation and Development
RBT	Rising block tariff
USBR	United States Bureau of Reclamation
WUA	Water users association

Summary

This FAO Water Report presents a review of international knowledge and experience in charging for irrigation services, drawing from published literature and six commissioned case studies in five countries. Together, these sources provide a broad spectrum of theory and practice, from less-developed to more-developed countries. The purpose of the report is to make available the results of a Department for International Development (DFID) (United Kingdom of Great Britain and Northern Ireland)-funded project to a wider audience in the hope of stimulating thinking about the practicalities of charging for irrigation water and, to an extent, explode a few popularly held myths about water pricing in agriculture.

The full data and material which form the basis of this document are to be found in two reports which are outputs from the DFID-funded project "Irrigation Charging, Water Saving and Sustainable Livelihoods". In analysing this material, the focus has been to identify the objectives that agencies set for their charging regime and to examine the extent to which different charging mechanisms have led to the realization of those objectives. While the introductory chapter provides a summary of terminology and basic theory, the work focuses on the application of charging tools and the practical lessons that can be drawn from documented experience, given an understanding of basic economic principles. The report therefore has a different focus and audience from other recent reports that give greater emphasis to economic modelling and applied theory. The findings should be of value to national policy-makers, donor agencies and researchers who formulate or advise on irrigation policy.

Policies of water pricing are affected by, and in turn affect, a large number of other important issues in the irrigated agriculture sector, for example, operation and maintenance; turnover and water user associations; rehabilitation and modernization of systems; increasing competition for available water with other sectors/users; international trade and commodity pricing. Much attention has been devoted elsewhere to these matters. In contrast, although much theoretical work has been done on the economics of irrigation water pricing, there is still a considerable lack of understanding of what impacts can be realistically expected from water pricing policies in practice, despite early publications such as FAO (1986). In order to focus attention on such a fundamentally important point, it was decided to confine the scope of this document to charging for defined objectives in irrigation, principally, for cost recovery and for limiting demand for water. Associated issues, including the ones set out above, are identified in the text but are generally not dealt with in detail. An extensive bibliography is provided to help the reader interested in the broader background to the subject.

The purpose of undertaking new case studies, outcomes from which are summarized in the text and Annex 2, was to identify the realities of charging in practice, to obtain more secure basic data and to detect social, financial, institutional and technical factors which may constrain the effective implementation of pricing policies.

The main conclusions of the review are summarized here:

i. **Terminology**: The terms price, charge, value, cost, fee and revenue are widely and often interchangeably used in the literature. Often such terms are imprecise or open to more than one legitimate interpretation. In this review, 'price' generally carries the implication of unit price – the actual or implied cost per cubic metre of water. Irrigation charges or fees relate to the overall payment that a beneficiary pays for the service – whether based on areas, volumes, crops or whatever. Costs are always complex – 'full' cost may imply some or all of: ongoing operation and maintenance;

amortization or recovery of capital costs; opportunity costs; social costs and environmental costs.

ii. **The wide range of charges**: There are frequently large differences in charges and charging mechanisms within a single country reflecting different objectives, different water sources, different degrees of water scarcity and irrigation schemes with different technologies, farm types or socio-economic objectives. Statements describing irrigation water charging at a national level must be regarded as indicative.

Price per cubic metre: There is a very large range in the reported volumetric price of water for irrigation. Prices as high as 18 to 29 US cents / m^3, applied as a rising block tariff, are reported in Israel. Spain reports prices of 16 US cents/m^3 on schemes drawing from deep aquifers. In the market garden sector of Holland, where growers irrigate greenhouse crops from a municipal supply, the price per cubic metre may be as high US$1.30, but this is an extreme case. At the lowest end of the range Canada and Romania report prices below 0.1 cent/m^3. A price of about 2 US cents/m^3 (US$20/1 000m^3) is a common 'average' volumetric price charged for irrigation water, but these other values show the extent of the range

Charge per hectare: Where irrigated area is used as the charging basis, comparison is made more difficult as it is not always clear in the literature whether figures quoted are seasonal or annual. Japan reports a figure of US$246/ha; China and Greece report ranges of US$92–210 and 50–150 respectively. US$40–50 /ha/year is a more representative 'average' charge in more developed countries. In India many states charge no more that US$10 /ha/year. Figures 3 and 4 in the text present the range of charges reported. Moreover, there is often considerable variation between theoretical or target rates and those actually charged in the field.

Collection efficiency: (Percentage of the billed amount that is collected.) Where information is provided, it indicates huge variation both within and between countries. For example, on the surface irrigation schemes of Bangladesh, collection rates are no more than 10 percent of the billed revenue, but on deep tubewells there is "almost full collection of revenues due". Of the countries where information on collection efficiency is reported, Mexico achieves the highest level with a national figure of 92 percent.

Proportion of costs recovered: There is more information available on this than on collection efficiency. The wealthier members of the OECD stand out as the few countries in the literature where there is full recovery of annual O&M costs and some recovery of capital costs. They include Japan, France, Australia, Spain and the Netherlands. However, in the overwhelming number of cases, water charging does not cover the annual O&M costs of irrigation schemes

iii. **Designing a charging system**: The objectives of a charging programme need to be articulated clearly in any discussion. The most widely pursued policy objectives are cost recovery and demand management. Macroeconomic concerns of resource allocation between sectors, pollution charging and benefit taxation are recorded in the theoretical literature but they are seldom the drivers of national policies. Cost recovery and water demand management are two distinct objectives which require different types of intervention. However, it is surprisingly common to find substantial documents where these different objectives are apparently interchanged at random. This confusion, or blurring, of objective must be avoided so that policy makers, and those who advise them, have a clear understanding of what they are seeking to achieve and the tools that are relevant to that objective.

Where the objective is cost recovery, the range of costs that may be factored into the calculation is large. In practice, most agencies seek only to recover annual operation and maintenance costs. Non-volumetric water charges are simpler to administer than volumetric pricing as there is no requirement for extensive measurement infrastructure and continuous field recording. Volumetric water pricing or tradable water allocations (quotas) are used where the objective is to reduce or limit water use in the agriculture sector. However, there is little practical evidence from the field to support the view that volumetric pricing has a significant effect on farmers' water consumption patterns. Even in Jordan, Israel and Morocco, countries facing extreme water scarcity, the aim of water pricing is to recover service delivery costs. Volumetric water allocations, rather than water price, are used to ensure that demand is limited and other sectors' needs are met. In all of these countries water is priced on a volumetric or approximate volumetric basis to indicate its value to users and discourage profligate use, but there is no attempt to use water pricing to achieve the balance between supply and the demand of competing sectors.

The most widely used charging structure, which is adequate where the sole objective is cost recovery, is a fixed cost per hectare. In some cases, this may vary according to crop type, with higher charges for more water demanding crops. Any price structure that contains a volumetric element is impractical where there is no infrastructure to routinely measure the volume used. Where this infrastructure does exist, a two-part tariff (with a fixed element to cover O&M costs and a variable element to reflect consumption) offers the benefit of assuring a more predictable basic income stream.

Water markets and tradable water rights could theoretically be more effective than water pricing as a means of achieving allocative efficiency. However, formal water markets may lead to inequitable access to water resources and disadvantage poor farmers, unless safeguards are provided to counter the tendency for water to flow according to purchasing power. Formal markets for large transactions between sectors require a well-defined legal and regulatory framework, as well as the infrastructure needed to move water from seller to buyer. They are found mainly in developed countries with Australia and Spain being widely cited examples.

It is concluded that recovery of O&M costs should generally not prove onerous to farmers, except for the poorest individuals and the poorest countries where special provisions/policies will need to be made. Nevertheless, farmers' dissatisfaction with levels of service and weak procedures for assessment, billing and enforcement commonly result in low levels of fee recovery. The principal constraint therefore appears to be in the management of systems and the administration of charging procedures in practice, rather than farmers' ability to pay.

iv. **The effects of charging on water saving**: The response in demand to volumetric water pricing is widely shown to be minimal. Current prices are well below the range where water saving is a significant financial consideration for the farmer. Volumetric prices may need to be 10–20 times the price needed for full supply cost recovery in order to affect demand. It is also apparent that, while a number of countries use pricing to influence farmers' use of water below a defined ceiling, the ultimate control mechanism is by management of allocations, or quotas. Despite widespread use of price to control demand in the water supply sector, practical constraints have meant there are very few places in the world where price is the primary method of control in irrigation.

It is logical to suppose that farmers' responses are influenced by the relative magnitudes of the cost of water and its value to them. In some of the case study countries, the current cost of water is equivalent to a small percentage of their net crop income. However, in the Tadla scheme, Morocco, fees for surface water are some 15 percent of average net income, yet farmers will sometimes pay for additional and more expensive groundwater to supplement their quota. Therefore, it appears that water prices may need to be of the order of at least 20 percent of net income to begin to have significant impact on water use. In many countries, the rates currently paid are only a few percent of net income.

Even if it were feasible to supply water volumetrically, and to charge on an individual basis large numbers of small farmers growing cereals on Asian canal systems, there would remain the serious political and social difficulties of raising charges by something like an order of magnitude in order to begin to exert some measure of control.

As water becomes increasingly scarce, competition for water between the agriculture, municipal and industrial sectors will inevitably increase. Although the agriculture sector is seen as wasteful in its use of water, three important points must be made concerning these losses: (i) 'lost' water often returns to an aquifer or river and can be accessed by other users. It is only 'lost' if it deteriorates in quality or drains to a sink from which it cannot be economically recovered. Thus switching to 'high efficiency' irrigation methods such as drip or sprinkler may not result in significant overall savings of water if the previous losses were recaptured by others. (ii) Where excess withdrawals return to a river or an aquifer, the cost of service delivery is increased but overall levels of water scarcity may not be affected. (iii) The farmers' in-field management of water usually accounts for less than half of the 'losses'. As individual farmers have no control of the conveyance and distribution canals, pricing incentives do not affect these losses.

iv. **Implementing charging polices**: Charging policies need to be formulated in full recognition of the various institutional and political factors can limit cost recovery, including:
   - The lack of political will to raise costs to farmers and slim down government agencies.
   - The lack of motivation on the part of collection agencies, as fees return to the treasury and recovery is not linked to future funding.
   - A vicious cycle of low O&M expenditure leading to poor performance and increasing reluctance by farmers to pay.
   - Insufficient resources for planning and implementing cost-effective charging mechanisms.
   - Practical and political difficulties associated with enforcement of pricing policies.

The widely advocated policy of irrigation management transfer does not necessarily ensure recovery of full supply costs. The literature indicates that whilst turnover often leads to an increase in levels of cost recovery, revenues are still generally insufficient to cover full supply costs, as tariffs are set too low.

Where volumetric pricing is proposed to limit consumption, delivery must be measured and controlled to the individual user. In many developing countries, the service is provided to an aggregated group of farmers. Massive investments in re-engineering would be required to provide, even potentially, for 'volumetric' delivery and pricing to each farmer. The challenge to administration and management would be unrealistic in the short to medium term.

The introduction of a water charging policy is therefore likely to be part of a larger package of measures designed to move to a virtuous circle where farmers are willing to pay for a good service, with the revenue being invested in sustained and improved service delivery. In the case of demand management, the literature again indicates that pricing is only a minor element. Allocation through legally recognized rights in water use and the use of tradable water rights are other elements that can emerge in such a package, but usually when infrastructure and governance conditions are sufficiently mature.

Acknowledgements

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The case studies were prepared by: Frank Van Steenbergen, Nawal El Haouri, Chris Perry, Chris Finney and Consolidated Management Services.

The review of municipal and industrial charging policies is based on exchanges with John Brindley, an expert who was intimately involved in the privatization of water services in the United Kingdom, and who continues to work within the regulatory process.

Alan Hall and John Skutsch made substantive contributions to the task of drawing together the material to form this single document.

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Chapter 1

Introduction

AIM AND PURPOSE

This document presents an analysis of experience in irrigation water charging, drawn from published literature and a series of six case studies. These sources provide a broad spectrum of experience from less-developed to more-developed countries. The aim has been to make an assessment of the claims concerning irrigation water charging as a tool for cost recovery (achieving financial sustainability) and demand management (achieving resource sustainability).

The findings should be of value to national policy-makers, donor agencies and researchers who formulate or advise on irrigation policy. The full data and material which form the basis of this document are to be found in two reports (see footnotes) which are outputs from a DFID-funded project "Irrigation Charging, Water Saving and Sustainable Livelihoods".

SCOPE AND LIMITS

Policies of water pricing affect, and in turn, are affected by a large number of other important issues in the irrigated agriculture sector, for example, operation and maintenance needs; turnover and Water User Associations; rehabilitation and modernisation of systems; increasing competition for available water with other sectors/users; international trade and commodity pricing. Much attention has been devoted elsewhere to these matters. In contrast, although much theoretical work has been done on the economics of irrigation water pricing, there is still considerable lack of understanding generally as to what impacts can be realistically expected from water pricing policies in practice, despite early reports such as that of FAO (1986). In order to focus attention on such a fundamentally important point, it was decided to confine the scope of this document to charging for defined objectives in irrigation, principally, for cost recovery and for limiting demand for water. The review of literature is confined to reports of field experience of irrigation water charging; it does not attempt to summarize the large body of economic theory relating to water resource allocation. Associated issues, including the ones set out above, are identified in the text but are generally not dealt with in detail. An extensive bibliography is provided to help the reader interested in the broader background to the subject.

The focus is on charging for irrigation water. Some might argue that this is a narrow perspective because agencies that provide irrigation water often provide closely related services, e.g. agricultural and storm drainage, domestic and commercial water supply, sewage disposal, flood control and groundwater management. Each of these services has its own financial dimensions. The nature of these services and their beneficiary groups are often different, so that trying to compile a comprehensive integrated description of the water charging issues across these various activities would encompass too many variables. Interest in irrigation charging is often focused directly on the two issues of financial sustainability of irrigation systems, and the problem of excessive water

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[1] Bosworth B et al .Water Charging in Irrigated Agriculture: Lessons from the Literature. HR Wallingford Ltd.

[2] Cornish GA , Perry CJ (2003) Water Charging in Irrigated Agriculture: Lessons from the Field. HR Wallingford Ltd.

consumption in irrigation or resource sustainability. Therefore, this review focuses specifically on irrigation water charging and does not address charging for non-irrigation services, although it is recognized that charging for these services may be a legitimate means of achieving financial sustainability.

For much of its rationale, the current interest in private sector participation in irrigation service delivery in general depends on the recent trend towards various forms of private management of municipal and industrial (M&I) water supply utilities. This review addresses water use in agriculture as it is the dominant consumer of water in most developing countries. However, it is important to understand the approach taken in the M&I sectors, distinguishing between those issues that are relevant to the irrigation sector and those that are not.

COUNTRY CASE STUDIES

Six case studies of irrigation schemes in five countries were carried out to supplement the literature review, to identify the realities of charging in practice, to obtain more secure basic data and to detect social, financial, institutional and technical factors which may constrain the effective implementation of pricing policies. The countries and schemes were selected to obtain a spread of experience from nations at different stages of economic development, characterized by varying degrees of water scarcity, with differing agricultural and water management practices.

The case studies refer to:

- ➢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 where the institutional environment differs.
- ➢Four government surface schemes on the Terai in Nepal, supplemented by information from two further schemes elsewhere, one of them a groundwater development.
- ➢Two schemes in Morocco, both surface irrigated and including privately-owned wells.
- ➢Schemes in the Former Yugoslav Republic of Macedonia originally constructed by the government but now in a process of transfer to water user organizations.

The information from farmers on these schemes provides a snapshot of conditions at a particular time (2002). However, reference to other local studies and data sources made it possible to draw wider conclusions as to: whether the systems are stable, improving or declining; the nature of policies governing irrigation development; and the role of charging to fund operation and maintenance (O&M) and influence demand for water. Chapter 4 provides details of the findings from the case studies.

TERMS AND DEFINITIONS

A wide range of terms and definitions are used in the literature to describe payments made for irrigation services, and the costs incurred in providing such services. A literature review must respect the definitions of the authors, but implicit in the variety of concepts applied by authors is a similar diversity in what readers may assume a term to mean in the absence of a specific definition. Below, the definitions applied to the case studies are set out, which also provides a framework to interpret the usage of other authors.

Water charges and water charging systems

The term "water charges" includes the totality of payments that a beneficiary makes for the irrigation service – fixed, volumetric, crop-based, etc. A water charging system embraces all of the policies, practical actions and mechanisms required to set the level of recoveries, decide the basis on which a charge will be levied, levy the charge, and collect the revenue. In some cultural or political contexts it is unacceptable to place a price on water and therefore other terms such as irrigation service fee (ISF) are used, with the emphasis being that the charge is made for the *service* of supplying water to the user, not for the water itself.

Water pricing

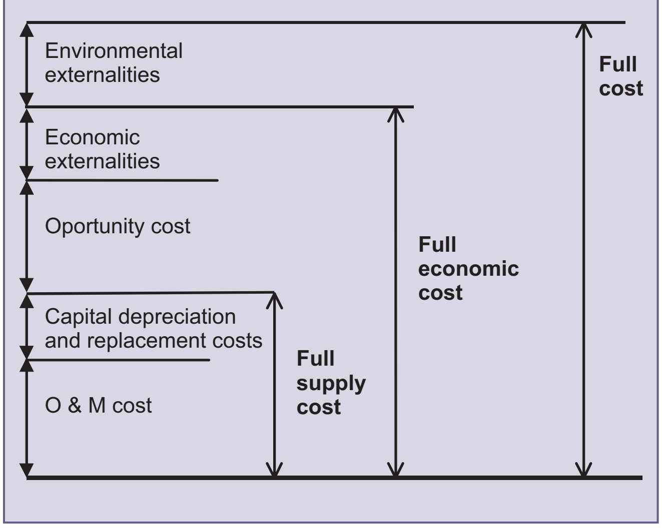
Water pricing is sometimes used in the literature to be synonymous with charging. More commonly, as here, it has the restricted connotation of price per unit quantity of water. The concept is clear in the case of volumetric pricing but where pricing is not volumetric, an implicit price can be derived by dividing the charge by the volume of water delivered. The actual or implicit price is useful when compared to the productive value of water (commonly referred to as the 'shadow price'), and the marginal cost of providing an extra unit of water.

Cost of water

The cost of water must be carefully distinguished from the price (though for the farmer, the cost is exactly equal to the price). Cost, in the literature and in the case studies tends to relate to the direct expenses incurred in providing the irrigation service. It is important to emphasise that the costs to an individual farmer will be very different from the total costs to society based upon a total economic valuation (TEV), for instance. This more general basis for establishing the 'cost of water', is set out, for example, by the Global Water Partnership (GWP) (2000a). This includes a full analysis of the different cost elements that may be factored into a calculation of the cost of supplying water – operation and maintenance, capital depreciation and replacement, opportunity costs (that is, benefits foregone when water is not applied to its most beneficial use); social costs; and environmental costs. The GWP identifies three types of costs, referred to as: full supply cost; full economic cost; and full cost (Figure 1). The full supply cost includes the costs associated with the supply of water, without considering externalities (externalities are the indirect consequences or side-effects of supplying water to a particular user or sector, that are not directly captured as costs in the accounting system). It includes the costs of O&M of irrigation infrastructure and capital investment. The full economic cost is therefore taken to include the full supply costs plus opportunity costs and economic externalities. Opportunity costs reflect the fact that water used in one role is not available to another user. Where the alternate use has a higher socio-economic value, then, from a classical economic point of view, there are corresponding costs to society arising from 'misallocation' of resources or inefficient use.. Externalities arise where costs or benefits associated with extraction and use of the resource are imposed on third parties. Externalities, both positive and negative, are an important component in costs related to irrigation water use.

Despite this all-embracing typology, the GWP definitions are not always adhered to, and some authors may use the same terms with different definitions. Even where terms do correspond, there is no universal agreement on what level of cost it may be practical to recover through water charging. In some countries that are members of the Organisation for Economic Co-operation and Development (OECD), 'full cost recovery' refers to O&M costs only, whereas in others it is the recovery of O&M and capital costs (OECD, 1999). In the European Union (EU), the term incorporates scarcity values and environmental externalities, a formulation similar to the GWP definition. It is unclear whether capital costs should include the costs of replacing equipment at current prices, the historical costs of existing equipment or some intermediate figure. Commentators mention both historical and current cost approaches. In the case of transfer of assets from public to private ownership, capital values may often be written down by using the historical construction costs rather than present day replacement value.

FIGURE 1
Components of water cost



Source: Global Water Partnership (2000a).

"Cost recovery" concerns full supply costs only (costs that can be defined fairly readily), whereas "efficient water allocation" within a country or basin context requires consideration of opportunity costs and externalities. These are valid concepts, but setting an agreed numerical value on them is a difficult process. In the words of one report: "information concerning opportunity costs is difficult to obtain, they vary by place and season, and even sophisticated research studies cannot estimate them in a way that is universally accepted" (ICID, 1997). Briscoe (1996) claims that estimated values of opportunity costs are crude and inexact, and depend widely on factors such as use, location, season, time, quality and reliability of supply. Their definition or estimation is important in the planning of resource allocation between sectors, but they seldom play a role in defining the price or price structure that applies to a given group of water users.

An additional complexity is that opportunity costs change dramatically as relatively small quantities of water move between sectors. The quantity of water required to meet full domestic demand is generally a small fraction of irrigation demand. Once that demand is met, the opportunity cost falls to the value of the residual consumer, i.e. irrigation.

It is therefore important to appreciate that in practice, the decision on precisely what values to incorporate in a cost calculation may be political rather then economic.

TYPES OF CHARGING SYSTEM

Irrigation services can be charged for in various ways. Sometimes a combination of charges is applied. Table 1 categorizes these systems in order of complexity.

Each of the systems in Table 1 provides different levels of incentive to irrigators to reduce consumption, and different structures of income to the service provider. In the case of flat-rate charges (types 1 and 2), the marginal price of water (the cost of an additional unit of water) is zero. Farmers take what water they can towards their needs, but the cost is unaffected by the amount taken.

Under a charging system within category 3, the marginal price the farmers pay is equal to the price per unit of water. The irrigators will pay more if they take an additional unit and less if they take less. In economic terms, this form of pricing provides an incentive to save water that is not provided by the flat-rate systems. For this reason, irrigation pricing based on the volume diverted has the potential to reduce consumption.

With rising block tariffs (RBTs), type 3(b), it is usual to apply low rates for substantial, initial entitlements combined with very high rates for additional water beyond a set threshold. This results in a low total cost and a high marginal price, because the marginal price is the price of the last unit consumed. By contrast, a high crop-based charge (type 2) represents a high total cost with zero marginal price.

Finally, a system of water allocation or rationing may be used to bring supply and demand into balance. In this situation, where the farmers receive less than they can use productively, they perceive the value of water in terms of potential crop output and

TABLE 1
Bases for irrigation water charges

Type	Detail
1. Area-based	1. (a) A fixed rate per hectare of farm, where the charge is not related to the area irrigated, the crop grown or the volume of water received. It is usually part of a "two-part" tariff designed to cover the fixed costs of the service. Different tariffs may be used for gravity and pumped supplies.
	1. (b) A fixed rate per hectare irrigated. The charge is not related to farm size, type of crop grown or actual volume of water received (except that a larger irrigated area implies a greater volume of irrigation water).
2. Crop-based	2. A variable rate per irrigated hectare of crop, i.e. different charges for different crops, where the charge is not related to the actual volume of water received, although the type of crop and area irrigated serve as proxies for the volume of water received.
3. Volumetric	3. (a) A fixed rate per unit water received, where the charge is related directly to, and proportional to, the volume of water received.
	3. (b) A variable rate per unit of water received, where the service charge is related directly to the quantity of water received, but not proportionately (e.g. a certain amount of water per hectare may be provided at a low unit cost, a further defined quantity at a higher unit cost, and additional water above this further quantity at a very high unit cost). This method is referred to as a rising block tariff.
4. Tradable water rights	4. The entitlements of users in an irrigation project, or more widely, other users, are specified in accordance with the available water supply. Rights holders are allowed to buy or sell rights in accordance with specified rules designed primarily to protect the rights of third parties. Sales require authorization by a licensing authority (as in the Murray Darling Basin Authority, Australia, and most western states in the United States of America), or may require court approval (e.g. Colorado, the United States of America) without reference to any specified authority.

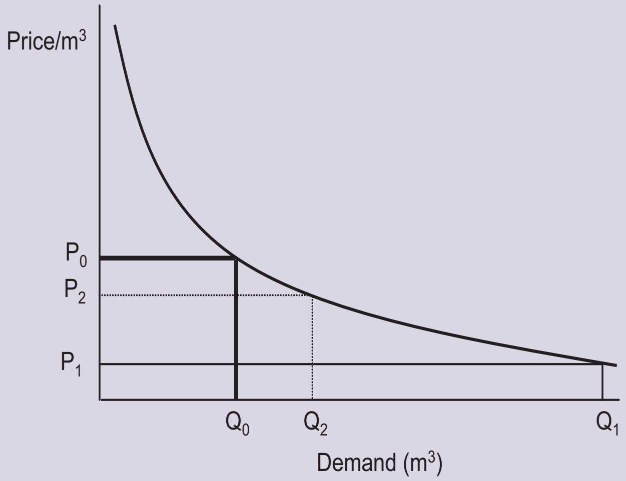
income. This valuation is the opportunity cost of water to the irrigators. Because of the opportunity cost to the irrigators, where water is scarce and rationed, farmers will use water carefully even though the marginal price to them may be zero. This higher value is of course applicable only at the farm level, and affects irrigation technology and crop choice: society may place an even higher value on the water in some alternative use, but an additional mechanism is required to realise that value.

THE THEORETICAL RELATIONSHIP BETWEEN VOLUMTRIC WATER PRICING AND DEMAND

The common perception is that raising prices will force irrigators to consume less or irrigate more efficiently and productively. In practice this 'neat' theory of economic demand rarely holds, but the basic economic theory is worth considering if only to establish where such perceptions arise.

Without going into detail on the economic valuation and allocation of water (which is covered in detail elsewhere c.f. FAO [2004]), Figure 2 presents a conventional economic relationship between price and demand. This predicts that demand for water (or any other commodity) will fall as price rises under perfect market conditions. If the sustainable quantity of irrigation water available is Q_0, then for any price below P_0 demand will exceed the available supply. When the price of water is higher than P_o, then there will be more water available than is demanded by irrigators at that price. In practice, the marginal price of water to irrigation users is often very low or zero. The

FIGURE 2
Demand for water compared with marginal price



situation of a low marginal price is represented by P_1 and the associated demand by Q_1. Demand exceeds the available supply substantially. Starting from P_1 and Q_1, and using pricing as a demand management tool, any increase in price would reduce demand towards Q_0. The hypothetical example represented by P_2 and Q_2 shows a substantial fall in demand (about half) achieved through a substantial increase in price (about double). Nevertheless, demand remains substantially higher than the available supply, and additional measures would be needed to ensure that sustainability is achieved and consumption is reduced to the sustainable level,Q_0.

The relationships illustrated here are hypothetical, but they point to the issues that determine the effect of pricing as a tool for demand management. The issues are:

- Is the current, or proposed, price close to the value or opportunity cost of water? If not, demand will exceed supply, probably by a large margin.
- Does the price needed to achieve an objective such as cost recovery relate to the value of water? If the price required for full cost recovery is still much lower than the value of water, which is usually the case in agriculture, it will do little to achieve the separate objective of reducing demand to a sustainable level.

The continuous relationship between price and demand in Figure 2 implies additional factors. Price only has the effect shown if it is related directly to quantity. If the charge for irrigation services is fixed per hectare, and hence the marginal cost of the water is zero, farmers will take as much water as they feel is useful, so long as they can make a profit.

Similarly, crop-specific charges (that is, a fixed charge per hectare of crop, perhaps set higher for more water-consuming crops) will only make farmers switch to less water-consuming crops when the irrigation charges are sufficient to make those less water-consuming crops relatively more profitable.

In both these cases, an increase in price eventually causes a fall in demand. However, the relationship is more like a switch (from full demand to no demand, or from high demand to low demand) than the smooth relationship implied in Figure 2. Establishing this direct link further requires that each purchaser be able to decide independently how much water to buy at the offered price (and on the assumption that this desired level of supply can be delivered individually to the purchaser which implies sophisticated water management and distribution infrastructure).

THE RELATIONSHIP BETWEEN PRICING AND TRADABLE WATER RIGHTS

It is also important to distinguish between direct volumetric water pricing and tradable water rights. In the case of direct volumetric pricing, each user decides how much water to buy for the quoted price, and plans the cropping accordingly. The total cost of water to the farmer will then be price multiplied by volume purchased. In this case, the water market is between the farmer and the water supply agency, in the same way that consumers buy electricity from their electricity utility.

Under a system of tradable water rights, each user's entitlement to water is specified as a volume, and the user will pay a fee for that right, usually related to the O&M cost rather than the economic value of the water. Collectively, those with water rights are allowed to trade water among themselves – and those who are more productive users (including commercial, industrial and domestic users) will buy the rights of less productive users, thus increasing the overall average productivity of water. In this case, the market is among rights-holders, a buyer will pay the holder of the water entitlement for the right to use the water, and the water service provider for the service provided.

As water rights are generally allocated so that their sum is equal to Q_0 (i.e. the quantity of water available on a sustainable basis) in Figure 2, this approach leads directly to an equilibrium between supply and demand. The total charge paid by an individual user will be the user fee, payable to the supplying agency, plus the cost of any water rights purchased from others.

The distinctions between tradable water rights and direct or volumetric water pricing are important:

- Where pricing is used directly to constrain demand, all farmers face higher charges for water (in order to balance supply and demand).
- Where tradable water rights are introduced, farmers can continue to farm as before, paying the irrigation service charge (ISC) associated with their operations. Only those entering the water market will pay (or receive) the additional charges associated with purchase (or sale) of water entitlements.
- Under a system of tradable water rights, the balance between supply and demand is ensured through the specification of the water rights (i.e. Q_0 is defined) rather than by price. Formal water trading is only feasible where water rights have been established, based on an accurate assessment of the available water resources (Q_0), and where these rights can be delivered and enforced effectively. This requires strong institutions and infrastructure capable of measuring and controlling delivery to holders of individual entitlements.

Without going into detailed analysis of the institutional implications of water markets (Gaffney, 1997) and the experience that has been gained in the United States and Australia, for instance, it is sufficient to note that these basic conditions may not be present in most developing countries which are typically coping with thousands, if not millions of irrigation water users and incomplete conveyance and trading infrastructure.

TRENDS IN INTERNATIONAL POLICY DEVELOPMENT

Water charging has been a policy issue since the Dublin International Conference on Water and the Environment in1992. Whereas the call for self-financing and recovery of O&M costs has a longer history, the Dublin Conference established the concept that water itself is an “economic good”. The principle, one of four agreed at the conference, suggested that full cost pricing, however defined, could be a potent instrument for water management, besides being a sound business principle.

Since the Dublin Conference, water pricing has been a focus of attention, sharpened by documents such as the water resource management policy paper of the World Bank (1993) and the water policy paper of the Asian Development Bank (Arriens *et al.*, 1996). The Dublin Principles made explicit reference to water as a social good only with regard to domestic water supply, viz., “within this principle, it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price.” The UN Conference on Environment and Development, Rio de Janeiro, 1992, added a social emphasis: “water is an economic and social good”.

At the Second World Water Forum in The Hague, in March 2000, the Declaration of the Ministerial Conference made “full cost water pricing” one of the seven challenges to resolving the perceived water crisis. The World Water Vision (World Water Commission, 2000) stressed the importance of the 'user pays' principle and promoted full cost water pricing. The Framework for Action (Global Water Partnership, 2000b) stressed the difference between water value (for deciding on alternative uses of a scarce resource) and water pricing (as an instrument to recover costs and provide incentives

BOX 1

Dublin Principle No. 4

“Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.”

BOX 2

Statement from the Bonn International Conference on Freshwater

"Water service providers should aim for financial sustainability through receiving sufficient income from their customers to finance operation, maintenance and capital costs. Balancing this, however, cost recovery objectives should not be a barrier to poor people's access to water supply and sanitation…Efforts to recover cost should focus on those customers who use most water. The authorities that set tariffs should be willing to charge the full cost to users that can afford to pay…Transparent subsidies can be applied where appropriate and necessary to preserve ecosystems."

for efficient water use). It called for pricing that would facilitate full cost recovery and encourage careful use.

The Bonn International Conference on Freshwater of December 2001 was more cautious. It played down the possible contribution of water pricing to water management, and instead focused on the recovery of operational and financial costs. This caution stemmed partly from the debate on "water as a human right" over the previous two years, which advocated that no one should be denied access to water. This suggests that agricultural water users (the customers who use most water) should be charged fully for operational and financial costs, whereas financial support to poor domestic users could continue (Box 2).

It is worth contrasting the global policy discussion since the Dublin Conference with water charging policies in practice. It appears that most headway has been made towards self-financing of domestic water supply. Less has been achieved in cost recovery and water pricing in irrigation services, or in financing other water services, such as wastewater treatment, drainage, flood protection and river basin management.

There has been substantive discussion in several major irrigating countries, such as India, Pakistan, Egypt, Thailand, Viet Nam, China and Indonesia, on the introduction of 'full cost' irrigation charging (usually referring to full supply cost). However, there has been little effective implementation. In some areas, there has been a reverse trend, where water charges have been abolished (Taiwan Province of China, Poland and Punjab, India), recovery rates have decreased (Eastern Europe and Pakistan) or the introduction of irrigation charges has stalled (Indonesia). A major exception to this development is the EU Water Framework Directive that aims at full cost water pricing in all member states by 2010 (Box 3).

BOX 3

EU Water Framework Directive, Article 9

Member states shall ensure that by 2010:

- Water pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive.
- There will be an adequate contribution from the different water uses, disaggregated into at least industry, households and agriculture, to the recovery of the costs of water services, based on economic analysis…

Source: European Union (2000).

BOX 4

Pricing and water rights: principled pragmatism

"Principled" because economic principles such as ensuring that users take financial and resource costs into account when using water, are very important. And "pragmatism" because solutions need to be tailored to specific, widely varying natural, cultural, economic and political circumstances, in which the art of reform is the art of the possible. The general arguments are illustrated by focusing on two major users – farmers and cities. Four issues are addressed:

- The quite different economic environments that pertain in these two sectors.
- The crucial distinctions between the perspective of economists and the perspective of users on what constitutes "appropriate pricing", and some of the implications of these distinctions for practice.
- The critical distinction between the financial cost of providing a service and the opportunity cost of the resource itself, and the implications of this distinction.
- A review of some "good practice" developments, and the implications for a country-specific, practical, sequenced approach to dealing with these crucial issues in World Bank-financed projects.

Source: World Bank (2003).

Savenije and van der Zaag (2002) make an important distinction in the interpretation of the Dublin Principle and subsequent statements. They identify two schools of thought: "The first school maintains that water should be priced at its economic value. The market will then ensure that the water is allocated to its best uses. The second school interprets 'water as an economic good' to mean the process of integrated decision-making on the allocation of scarce resources, which does not necessarily involve financial transactions." The second principle means that economics, properly understood, is about how best to meet all human wants: to treat water as an economic good is to be concerned with more than its allocation to highest value use.

Most recently, the World Bank's Water Resources Sector Strategy (2003) has introduced the concept of principled pragmatism, recognizing that water resource management is more complex and nuanced than first suggested in the call for "full cost pricing". Box 4 shows an abstract from the document and the issues that are to underpin the World Bank's pragmatic approach. The document signals a significant move away from what some saw as a belief that "full cost recovery" could bring about equitable and sustainable service delivery and an optimal distribution of water between competing demands in all cases.

EXPERIENCE FROM MUNICIPAL AND INDUSTRIAL WATER SECTORS

The World Bank strategy document (2003) identifies the difference between agricultural and urban water users in terms of the markets in which they operate. Policies of pricing and subsidy in one urban centre are said to have no material effect on what is an 'appropriate' price in another urban centre. However, in the irrigated sector, because products are traded nationally and internationally, pricing policies in one location can have a significant impact on what can be charged elsewhere. The document stresses the difference between the actual financial costs of service delivery and the opportunity cost of water in the two sectors. In the urban sector, the financial costs are high, while the opportunity cost – the value of the water used in the 'next best use' – is low. The reverse is generally true in agriculture, where the unit cost of delivering very large volumes of untreated water is relatively low but the opportunity cost can be very high if water is scarce. Translating these theoretical costs into incentives to guide the utilisation of water by irrigators raises severe practical difficulties.

The experience of the water supply sector in the United Kingdom since privatization in 1989, indicates the similarities and differences between urban and agriculture sectors in terms of cost recovery and opportunities for pricing to be used for demand management.

The regulatory system for water supply companies in the United Kingdom defines three categories of costs:

- operating costs, such as plant, labour and materials;
- capital costs of new and replacement works (ie current and future capital costs, not historical costs);
- the cost of obtaining the capital needed to build new and replacement works.

A water utility sets charges so that income matches these costs plus a proper return on capital. The tariff can be structured to distribute the burden of the costs across the users as required. However, water utilities are almost always monopolies – consumers cannot choose among competing suppliers. In an unregulated monopoly, there are dangers of insufficient capital maintenance, allowing deterioration of the assets, or excessively high charges. Therefore, a regulator has to police the proper performance, determine reasonable costs, ensure that the capital value remains appropriate and decide the appropriate level of return to investors.

Within the tight relationships between costs and charges, there is limited scope for setting tariffs that might influence the behaviour of the water users. However, as water prices began to rise in the United Kingdom in the 1990s, many manufacturing and process businesses commissioned water audits and reduced their use significantly. However, domestic customers take two-thirds of the water supplied and are less inclined to cut consumption, as water is not generally a large part of the household bill. In consequence, the regulators and the industry are promoting water-efficient devices, such as smaller toilet cisterns and more efficient washing machines. Much research has been done on the components of water use and many appliances are now more water efficient. Thames Water, which supplies 2 000 Ml/day, claimed savings in 2001 of 0.1 Ml/day from the introduction of efficiency measures (a saving of 0.005 percent). However, it is difficult to assess whether the small reduction actually represents a true reversal of an otherwise rising trend. Furthermore, these "efficiency" measures are only water saving in the sense that the water passing through the household is reduced: the vast majority of water delivered to a house is taken back for treatment and re-use. Unlike in irrigation, where the purpose of water use is to consume it through evapotranspiration, domestic use is non-consumptive – for washing and flushing waste. Utilities encouraging lower water use in the domestic sector are attempting to ensure that their infrastructure is adequately sized to deliver, recover and treat water; they are not trying to reduce consumption

When water is scarce, the surest and most common way to make customers use less is to limit supply. First, use of hosepipes is banned and thereafter water is made available only through standpipes. Experience in Yorkshire, the United Kingdom, in 1995 shows that this approach is only acceptable in the rarest of circumstances – possibly once in a 100 years or so. Apart from these rather drastic measures, effective signals can only be given through a volumetric tariff. This process requires reliable meters on every consumer connection, which is not universally seen as an economic investment.

However, if metering is in place, tariffs can be arranged, within the total revenue profile, to give signals to high users or protection to the needy. This is particularly true in a monopoly, where competitors will not undermine the structure with opportunistic bids. Rising Block Tariffs do send clear signals to users but there are associated problems. More sophisticated meters would be needed to measure high use at specific times periods; meters would have to be read, not just estimated, as is commonly done at present. In domestic supply, it is difficult to distinguish between profligate high consumption and high consumption by large families or for medical reasons – so tariff volumes would need to be negotiated on a household by household basis, while at present less than 15% of household water deliveries are metered. A simple option would be to charge punitively for any use greater than the annual average, thereby penalizing anything but steady consumption. Some pilot studies were carried out in the United Kingdom about 12 years ago to establish use patterns; metering as well as a few RBT and seasonal tariff systems were included. The main conclusion was that households use some 5–15 percent less water on first being connected to a meter; the impact of other tariff systems was less conclusive.

This brief overview of the M&I sector highlights important and intuitively predictable similarities with irrigation services:

- the components of the service cost – O&M, rehabilitation and improvement, capital costs;
- the need to identify appropriate levels of expenditure clearly;
- the need to identify sources of funds for these costs, and appropriate charging strategies;
- demand is not very price sensitive provided the cost is small in relation to overall budgets.

Other aspects, which relate to general experiences in irrigation, are:

- In the United Kingdom, metering of domestic use is currently limited to 23 percent of households nationally.
- Metering is politically sensitive and not enforced, even at the "regional" level of a large residential complex.
- Sophisticated metering for a commodity priced at about US\$1.4/m^3 is not financially viable (the corresponding value in irrigation is less than 10 percent of this figure).
- The "capital cost recovery" in M&I is substantive for current and future investments, but very limited in respect of historical investments.

A critical difference between M&I services and irrigation is that the dominant proportion of the total cost of providing the M&I service (typically US\$1.4/m^3) is treatment and operational costs, capital maintenance and replacement. In irrigation, treatment costs are essentially zero, and other costs per cubic metre are low given the very large volumes of water delivered through very simple infrastructure – the total service cost may lie in the range US\$0.02 - 0.04/m^3.

The implication is that a resource charge on water sufficient to influence demand in the M&I sector would render irrigated agriculture completely unprofitable. Essentially, these are two markets that barely intersect, except for supplementary irrigation of very high value crops. The M&I sector is a high-cost, low-volume market, whereas irrigated agriculture is a low-cost, high-volume market. In sum, the lessons from the M&I sector are clear as regards recovery of costs, and indeed which costs can be recovered, but they offer no great insights in relation to demand management in irrigation.

Chapter 2

Objectives of irrigation water charging

Water policies and strategies in many countries now require the implementation of some form of charging for irrigation services. Most commonly the stated objectives of these policies relate to cost recovery – especially recovery of the ongoing costs of operation and maintenance – and sometimes the need to conserve water. Often, these objectives are qualified by concerns at affordability and access to services for the poor. In the literature, considerable attention is devoted to the theoretical role of economic instruments – pricing and markets – to encourage productive use and optimal allocation.

This chapter summarises the most significant aspects of the objectives of water charging, based on an extensive literature review. The full bibliography is listed at the end of this report. Here, to improve readability, references to points which are widely agreed are omitted but key issues raised by specific authors are referenced.

Clarity of objectives in formulating water charges is essential: some objectives are in direct conflict (high charges to discourage waste will impact heavily on the poorest farmers; sophisticated charging systems based on volumetric measurements are expensive to introduce and operate, increasing bureaucracy). Other objectives are simply unrelated (the charge required to recover O&M is unlikely to be the exact charge necessary to balance supply and demand). Thus a clear definition of what charges are designed to achieve is essential. Box 5 provides an overview of typical water charging objectives referenced in the literature and found in the field. The following sections discuss these in more detail.

BOX 5

Objectives of irrigation water charging

Service delivery – cost and accountability

- To cover the costs of providing the service without subsidy – ranging from O&M costs to full supply cost, including capital expenses and replacement costs.
- To fund adequate maintenance of infrastructure, preserving its productive function.
- To improve accountability of the water provider to users.

Demand management, water allocation and pollution control

- To reduce excess demand
- To provide an incentive for the efficient use of scarce water resources.
- To allocate water to the highest priority uses.
- To provide incentives to improve water quality, reduce pollution levels or protect the environment.
- To encourage wise investment decisions by public and private organizations.

Social objectives

- To create a benefit tax.
- To ensure equity of access to water or the benefits of its use.

SERVICE DELIVERY – COST AND ACCOUNTABILITY

To cover service costs and fund adequate maintenance

Reform of water pricing is most often driven by pressure on government budgets, rising costs of providing services, and government desire to reduce subsidies. For many years, the World Bank has encouraged governments to employ a policy of cost recovery, on the principle that users should cover O&M costs and some of the capital costs.

Acceptance of the rationale for recovering ongoing costs is almost universal (even if implementation is not). Full or partial recovery of investment costs is more controversial because irrigation is often seen as a development expenditure for backward areas, benefiting not only the poor farmers but also society more generally through lower food prices and food security. Where these costs are not recovered, governments pay the difference, thus subsidizing the agriculture sector, a politically sensitive sector, or the infrastructure deteriorates. The International Water Management Institute (IWMI) suggests that levels of subsidy generally declined during the 1990s as governments sought to implement cost recovery programmes (IWMI, 2002). Nonetheless, Dinar, Balakrishnan and Wambia (1998) report that in Punjab, Pakistan, the cost recovery ratio (ratio of income from water pricing to O&M expenditure) was 38 percent in 1994–95, falling to only 26 percent in 1995–96.

Although commentators generally use the term 'cost recovery', Small and Carruthers (1991) distinguish between 'cost recovery' and 'irrigation financing'. Under 'cost recovery', all funds collected go to the government treasury department. In 'irrigation financing', funds are retained within, or returned to, the irrigation agency to meet actual irrigation costs. This distinction is another way of underscoring the need to go beyond a 'simple' calculation of the level of cost to be recovered and making explicit the way in which funds raised are used to benefit the irrigation department or the individual scheme.

The conclusion of most authors is that beneficiaries should pay the full ongoing costs of system operation, maintenance, replacement and upgrading of facilities. Such payments should be clearly designated for use by the operating agency, and accounting procedures should be transparent and encourage efficiency in the operating agency. The extent and form of capital cost recovery (for original investments) is a matter for political decision, but again should be open and transparent. These are the criteria applied in the UK's water privatisation and in Australia's Murray Darling basin, confirming their acceptability in developed economic environments in both irrigation and water supply sectors.

To improve service delivery

Ray (2002) emphasizes that irrigation departments in many countries need to improve the O&M of the main canal system and that "incentives for their staff members to operate efficiently are at least as urgently needed as those for farmers". According to some writers, water charging can accelerate this process. For Indonesia, Gerards, Tambunan and Harun (1991) state that "the real question for ISF success is whether the Irrigation Service is willing to redefine its role and function… Rather than an attitude of instruction, managers and field personnel of the Irrigation Service have to reassess their role, and have to accept water users as counterparts, almost as co-system managers."

The same argument has been used in the irrigation sector reforms in Pakistan, where water delivery contracts would include a penalty on the irrigation provider in case of non-performance except in extenuating circumstances (Euroconsult, 1998). A similar discussion has started in Thailand, where the introduction of cost recovery would come with responsibilities for both service provider and customer. Despite these indications of intent, there is no published evidence of water pricing leading to better service delivery to farmers. However, the contrary situation, that poor service delivery leaves farmers unwilling to pay, is frequently cited.

DEMAND MANAGEMENT, IMPROVED WATER ALLOCATION AND POLLUTION CONTROL

Demand management - an incentive for efficient use

It is argued widely that low water prices in a water-scarce environment send the wrong signal to water users. Farmers do not have any incentive to reduce water use or adopt water-efficient crops. Indeed, they may adopt water-intensive crops, leaving less-favoured farmers with no irrigation service, and over-irrigate their fields. Low pricing leads to overexploitation of scarce water resources – a particularly common problem in groundwater-irrigated areas. Where charges are not linked directly to the volume diverted or consumed, e.g. where charges are fixed per hectare of crop, overall charges may be high, but there is no direct incentive to decrease consumption at the margin.

The logic of pricing for demand management runs as follows: if the primary objective of charging is to recover costs, the issue is whether the unit price implicit in that objective is the same as that required to match demand and supply – in a year of drought as well as a year of plenty. Normally the two prices do not coincide and a considerably higher unit price may be needed to influence demand which will be politically sensitive (not least because cost recovery will now exceed the target level). This can be avoided by a rising block tariff (RBT) where some water is available at a low unit price and additional water at progressively higher prices. In this way, the total charge is kept equal to the target cost recovery level while the marginal unit price is high. However, other complications remain: first the basic issue of management, monitoring and record keeping (which will inevitably be complex and expensive); and second the fact that if the price is wrongly set, the demand may still exceed supply. The solution to this is usually to set a volumetric entitlement or quota, below which charging is volumetric or on a rising block basis (see Box 7). At this point, since appropriate water allocation and demand management are being achieved without reference to prices, the expense and complexity of pursuing pricing in the first place must be questioned. Chapter 4 discusses further the limitations of pricing as a practical tool for demand management in irrigation.

Allocating water to highest priority uses

As summarised above, many authors, and indeed experience from real world water resources management, believe that pricing water to manage demand is unworkable in most situations. However, other authors contend that pricing should go further. Thus, Dinar and Subramanian (1997) urge that ‘getting the price right’ to reflect the social value of the resource is important. Ahmad (2000) maintains that “the economic or political dimensions of water scarcity and its low price mean that agriculture should release water to other uses, because the economic value of water is much lower in farming than for domestic or industrial use”. However, Svendsen (2001a) points out that winding down the agriculture sector may not be a viable option for governments where there are no alternative forms of employment for farmers. Economic theory cannot override political reality. In practice, the difference in value between using water for irrigation and using it to meet M&I needs, i.e. the opportunity cost of irrigation, may not be as high as some argue if the multiplier impact of agriculture on the local economy (the off-farm sector) is taken into account. Furthermore, once M&I demand is fully met, the opportunity value of water drops effectively to zero. Overexploited catchments and water-short areas receive considerable attention, but urban demands in many countries can be satisfied using just 20–50 percent of available supply in all but the driest years. In these situations, the permanent transfer of water from agriculture to other sectors would be counterproductive. Legal provisions, ensuring that agriculture would surrender water to urban needs in the occasional dry years under a system of seasonal allocations, would be a better approach than one reliant on the vagaries and complexities of the market. In overexploited catchments, negotiated reallocation may be the best solution.

The views summarised above are in fact contradictory. One group believes that determining financial prices such that demand will equal supply is unmanageable; the other believes that prices should embody not only the influence of financial market forces, but also social, environmental and broader economic considerations.

Tradable water rights go some way to bridging this gap: rights to use water are assigned to individual beneficiaries, ranging from farmers to towns to environmental uses, navigation, etc. Those wishing to buy or sell water do so through a regulated market, which monitors examines third party impacts and controls the transfer of rights to eliminate negative third party effects. This allows security of supply to users, the option to enter the market – and hence generally improve water allocation – and the possibility for the state to enter the market to purchase water for environmental or social purposes. Users thus become aware of the value of the resource they are using.

The World Bank's Water Resources Sector Strategy gives strong support for the role of water markets as a means of ensuring that users understand the opportunity cost of water to different sectors. However, it should be clear that farmers need to have a legal entitlement to a water right, which they are able to trade. Leaving aside the institutional requirements, water trading requires infrastructure to move measured volumes of water between potentially distant parties.

Improving water quality

Maintenance of water quality is usually viewed as a public good and, therefore, it is controlled by regulation. Johansson (2000) remarks that there are two principal difficulties to using water pricing to solve water quality problems: (i) the impacts vary across time and space; and (ii) in non-point source pollution, the source of pollution is typically unknown. Dinar and Letey (1996) explore possible economic incentives to reduce polluted effluents from farms, with examples from California. The direct way is to tax the disposal of polluted drainage water on a volumetric basis. However, this imposes high monitoring costs. Some commentators maintain that raising the irrigation water price induces improved irrigation efficiency and hence reduces drainage flows. However, the link between price and volume diverted is not always apparent or easy to manage. Young and Karkoski (2000) describe a successful scheme of tradable discharge rights in California, the United States of America, to reduce agricultural pollution from non-point sources. All these references to pricing for pollution control focus on the United States of America. In the USA, a number of favourable conditions prevail, including widespread acceptance of the principle that "the polluter pays", backed by systems of monitoring and evaluation to enforce the principle. Considerable work is needed to achieve similar acceptance in many developing countries.

SOCIAL OBJECTIVES

Investments in surface water resources are made predominantly by public agencies, although investment by beneficiaries or the private sector has been common in some countries. Groundwater development is predominantly a private sector activity. Under public investments, policies of full financial cost recovery imply that beneficiaries are not subsidized. Indeed, the users ought to pay full O&M costs plus replacement costs, if investment is to be sustained. At the same time, and sometimes in conflict with the foregoing, fairness demands that all users get sufficient water to meet their basic (domestic) needs, and that water is allocated to sectors where there are apparently no direct beneficiaries from whom to recover costs (e.g. wetlands and nature reserves). However, political priorities, social policies or vested interests have to be taken into account. Where political pressure is an important determinant of the investment decision, a stated and credible policy of investment cost recovery may be an effective incentive for rational, public decision-making (Svendsen, 2001a).

There are few practical examples of charging used as a benefit tax to help fund other sectors. Saleth (1997) describes one case in Maharashtra, India, where part of the revenue finances primary education and an employment guarantee scheme. However, it is not clear whether the diversion of revenue to other sectors implies recovery of more than full costs. In most countries, collected water fees are insufficient to cover costs of providing water services, let alone subsidize other sectors. Fees usually go to the finance ministry and do not remain on the scheme or in a relevant government ministry.

Johansson (2000) considers equity of water allocation to be "the 'fairness' of allocation across economically disparate groups in a society or across time and may not be compatible with efficiency objectives." Therefore, charging could be used as a benefit tax, to distribute the benefits received by irrigators to others in society or to deprived groups within the system (the poor, tail-end farmers, etc).

Equity, rather than being an explicit objective of water pricing, can in some circumstances be associated with demand management. For example, the use of rising block tariff systems in the water supply sector, which ensure that all users receive a basic service at a low cost, while higher users pay disproportionately more. However, the different characteristics of demand in the irrigation sector make the application of a similar system there less attractive. If the aim were to limit overall water use per land holding, in order to protect the small farmer, then direct control of allocation would be more effective, and less complex, than a rising block tariff system.

SUMMARY

Although the available literature identifies a number of theoretical objectives of irrigation water pricing, in practice just two objectives dominate most of the literature and practice: (i) to achieve some level of cost recovery, and (ii) to bring about a reduction in irrigation consumption. The target level of cost recovery, or the magnitude of any reduction in consumption, will vary between schemes and countries.

Some commentators suggest that these two objectives may be combined and addressed through a single approach. However, it is unlikely that the two objectives will coincide precisely, so that additional measures may be required. The following two chapters indicate that it is important to match the charging tool with the objective. Furthermore, while irrigation charging in some form is widely accepted as a means to achieve some level of financial cost recovery, there is debate over the merits of direct charging and other economic tools, such as water markets, to make farmers aware of the opportunity cost of water.

Chapter 3

Pricing methods

NON-VOLUMETRIC METHODS

The only entirely non-volumetric system of water charging is based on the size of the farm. In some Indian states, the land tax depends on whether the land is capable of being irrigated; elsewhere, particularly where a two-part water charge is imposed is, one component is often related only to the size of holding, thereby providing the irrigation agency with a guaranteed source of income. In some areas where rice is the prevalent crop, the water charge is dependent on the area actually irrigated. In perhaps the most common form of charging system, the payment is based on the area irrigated and the crop – so that higher rates may be payable for more water-consuming crops. These various systems in fact introduce a degree of volumetric payment. A farmer who irrigates five hectares has received more water than a farmer who irrigated two hectare, and a farmer irrigating sugar cane uses more water than a farmer irrigating cotton. However, there is no direct linkage between volume and payment – so that the same charge is paid in a particularly dry season as in a very wet season. Assessment based on irrigated area and crop requires considerable resources and effort to carry out. The system is also prone to abuse, particularly collusion between the farmer and the assessor to reduce the charge. Box 6 illustrates some of the practical difficulties in the operation of an effective area-based charge.

BOX 6

Assessment based on irrigated area – experience from Sindh Province, Pakistan

Irrigation water charging is based on the area cultivated and the crops grown. Much effort and time is needed to collect information on these two parameters for an area as large as Sindh.

The basic unit of assessment is the revenue village. Assessment is carried out after each cropping season, theoretically based on field walkthroughs. Farm areas and owners are identified, based on the area maps, which are often outdated. Each farm is then divided into cropped acreage plots and the assessment of each plot is carried out by applying the rate for that crop. Under this method, the revenue officials use their skill and experience, and sometimes judgement, to determine whether a selected acre has produced a full yield or some percentage of full. This figure is used to calculate the water charges. However, the method is open to manipulation and leads to underassessment. There are nine main charge rates, including kharif and rabi crops. Furthermore, rates for government and private lift schemes are double and half the gravity rates, respectively. All these factors increase the opportunities for misreporting.

For several years, the assessment by the Revenue Department was double-checked by the Irrigation Department. Assessments were generally found to be as much as 50 percent higher than those of the Revenue Department.

There is considerable ill feeling among farmers towards the water charge assessment by the Revenue staff, which makes them very unwilling to pay. The main complaint concerns the arbitrary assessment of the area under cultivation. A common grudge is that, as staff are forced to be lenient towards large landowners, they try to achieve targets by overcharging smaller landowners.

Other non-volumetric methods described in the literature are: output pricing, where the water fee is levied on each unit of output produced by the user; and input pricing, where a farmer pays for irrigation water indirectly through higher prices for inputs purchased from the government or water agency. Both input and output pricing avoid the need to measure the volume of water diverted or consumed. However, neither measure is favoured by economists because of distortion effects on the price of crops (Rhodes and Sampath, 1988). This review found no evidence of the application of these two methods in practice.

Where the water flow is reasonably constant, charging for time of delivery is an implicit form of volumetric charging. This method is easier to monitor and is practised on many small-scale, farmer-managed irrigation systems. Payment is often in kind rather than in cash, and the main objective is to ensure fairness of distribution rather than efficient allocation of a scarce resource. However, the principles are otherwise similar (Small and Carruthers, 1991).

Abstraction licences for groundwater pumping can function as a proxy for volumetric charging or may depend on volumetric measurements. They are more common in developed countries where individual farmholdings are larger. The farmer meets all capital, operating and maintenance costs of pumps or other infrastructure and in addition pays an annual licence fee for abstraction, either a flat-rate annual tariff based on the pump capacity or a two-part tariff. In the United Kingdom, a two-part licence fee is used. A fixed element, making up 25–50 percent of the annual charge, is determined by the maximum volume that is permitted; the remaining component is determined by the volume actually abstracted (OECD, 1999). This system requires metering of water use.

VOLUMETRIC METHODS

Volumetric methods charge per unit volume of water supplied at the measuring point (Box 7). They require:

BOX 7
Water allocation and rising block tariffs in Israel

Israel faces severe water scarcity but water charging is not used as the principal tool to reduce demand in the agricultural sector. The 1959 Water Law nationalized almost all water sources and established the Water Commission Agency to oversee the development and management of water sources and the allocation of water allotments to different users. Priority has been given historically to the agriculture sector, which has support from a strong political lobby. Since the early 1990s, the Ministry of Finance has sought to increase water charges paid by farmers. However, the farming lobby has refused to accept increased prices, pressing instead for the development of additional water sources, including desalinization.

At present, farmers receive a water allocation for which they are charged on an increasing block tariff according to the percentage of the allocation used:

First 50 percent of allocation	US$0.18/m^3
51–80 percent of allocation	US$0.22/m^3
81–100 percent of allocation	US$0.29/m^3

The Water Commission Agency has responded to shortage by cutting back allocations to the agriculture sector. However, Becker and Lavee (2002) argue a theoretical case in support of water pricing, rather than allocation, to reduce agricultural demand.

- information on the volume used by each farmer or a defined group of users below the measuring point;
- a central water authority or water users' organization to set the price, monitor use and collect fees.

Where there are many small farmers and water is distributed in open channels, the costs of installing water measuring devices and monitoring individual users are often prohibitively expensive – especially in systems designed to provide uniform schedules of irrigation over large areas. In these cases, water can be delivered to an intermediate point, e.g. farmers' organizations, at the head of secondary or tertiary canals, leaving farmers with the responsibility of distributing and charging individuals for water. Favoured by governments and donor agencies, the compromise involves "devolving the most difficult part of the operation, the actual interface between 'supply' and 'demand', to others [the users]" (Perry, 2001a). Where government agencies are unable to measure or charge individual farmers volumetrically, the assumption that farmers' organizations will be better equipped to do so is questionable. There is perhaps scope to mix volumetric charging (to a user group) and area-based charging for the members of that group. Sampath (1992) points out that volumetric pricing may be difficult to apply in systems operating under rotational delivery or proportional distribution (a large proportion of the irrigated area in the developing world). There may, however, be some scope for moving towards systems of arranged delivery and volumetric delivery at an aggregated level e.g. to WUAs rather than to individual farmers. This is commonly found in Morocco and other countries where there was a significant French influence on design

Some commentators emphasize the need to charge per unit of water consumed (evaporated or polluted, however that may be determined) as distinct from the volume diverted. They emphasise the point that scarcity is caused by consumption, not by diversion. In most irrigation systems, it is the consumption of water (through evapotranspiration, pollution or loss) that is the key factor in water scarcity, rather than the quantity of water diverted. In some cases, water that is 'lost' from a system will be stored (e.g. in an aquifer) and used later in the season or elsewhere. An example of water actually lost from a system is where it becomes polluted in the recycling process and cannot be used downstream. Rosegrant (1997) adds that water can also be lost if its recovery becomes too expensive, e.g. by percolation to a deep aquifer. However, from the perspective of capital investment and financial management of the system, the volume of water withdrawn is significant, as costs relate to the volume of water diverted.

The magnitude of reuse will vary between basins, depending on geology, topography and levels of demand. The example in Box 8, illustrating water reuse in the Nile basin downstream of the Aswan High dam, shows a situation of intensive reuse. Of the almost 55 bm^3 diverted for irrigation, only 38 bm^3 is actually consumed, but the 'losses' are used in other parts of the basin through recycling of water from the drains and particularly from the underlying shallow aquifer.

For the foreseeable future, volumetric charging for water will continue to be based on the volume diverted or abstracted from the source, rather than the volume consumed by the crop or lost to a sink. Not only do problems of assessment make alternatives difficult, but the capital and operating costs of a system are determined by the volumes of water abstracted and conveyed, not the volume consumed. To summarize, water scarcity and water pricing to reduce demand (resource sustainability) should focus on the volumes of water consumed while concerns for cost recovery (financial sustainability) are linked to the volume diverted and managed, irrespective of whether it returns to the basin for use by other downstream users.

In practice, volumetric methods of supply to individual farmers are probably not feasible in large parts of the developing world at present because of the costs and

BOX 8

Water reuse in the Nile river system downstream of the High Aswan Dam

Data for water year 1992/93		Billion m^3
Inflow to basin		
Releases from High Dam, rainfall, deep groundwater		57.94
Reported diversions from Nile and drains		
For irrigation	54.97	
For other uses	11.17	
		66.14
Reuse		
From drains and shallow groundwater	40.01	
Consumptive use/evaporation		
Irrigation	38.03	
Other	4.98	
		43.01
Proportion of inflows reused	69%	

Figures based on data assembled by Keller (Personal Communication, 2004) from different Egyptian government agencies.

complexity of installing large numbers of measuring devices, and the vulnerability of available devices to accidental and malicious damage.

MARKET-BASED METHODS

Rosegrant and Binswanger (1994) suggest that water markets provide a flexible and efficient way to allocate water while providing incentives that are beneficial for water users. Where water savings are tradable, they provide extra income to farmers, while pricing leads to a reduction in income. This analysis misses the difficult issue of diversion versus consumption. A farmer with a right to divert can, by changing his technology from (say) flood irrigation (40 percent on-farm efficiency) to sprinkler (80 percent on-farm efficiency) reduce his diversions substantially while maintaining the same consumptive use. If his previous excess diversions were contributing to aquifer recharge, and he sells his saved water to a user elsewhere in the basin, the aquifer conditions will change. Politics may complicate markets too: agricultural water users may use their political power to intervene in markets in order to prevent the "logical" redistribution of water out of agriculture to higher value uses. The same authors stress the difference between administered prices, set to reduce demand, and tradable water rights. The value of subsidized irrigation services is often capitalized into land prices. In such cases, raising water charges to reflect the value of the irrigation service is unsustainable for farmers who have paid the premium price for land plus subsidized water. Moreover, the move would be unpopular among other farmers who have profited from cheap water. However, a defined tradable water right, with charges related to the cost of the irrigation service, allows farmers to continue farming or to sell the right at an open market price to the highest bidder. The system has the long-term benefit of allowing water to move to the highest value use, while providing a stable charging environment for the irrigation agency and those not participating in water trading.

Water markets can be formal or informal. Informal water markets around privately-owned wells exist in India, Pakistan, Chile and Mexico. Transactions are typically small scale and local, selling surplus water to neighbouring farmers or towns. There is an extremely well-developed informal market for water in Bangladesh, where water from shallow tubewells, of which there may be 700 000 in the country, is sold to groups of 14–17 farmers. Through this informal market, more than 10 million farmers gain access to irrigation water.

Formal markets in Spain and the United States of America involve tradable water rights, permanent or seasonal transfers or transactions between sectors and jurisdictions. Probably the most advanced system of tradable water rights now in operation is in the Murray Darling Basin in Australia, where diversion entitlements are traded at seasonal and permanent levels with a defined security of availability (Box 8).

The debate concerning water markets focuses on their feasibility (high transaction costs, externalities, lack of legal and institutional framework) and on equity issues. There is concern that poor farmers or households will not be able to pay high prices for water, and that they will be disadvantaged by markets. Referring to small farmers who cannot afford their own pumping equipment, Meinzen-Dick (1997) argues that informal markets increase these farmers' access to water. Ultimately, markets are rarely undistorted even in sophisticated economies. Market-led systems alone cannot overcome potential conflict between the different objectives of productive efficiency and poverty reduction.

PRICING STRUCTURES IN PRACTICE

In the water supply and sanitation sector, Boland and Whittington (1998) make a critical assessment of RBTs, which "have become the tariff structure of choice", being used widely in water supply projects in the developing world. The price charged per unit volume rises with increasing consumption. This mechanism cross-subsidizes the cost of a basic supply to poorer consumers by charging more than the supply cost to wealthier consumers, who consume much greater volumes. Experience cannot be directly transferred between the two water sectors, nonetheless, Boland and Whittington question the value of RBTs on a number of counts and urge the greater use of simpler, two-part tariff structures – a fixed, service charge and a variable charge determined by the volume consumed.

RBTs and simpler two-part tariffs require volumetric measurement of supply. For this reason, they are not in widespread use in the irrigation sector. Such tariffs have been used in Jordan and Israel, where the supply to individual farmers is metered. However, in both countries, central government imposes an upper limit, which determines the maximum volume that may be used for irrigation. Within that allocation, some water saving may be achieved through the incentive of increasing tariffs. Shevah (undated) states that the RBT system has led to irrigation water savings of 10–15 percent in Israel. In Jordan, discussion of pricing reflects concerns over cost recovery in the state-managed Jordan Valley Authority rather than an attempt to use price to control demand (Box 9).

Most irrigation agencies rely on simple, fixed-cost, pricing structures, most frequently based on the area irrigated. Even in an advanced and water-scarce economy, such as Spain, the most widespread charging mechanism is a fixed charge per hectare, although there have been trials of water metering and two-part tariff structures on three Spanish schemes. On these schemes, the variable element reflects the energy cost associated with pumping and pressurizing water delivery systems rather than a direct charge for water according to the volume diverted. Once again, in water-scarce basins, water allocation, rather than price, is used to control demand and ensure adequate supply to industrial, municipal and environmental sectors. In France, Tardieu and Prefol (2002) describe the current system of water quotas for farmers, arguing that

BOX 9

The Murray Darling Basin, Australia

The Murray Darling Basin, in south eastern Australia, spans three states and comprises an area virtually the size of South Africa. Water supplies are scarce and extremely erratic; soil salinity is severe. In a process that began more than 20 years ago, water rights, based on historic patterns of use, have been formalized so that each riparian has an entitlement, or entitlements, specified in terms of volume and security. Highly secure rights are met, or exceeded, in almost every year; less secure entitlements may only be met in one out of every four years. Thus, variations in the security of entitlement permit allocations that are consistent with the erratic nature of water availability. Salinity entitlements – the rights of an area to export salt – are also specified, and each area must stay within its entitlement, or face significant financial penalties. Water deliveries are measured at the farm gate, primarily in order to confirm that entitlements have been taken.

Once water rights had been established and documented, the possibility existed to allow their trade. The system is complex, given the possibility to buy and sell seasonal or permanent entitlements to water, high security entitlements, and low security entitlements.

The complexity of ‘definitions’ of water entitlements reveals the body of knowledge and legislation required to specify water rights. An additional complication, being addressed currently, is the possibility to trade water at significant distances, i.e. outside a local jurisdiction – which inevitably involves third-party impacts on river flows, recharge, etc. This process, which introduces interstate trading, is now being implemented. It involves a number of key components:

- ➢ Water 'equivalence' ratios. These define at the basin scale what a unit of water in one place equates to in terms of water at another location. Thus, a purchaser of 100 units for use in Location A may have to buy 120 units from Location B, or 95 units from Location C in order to have the supply he needs. These ratios lead to variations in price between locations for a given quantity of water.
- ➢ There are procedures within each state’s water licensing authority to authorize sales and purchases (both states have to concur).
- ➢ Annual adjustments to state allocations, by the Murray Darling Basin Commission, reflect transfers.

The entire process of transferring a water right involves 12 steps. To date, water trading is limited. Permanent water transfers are taking place at an average rate of about 1 percent of total availability per year; temporary transfers are occurring at a rate of around 10 percent of total availability per year. Transfers are almost exclusively within agriculture, rather than between sectors. The impacts of this trading have been:

- ➢ Pressure on water use has increased because previously “dormant” entitlements, perhaps of low value in a particular location, are no longer left flowing downstream to alternative users but are rather sold to someone who will use the entitlement.
- ➢ Many farmers (large and small) have “cashed in” their water entitlement and retired.

The general lesson is that water trading can work to move water from lower to higher value uses, provided:

- ➢ water rights are in place, measured and enforced;
- ➢ infrastructure exists to divert water entitlements from one location to another;
- ➢ legal and administrative arrangements exist to monitor and oversee market operations.

Source: Murray Darling Basin Commission (http://www.mdbc.gov.au/index.htm).

BOX 10

Jordan – managing water scarcity

Countries whose renewable water resources are less than 1 000 m^3 per capita/year are considered to be severely limited in socio-economic and environmental terms. Jordan has 209 m^3 per capita/year. Driven by this scarcity, the main objective of the Jordan Valley Authority, the body responsible for the overall operation of the Jordan Valley irrigation system, is to balance supply and demand between the irrigation sector and the municipal demand of Amman. Within this situation of extreme water scarcity and with increasing demands for water to be transferred from agriculture to meet the growing needs of Amman, the existing volumetric water pricing system is not used primarily as a tool to manage demand. Rather, fixed, volumetric allocations are made to farmers at the beginning of the season. Volumetric charging is expected to give the farmers some sense of the value and scarcity of water but the key objective of charging is to recover O&M costs. Similarly, the water supply to Amman is ensured not by pricing but by clear allocation, assisted by preseason simulation modelling of demand and supply (Huppert and Urban, 1999).

Water fees cover approximately 50 percent of irrigation O&M costs and would need to triple in order to achieve full cost recovery. However, there is strong political pressure to keep the fees low.

It is hoped that increased water fees will produce increased water use efficiency. However, although “the level of water charge has been subject to constant debate in recent years…the institutional aspect of financing has been touched upon less frequently”. The fact that the assigned maintenance budget is independent of the fees collected reduces the incentive to make the charge work effectively.

Despite wide-scale adoption of drip technology, application efficiencies for irrigation water have not improved significantly and distribution efficiency remains low. Farmers perceive the water supply to be unreliable. Thus, when water is available, they tend to over-irrigate in order to store water in the soil, a situation that leads to greater “losses”.

wider use should be made of step pricing to ensure compliance with the quota, rather than reliance on metering and financial penalties for over-consumption.

SUMMARY

Under area-based pricing systems, which are most commonly used, farmers pay a fixed fee per unit of land, assessed either on the basis of their total holding, the irrigated part of it or the actual crops irrigated. The system is relatively easy to administer, but is open to abuse, particularly through collusion between the farmer and the assessor to reduce the scale of the charge. Assessment based on irrigated area would appear to be the fairer method, but it requires considerable resources and effort.

Volumetric methods may not be feasible in large parts of the developing world because of the costs and complexity of installing large numbers of measuring devices on the supply to small farmers, and the vulnerability of available devices to accidental and malicious damage. In some circumstances, as practised for example in China, measured volumes of water can be delivered to an intermediate point, e.g. a township or farmers’ organization, giving farmers responsibility for distributing and charging for water. Systems of bulk volumetric charging and area-based charging to group members can then co-exist. RBT pricing depends on volumetric measurement and so is not common in irrigation, particularly in the developing world.

Where the flow of water is reasonably constant, the duration of delivery may be adopted as a proxy for the volume passed.

Formal and informal water markets exist in various parts of the world. In shallow groundwater areas, pump owners may choose between farming themselves or selling a water supply service to others. However, in the absence of defined water rights such systems are pumping markets rather than water markets, with no assurance of sustainable usage. Significant trading in water rights is underway in Australia, underpinned by clearly specified rights and a complex administration system to ensure proper accounting of third party impacts.

Chapter 4

Linking charging objectives and methods

INTRODUCTION

There must be clear linkages between policy objectives and charging methods, and consistency with other activities, investments and projects in the sector. The conclusions of the previous chapters are that two issues dominate current priorities – recovering costs to achieve financial sustainability, and limiting demand for water to the environmentally sustainable level. A third issue – providing a mechanism that facilitates transfer of water use from lower to higher value uses (whether 'value' is financial, economic, social, or whatever) is of significant concern to planners and policymakers, and can be addressed through tradable water rights. Table 2 summarizes the relationship between different pricing tools and these policy objectives.

The most obvious choice for a system to recover costs is an easy-to-implement, non-volumetric method, such as area pricing or output taxation. Area pricing has little or no effect on demand for water by individuals and its effect on water productivity is negligible. Indeed, imposition of high, non-volumetric, charges may lead to higher water use as users feel entitled to use as much as they want, as it has been paid for. Volumetric methods are intrinsically unsuited to the recovery of costs, because while the costs of system operation are relatively stable, the revenues from uncertain sales – possibly compounded by uncertain prices – provide an operating agency with limited financial security. Tradable water rights separate the issue of revenue generation (the payment by users for the cost of supplying) from pricing the resource (payments among the holders of water rights for the benefit of use).

Where the objective is to control demand, there are three options: quotas (which is not a charging mechanism); volumetric charges at levels sufficient to induce the required reduction in demand; or tradable water rights. Chapter 3 indicates that volumetric charging is not observed as a mechanism to bring demand and supply into balance – this is better achieved through water allocations (quotas). Volumetric pricing can promote some degree of water conservation. However, at the prices normally applied, their influence on the level of demand expressed is slight. Formal water markets require the allocation and monitoring of water allocations in order to function, which in turn provides a mechanism to manage overall demand. When well developed, such markets can also facilitate the redistribution of water between sectors.

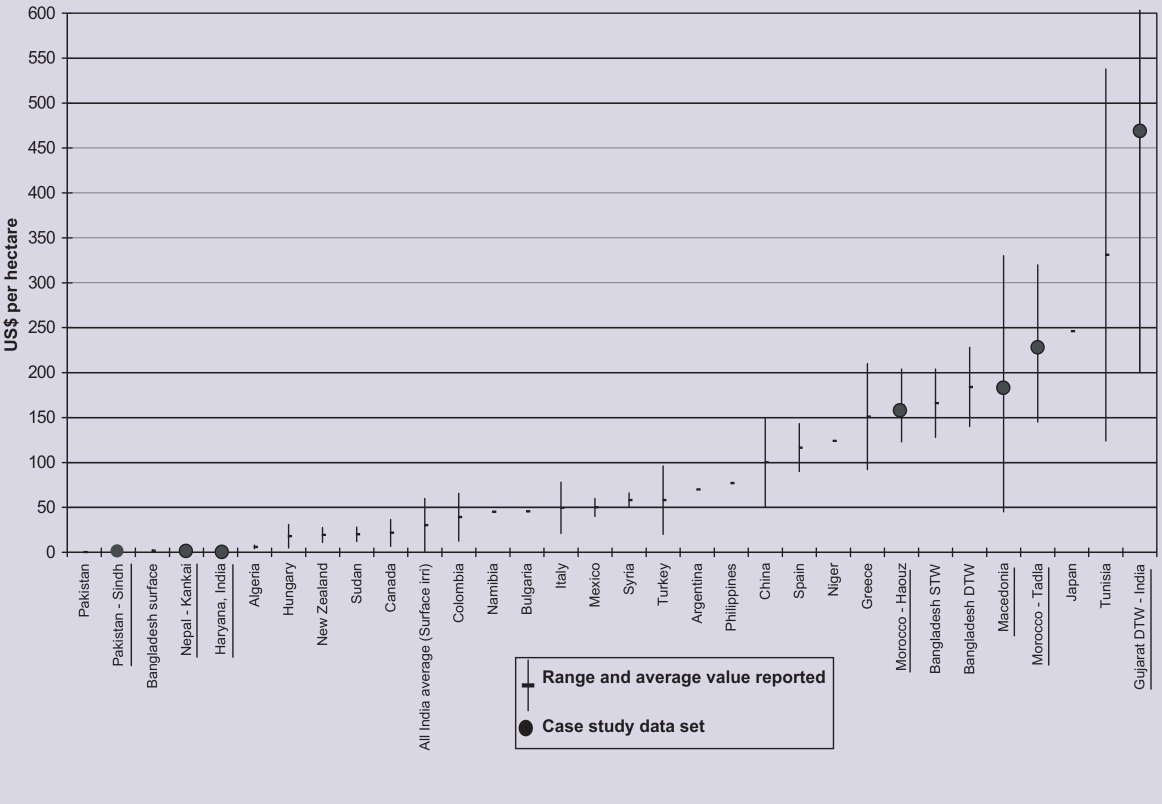
This chapter analyses the case studies undertaken for this project, plus the findings from the wider literature review, in order to assess the extent to which the objectives of

TABLE 2

Summary of the relationships between irrigation charging objectives and pricing methods

Pricing method	Charging objective		
	Cost recovery	Demand management	Encourages reallocation?
Non-volumetric methods	Yes	No	No
Volumetric charges	Uncertain	Positive but not necessarily adequate	Possibly
Tradable water rights	Yes, but separately achieved	Yes	Yes

FIGURE 3
Global range of irrigation water charges per hectare



cost recovery and demand management are addressed and achieved in practice. Table 3 presents a summary of the financial and economic aspects of scheme performance in the case studies. Figures 3 and 4 place the case study data within the wider global range. The world-wide data have been compiled from the extensive sources listed in the bibliography. A tabular summary of the six case studies, assessing the extent to which either cost recovery or demand management objectives are realized, is included in Annex 2. A full presentation of the material which underpins the analysis is to be found in two reports, Bosworth et al (2002), Cornish & Perry (2003).

ACHIEVING COST RECOVERY

All the case studies report the objective of recovering O&M costs from beneficiaries, while three (Gujarat, Former Yugoslav Republic of Macedonia and Morocco) 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 actually cover or exceed the O&M costs. In the Haouz scheme, Morocco, where the O&M costs per hectare are less than half those at Tadla (a smaller and older scheme), 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 applied to electricity for agriculture. If this subsidy were removed, it would prove uneconomic for farmers to continue pumping water to irrigate alfalfa unless the price of the crop increased.

FIGURE 4
Global range of irrigation water prices per cubic metre

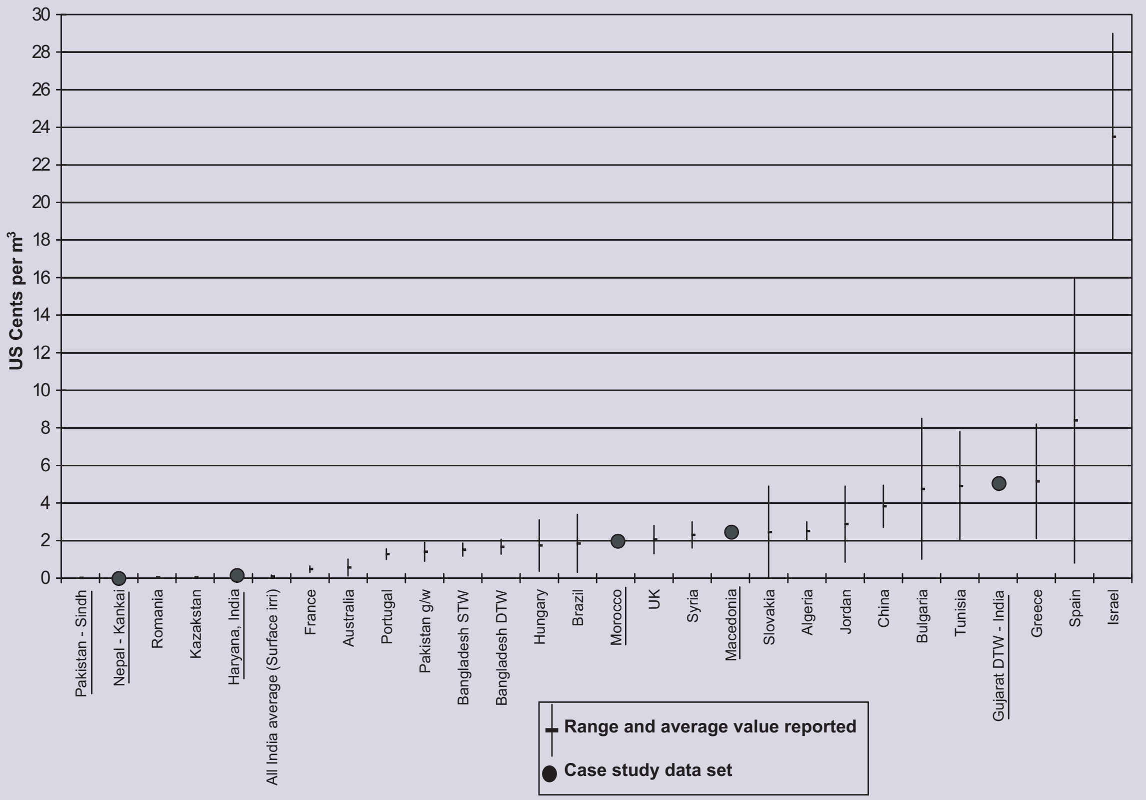


Table 3 shows that the tubewell farmers in Gujarat and farmers on the Tadla and Haouz schemes in Morocco pay 37, 17 and 7 percent, respectively, of their net income in water charges. In all three cases, the recovery rates are high – 100 percent in the case of Gujarat. In these cases, the fee collection process is transparent and the fees collected are retained and used on the scheme. Farmers understand, and are content with, the service provided. In Haryana, if the present cross-subsidy from other sectors were removed, farmers would face a threefold increase in the water fee to meet required O&M costs. However, this would still only represent 1.5 percent of net farm income per hectare. Here, farmers' unwillingness to accept, rather than their inability to pay, a large price increase would be the principal constraint. In the example of the Former Yugoslav Republic(FYR) of Macedonia, farmers would face a doubled water price (of US$0.04/m^3) to meet estimated necessary O&M costs, equivalent to 20 percent of average net income. Such a price would be very high by international standards. Given the weakness of the agriculture sector in the FYR of Macedonia and the condition of irrigation infrastructure, the goal of recovering even annual O&M costs from irrigation charges appears unrealistic.

In Nepal, where agricultural productivity is low, the ability of small farmers generally to pay fees high enough to cover annual O&M costs must be questioned. On those schemes which are in better condition and delivering better service, the full O&M fee would represent about 5 percent of net income per hectare, which is affordable. However, on deteriorated surface schemes, where total average farm incomes are lower, the proportion rises to 8 percent and is greater still for pumped schemes. 'Affordability' is not a simple criterion. Where irrigation supplements rainfall, as in Nepal, it is important to assess the net incremental return to irrigation,

TABLE 3
Summary data from the case studies

	India		Former Yugoslav Republic of Macedonia	Morocco		Nepal				Pakistan
	Gujarat	Haryana	All	Tadla	Haouz	Kankai	Khageri	Tilawe	West Gandak	Sindh
Water source	**Tubewell**	**Barrages**	**Principally surface water**	**Dam**	**Dam**	**Gravity run of river**	**Gravity run of river**	**Gravity run of river**	**Gravity run of river**	**Barrage**
Nominal command area (ha)	20 (each)	2.2 M (total)		92 000	310 000	7 000	3 900	5 600	8 700	5 M
Estimate of required annual O&M cost (US$/ha)	300	2.5 [1]	200	127	54	11	17.5		15.5	10.6
Annual actual allocation from finance ministry (US$/ha)	0	0	22	124	31	6.3	9.1	3.3	2.6	
Current water 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) [2]	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
Current water fee as % of net income	37	0.5	1–20	17	7	0.8	0.7	0	0	0.8–3
Required O&M cost % of net income	37	0.5	2–33	15	3	4.5	8	-	8	4

Notes:
1. Required O&M cost in Haryana is low because of to cross-subsidy from M&I sectors.
2. Income per hectare after deduction of all production costs except the cost of water
3. Fees shown recovered at Haouz are levied on a part of the area only.

that is, the net return to irrigation in excess of the income that could be obtained from rain-fed farming. This is because it affects farmers' willingness to invest the greater money and effort needed for irrigated agriculture. For schemes in arid areas, where crop production cannot occur without irrigation, the net return is effectively the same as the net incremental return. However, in supplementary irrigation, incremental net returns to irrigation are substantially less than net returns to agriculture because rain-fed production may produce significant yields. In the best surface scheme investigated in Nepal, the annual incremental net return to irrigation of the average farm (2.1 ha) was some US$205 - of which full O&M fees would take 11 percent - compared with a net return to irrigated agriculture of US$507. On the worst scheme (Tilawe), the incremental net income was US$82 for the average farm (1.1 ha), of which necessary O&M costs would take some 30 percent. The average incremental income in unfavourable seasons would be substantially less than these figures. For the poorest farmers on a scheme, whose incomes are barely at the subsistence level, raised irrigation charges would be particularly difficult to meet. In such conditions, both the ability and willingness to pay of small farmers must be doubted. Thus, for the general run of schemes in Nepal, it seems that the returns to water would have to rise before a general policy to recover full O&M costs could be considered.

In Sindh Province, the fee would again represent about 4 percent of net income per hectare, although the price per cubic metre is low in comparison with the other case studies outside the Indian subcontinent. In practice, existing fees are currently well below even this low figure, and with fee collection rates at less than 30 percent. Irrigation in Sindh remains entirely dependent on large, annual government subsidies. One factor that makes farmers in Sindh better off than their counterparts in Nepal is the average size of an irrigated farmholding. In Sindh, holdings average 6 ha, while on many Nepali schemes the average is little more than 1 ha. Thus, although average net incomes per hectare in the two cases may be very similar, the larger holdings in the Sindh provide a better household income, making it more likely that farmers could pay to cover annual O&M needs.

With the exception of the studies on Nepal and the Former Yugoslav Republic (FYR) Macedonia studies, Tables 3 and 4 suggest that it should be financially feasible to recover full annual O&M costs from farmers. However, legal, political, social and administrative constraints may prevent the effective recovery of fees. Furthermore,

TABLE 4

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)[3]	Present fee (US cents/m^3)	Fee required to meet required O&M expenditure (US cents/m^3)	Required fee as % of actual net income
India, Haryana	500	7 000	7.1	0.04	0.11 [4]	0.5
India, Gujarat	800	6 000	13.3	5.0	5.00	37.0
Former Yugoslav Republic of Macedonia	1 000	5 000	20.0	2.4	4.00	1-20
Morocco, Tadla	865	7 400	13.4	2.0	1.72	15
Morocco, Haouz	1 705	6 250	27.3	2.0	0.86	3.0
Nepal	200–250	2 000 [5]	12.5	0.1	0.55–0.88	4.5-8.0
Pakistan, Sindh	236	8 000	3.0	0.06	0.13	4.0

Notes:

1. Income per hectare after deduction of all production costs except water. In some cases, average of a range
2. An assumed annual irrigation depth has been used for each case study where field data were not available.
3. Net water value is the farmer's net income per hectare divided by water used.
4. Based on an estimate of O&M fees in Haryana if cross-subsidy from other sectors were removed.
5. Water consumption based on supplementary irrigation to monsoon crop.

while 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 obtaining lower net incomes. Therefore, careful analysis is required before drawing general conclusions about 'affordability'.

Of the three case studies where it is aimed to secure a substantial element of capital cost recovery (Gujarat, FYR Macedonia and Morocco), only the small, user-funded and user-managed deep tubewells of Gujarat are successful in recovering capital expenditure. Of the Moroccan schemes, management at Tadla regularly recovers more than its O&M expenditure but does not achieve a target of 40 percent of capital costs. The situation at Haouz is unusual: fees would be sufficiently high to recover O&M plus capital costs if universally levied. However, in practice they are only charged to a fraction of the total number of beneficiaries. In FYR, Macedonia, the area irrigated is declining and infrastructure is being abandoned. The reasons are complex but it seems that water management organizations cannot afford to pay the costs of historical bad debt and capital depreciation.

It is difficult to obtain reliable data on the magnitude of charges required to recover the full supply cost, i.e. including capital costs, on most schemes. However, it may be that the steep fall in agricultural commodity prices in recent decades – to the benefit of the non-agricultural poor – means that full recovery of O&M plus capital costs can seldom be achieved. Box 11 describes the changing approach to capital cost recovery adopted by the United States Bureau of Reclamation (USBR) in the United States of America.

BOX 11
Cost recovery in California, the United States of America

Teerink and Nakashima (1993) give a résumé of water supply pricing in California, the United States of America. Water pricing is perceived as a mechanism to recover costs – there are no practical examples of its use as a demand management tool.

Historically, irrigation districts, and thus individual farmers, drawing water from infrastructure built by the USBR were expected to pay water fees to cover the annual O&M costs. Capital costs were to be recovered through long-term repayment with no interest charges. In some instances, these terms were relaxed and irrigation districts were charged according to their ‘ability to pay’. This subsidy was justified on the basis that the original federal investment was made to achieve regional development and that full cost recovery was not always a precondition to investment.

The 1982 Reclamation Reform Act imposed the need for much greater cost recovery by the USBR from irrigation districts. Since then, water prices have risen sharply when long-term contracts between the Bureau and districts have come up for renewal.

Water prices vary considerably between districts, depending on annual O&M costs, the extent of past underpayment of capital costs, the interest on that, and requirements for new capital expenditure. The irrigation district then adds its own costs such that farmers may pay as much as US$44/1 000 m^3).

A US General Accounting Office report stated that, in 1984, irrigation and municipal/industrial customers had repaid only 5.5 percent of the capital investment of US$1 380 million. Furthermore, the existing water rates did not cover the annual O&M costs. Therefore, new contracts were to be negotiated, “aimed at recovering, within 50 years, that portion of the existing plant in service allocated to irrigation and municipal/industrial water.”

The evidence is that water pricing in the irrigation sector has been used solely to recover some portion of O&M and capital costs. Full cost recovery of capital investment has only recently become an objective of federal (USBR) schemes. In some schemes, long-term, fixed contracts have meant that water fees have not covered annual O&M costs.

Improving cost recovery – the role of irrigation management transfer

The discussion on what price to charge should be secondary to the issue of improving recovery rates for any charges that are set. The summary information presented in Annex 1 shows that recovery rates of water charges are usually below 50 percent. Moreover, in several countries, levels of recovery have declined. In Pakistan, recovery rates dropped from 38 percent in 1994/95 to 26 percent in the following season; in FYR Macedonia, they fell from 88 percent in 1990 to 35 percent in 1995; in India, they decreased from 64 percent in 1974–75 to 8 percent in 1988–89 (Saleth, 1997); and in Suriname, water users stopped paying water charges altogether and water boards practically disappeared (Risseeuw, 1997). In Croatia, no charges are collected for irrigation because the area and income involved are too small to justify the costs of collection (Ostojic and Lukšic, 2001).

Transfer of poorly maintained irrigation systems to users is often seen as a way to improve O&M and to reduce costs to the state and the users. However, where systems are already chronically under-funded, the result will be further deferral of maintenance and general decline. Governments then have to borrow to rehabilitate their irrigation systems, creating a vicious circle. Underassessment of the true cost of service provision can be as great a problem as non-payment of fees by farmers.

Reviews of irrigation management transfer (IMT) policies demonstrate that recovery of water charges does not necessarily cease to be a problem after management transfer. Many transferred schemes struggle to enforce fee collection. For example, in Colombia, the level of cost recovery declined in two out of three case study areas after IMT (Vermillion and Garcés-Restrepo, 1998). These findings reinforce recent appreciation that governments' support for transfer should not be terminated abruptly following transfer. Institutional, rather than financial, support is likely to be needed for some time post-transfer.

DEMAND MANAGEMENT AND WATER SAVING

Ray (2002) discusses the assumptions implicit in 'getting the prices right' in order to deter wasteful use of water and to achieve irrigation efficiency (Box 12). Ray concludes that these assumptions are invalid for India, and that enforceable and transparent allocation rules may be more effective to curtail water demand. Molle (2001) reaches similar conclusions for Thailand.

'Getting the prices right' is a complex issue, not least because of the multiple uses which may be made of water from irrigation systems. As indicated elsewhere, detailed discussion is not made here of such issues, but they are addressed by e.g. Facon (2002). Some authors suggest that the value of water (or any other resource) is the maximum amount the user is willing to pay for the use of the resource. Where pricing is used as a regulatory measure to ensure efficient allocation of water resources between sectors, all economic costs – including opportunity costs, positive and negative economic externalities – need to be taken into account.

A major obstacle to the introduction of volumetric water pricing is the high cost of the required measurement and billing system. Where farmers are many and farm sizes are small, the process of monitoring water use, billing and collecting fees is difficult and carries high overhead costs. Water measuring devices at farm level and institutional infrastructure are rare and generally unserviceable in the developing world. Perry (1995 and 2001a) shows that in Egypt and the Islamic Republic of Iran, the costs of charging individual farmers are likely to outweigh the projected benefits. Apart from some higher-income countries, the high costs of associated with charging individual farmers present problems for volumetric pricing. A study of OECD countries shows that volumetric pricing in agriculture is not widespread because of practical difficulties (OECD, 1999). As long as the transaction costs remain a high percentage of the revenue collected, or of the value of the production, volumetric measurement is difficult to justify.

BOX 12

Assumptions underlying the use of pricing for demand management

'Getting the prices right' in irrigation is based on many assumptions:

1. Water prices are significant in the overall crop budget, and as a fraction of crop net revenues. If not, the effect of price increases may be so small that the water demand will barely respond.
2. There is a volumetric link between what farmers pay and what they receive. Where water is charged by the hectare, its marginal cost is zero and higher prices cannot induce efficiency.
3. Farm level inefficiencies are large in relation to overall system inefficiencies. If not, the farm may not be the place in which to look for water savings. Instead, aggregrated supply to a group might be considered.
4. Farmers do not diversify into high-value crops and irrigate using wasteful methods *because* water is so cheap. Where low-value crops are grown for other reasons, e.g. for their own consumption, or because of labour constraints, price signals may not have the expected effect.
5. The changes to the physical infrastructure that are necessary in order to implement water trades or volumetric pricing, such as measuring devices and channels for conveyance, are not prohibitively expensive. Where they are, any gains from trade will be neutralized by these implementation costs.
6. Tradable water rights can be allocated and enforced without high transaction costs, and any significant third-party effects can be countered. If not, these costs and potential losses will overcome the benefits of trade or local water savings.

N.B. Points 1, 3 and 4 relate to the theoretical effectiveness of price incentives rather than the practical issues of implementation. Points 5 and 6 relate to the difficulties of implementing higher water prices or tradable water rights.

Source: Ray, 2002.

In parts of China, volumetric supply and billing to townships (and nowadays some WUAs), coupled with pre-payment for water, appears to be successful. Acknowledging the considerable differences in social and institutional arrangements, there may be lessons here for other parts of SE Asia, as Facon (2002) argues.

In Gujarat, Haryana, Morocco and Pakistan, water is particularly scarce, agricultural demand continues to grow, and there is increasing competition between sectors for a limited resource. Nonetheless, agencies in those states and countries have not explicitly identified water demand management as an objective of pricing, although Morocco does charge volumetrically below an imposed limit.

Case study areas

Gujarat

In the study area in Gujarat, aquifers and groundwater quality are in decline, and the government currently has no mechanisms to address the issue other than the price of electricity. As there is full flexibility and control over water deliveries at farm level, volumetric pricing is feasible and indeed it is practised by the farmers' groups who own wells. Although the state subsidizes electric power, current prices for irrigation water in Gujarat are high by international standards (Figures 3 and 4). However, the high price has failed to prevent overexploitation of the aquifers. Given the site-specific nature of farmers' crop selections, varying market prices for crops, different water table depths and the variable yields of different aquifers, it is unlikely that a uniform policy of increased energy prices could reduce irrigation demand to the levels needed to sustain ground water levels.

The twin problems of overexploitation of aquifers and near-bankruptcy of state electricity companies are linked. However, it seems unrealistic to expect a pricing policy for electrical energy to solve both problems. If the flat-rate tariff structure for agriculture is replaced, so that farmers pay for the amount of energy actually consumed, the energy suppliers may be returned to solvency, provided that collection can be enforced. Practically, it is difficult to envisage an energy price alone achieving a balance between water supply and demand, since the price needed to achieve any sort of effective restraint, like the water charge on surface schemes, would need to be raised many times over against vocal public opposition. Without the introduction and implementation of effective abstraction licensing laws, it seems that balance will only be achieved by the draw-down of aquifers to a point where further pumping becomes uneconomic, or the aquifer becomes too saline for productive use.

Haryana

The State of Haryana addresses the issue of water scarcity by a system of water allocation. Allocation decisions between sectors are made at the political level, and that between farmers is based on well-established and fixed rules. First, the water demands for non-agricultural and agricultural use are prioritized 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 in the upper levels of systems. Thus, there is essentially no scope for moving towards more flexible and volumetric delivery with pricing at the farm level. It can be argued that this system of water allocation, both between sectors and among farmers, is an economic instrument in that allocation decisions are based on the perceived value of a scarce resource. However, the system does not rely on the cost to the user of the resource either to control demand or achieve a planned distribution, and, indeed, the present water price is insignificant to the relatively affluent large farmers of the area. The preferred crop choices (cereals) do not provide the farmers with obvious motivation for introducing water-saving irrigation technologies.

Increasingly, the system does not operate as well as formerly, in the face of a number of adaptations to operational practice, of de-facto physical changes and a changed role as farmers increasingly supplement supply with groundwater. Nonetheless, it provides a well-codified and recognised framework for water management.

Morocco

Irrigation authorities in Morocco depend on a combination of relatively high water charges, which discourage waste, and seasonal allocations to ensure that supply and demand are in balance. It is the allocation system that constrains use. The vast majority of farmers would take more water at the prevailing price, and development of more expensive groundwater within irrigated areas is progressing rapidly. Increases in volumetric prices to discourage demand for surface water may lead to unsustainable use of groundwater, which is a serious problem in many areas outside the irrigation schemes. Furthermore, since much of the groundwater comes from the formal irrigation system, reduction in use of surface supply will have corresponding effect on the availability of groundwater.

Pakistan

In Pakistan, water is scarce, and the underlying legal, administrative and system design is the same as in Haryana. However, performance in terms of cost recovery and allocation of water at the farm level is far inferior. Water charges are lower and collection rates are poor. The physical system has not been maintained well (which leads to inequitable distribution), and it has been tampered with. Thus, the design, intended to ensure automatic distribution of the proper amounts of water to each area, is circumvented. Scarcity of water is 'managed' by delivering what supply is available – meaning that those with best access to water take as much as they want, while those with poorer access have what may be left.

Volumetric charging in practice

It is helpful to compare the unit value of water (represented by net farm income divided by quantity of water used) with the unit cost of water (indicated by the irrigation charge divided by the quantity of water used) – columns 4 and 5 in Table 4. The higher the value–cost ratio becomes, the greater will be the demand for water, and the larger will be the increase in price required to influence demand. In the case studies, the indicator varies from a value of about 3:1 for tubewell users in Gujarat to about 180:1 in the surface systems of Haryana. Nepal and Pakistan show ratios of 125: 1 and 50:1, respectively. Farmers are generally unlikely to reduce their consumption of water significantly until its cost begins to approach its value to them. As water prices generally still represent only a small percentage of farmers' net incomes (Box 12), increases of more than an order of magnitude would apparently be needed to influence demand. It would generally be politically and socially unacceptable to enforce change of this magnitude.

The impact of volumetric water pricing and farmers' response to increased charges depends on a variety of factors. Box 13 provides an overview of factors that influence the price elasticity of demand for irrigation water – that is the change in quantity demanded for given change in price.

Irrigation water demand curves in Spain exhibit a perfectly inelastic (non-responsive) stretch at low prices and become elastic beyond a certain threshold (Varela-Ortega *et al.*, 1998). As prevailing prices are low, this implies that only considerable increases in price, i.e. setting the price above the threshold, will induce the desired efficiency. Existing low prices of water may be the main reason why farmers are not very responsive to price changes. Moreover, factors other than price may have a greater impact on the quantity of water demanded, e.g. climate variation, agriculture policy,

BOX 13

Pricing as an incentive for water saving

In the cases of Haryana and Sindh, the current water fee is less than 3 percent of the net revenue from irrigated crops. Neither of these states identifies demand management as an objective of water pricing, despite the fact that competition for water is growing. In Morocco, farmers are willing to pay as much as 17 percent of their net income for a moderately inflexible, but reliable, surface water supply. In Gujarat, where farmers have complete flexibility of control over their own wells, they will pay more than 30 percent of their net income for water. Even at this price, there is no evidence of farmers investing in improved water management technologies at field level. If policy-makers in Haryana and Pakistan were to consider using water pricing to deter farmers from using water, they would need to raise current fees twentyfold or thirtyfold to reach 15 percent of net income. No agency or government could expect to introduce price increases of this magnitude in the short term. Prices would have to rise over time and be matched by improvements in service delivery. The studies from Pakistan and Nepal also demonstrate that systems of fee collection and enforcement need to be improved significantly as present systems achieve no more than 30–60 percent collection of very low fees.

BOX 14

Elasticity (responsiveness) of demand of agricultural water

Values of elasticity of demand are normally negative, as demand falls when price increases. Higher absolute values of elasticity indicate that the percentage change in volume demanded is large compared with the percentage change in price. Price elasticity estimates from a study in OECD countries vary considerably, from -17.7 to -0.05 (OECD, 1999). The price range for which the elasticity is measured is probably the most important determining factor: the higher the price range, the higher the elasticity, or conversely, the lower the initial price, the smaller the farmers' response to a price increase

Elasticity depends on:

- Initial price of water: the lower the price, the less responsive farmers are to price increases.
- The availability and relative cost of alternative water sources.
- Crop value: elasticity is higher for low value crops.
- Production costs: where water is only a small part of total input costs, there is little incentive to change irrigation methods; thus high production costs lead to low elasticity.
- Application rates: where farmers are applying excessive amounts of water, there is scope for conservation without the necessity to change irrigation method.
- Ability to change crops (climate, soils and markets).
- Ability to change to more efficient irrigation technology.

One study suggests that water demand is inelastic only up to a given price level. Beyond this price 'threshold', water demand may be very price responsive. The level of price 'threshold' depends on:

- the economic productivity of water;
- the price of water compared to overall production costs;
- the set of alternative production strategies, to substitute for water consumption;
- the proportion of land devoted to permanently irrigated crops;
- the irrigation technologies in place.
- the size of water allotment.

Depending on the irrigation technologies in place, short-term elasticity may be very low compared to long-term elasticity (switching to more water efficient technologies or management practices takes time). Where efficient, high-technology, on-farm water management is already in place, this effect is reduced.

Source: USBR (1997).

product prices, and the reliability of the water supply. Malla and Gopalakrishnan (1995) report that price increases in Hawaii had no significant impact on water use, as climate factors, such as rainfall, primarily determined water use decisions.

Ray (2002) stresses that even where volumetric pricing leads farmers to improve their water use efficiency, they can only improve the management of that fraction of diverted or released water that reaches their fields. On many large surface-irrigation schemes this might be as little as 25 percent; the rest of the water released may be lost in conveyance and no pricing policy is likely to address these losses.

Berbel and Gomez-Limon (2000) estimate that farm incomes in Spain will have to decrease by 40 percent before water demand decreases significantly. Perry (1995) estimates that inducing a 15–percent reduction in water demand in Egypt through volumetric pricing would decrease farm incomes by 25 percent. The study by Ray (2002) on water pricing in India uses an analytical model to show that in order to induce the water-conserving response under existing allocation practices, a sixfold price increase would be needed. In the Islamic Republic of Iran, to be effective in curtailing demand, water prices would need to rise by a factor of ten (Perry, 2001a). Price increases of this order of magnitude are quite unlikely in the prevailing political context and thus the political feasibility of volumetric water pricing, as a tool to curtail demand, is questionable. This is particularly valid in most developing countries where existing water prices are very low – well below the threshold where a significant response to price is seen.

Severe impacts on farm income are implicit in using water pricing as a means to limit demand.

Enforceable and transparent allocation rules and abstraction licences may be a more effective way to curtail demand (Perry, 2001a; Ray, 2002). Although there are clear difficulties in enforcing allocations, the previous sections have shown that well-established systems such as *warabandi* in north India can be effective, and that the effective enforcement of unpopular pricing measures is arguably considerably more problematic.

Theoretical analyses made for the US, Bernardo and Whittlesey (1989), suggest that farmers in Washington State would aim to reduce water use at the cost of increased labour by switching to a more efficient use of their current irrigation technology. Consequently, under restricted supply (rationing), water use apparently could be reduced by up to 35 percent for surface irrigation and 25 percent under centre-pivot schemes, without greatly affecting farmers' incomes. Hoyt (1984) reaches similar conclusions for groundwater use in the Texas High Plains. However, increased water extraction costs and crop prices appeared to have no significant impact on the efficiency of water use. Hoyt argues that, owing to the inelastic demand for irrigation water, reliance on price mechanisms to conserve water has limited impact in the short run. Only if prices increase dramatically, do capital investments in more efficient irrigation technology become viable – at considerably reduced profits.

It is also important to the issue of saving water that 50% or more of water lost on surface irrigation systems occurs in the main system, upstream of the area traditionally controlled by farmers. Charges levied on farmers can therefore clearly make no impact on a large part of the total system 'loss'.

SUMMARY

All the government agencies reviewed in the case studies state that their primary objective in charging is to recover O&M costs. In practice, the objective was only realized in three of the eight cases. Capital costs were only fully recovered in one case and, partially, in a second case.

In most cases, the benefits of irrigation substantially exceed the basic costs of delivery. Farmers' unwillingness to pay generally constrains efforts to recover O&M costs. However, in the poorest countries, small farmers may face real difficulties in paying the full O&M cost. Governments may need specific policies to assist the poorest farmers in such circumstances.

Management needs to establish a consistent and reliable water supply, with transparent systems for assessing and collecting fees and sufficient in-built flexibility to meet farmers' needs. Charging systems need to be supported by clear land and water rights and the effective rule of law. 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 and effectiveness of water delivery. From their side, farmers must perceive true benefits in paying for what they have often viewed as a 'free' government service.

For the cases investigated, the unit value of water in agriculture was compared with its unit cost. Apart from the privately-owned wells in Gujarat, high ratios on all case study schemes suggest that the price of water would have to rise by at least an order of magnitude to affect demand. Such price rises would be difficult to enforce and threaten the livelihoods of the poor. The wider review of literature supports the concern that the responsiveness of demand to water pricing is usually low. Models indicate that if price is used to bring about substantial reductions in demand this will usually be at the cost of disproportionately greater reductions in net farm income.

There are very few places in the world where pricing is the prime mechanism for constraining irrigation water demand. High marginal prices for water will prompt some reassessment of water use by farmers and a more conservationist attitude, but moves to balance supply and demand in overexploited basins are led by water allocation. In the case study locations where water is particularly scarce, controls over water allocation (rationing) are used to limit consumption. In Haryana and Pakistan, water is distributed under the *warabandi* system. In Morocco, farmers order and pay for water on the basis of volume, but their overall use of the resource is limited by a fixed quota.

If water fees were increased to the levels required to bring about significant reductions in demand, there would be a substantial threat to the livelihoods of smaller and poorer farmers. The case studies do not provide evidence on this point because none of the countries concerned has pursued such a policy. Nonetheless, it is concluded 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. As with other economic instruments, these approaches also require significant and sustained political support, and the technical infrastructure to measure allocated volumes and permit water transfer between users.

Chapter 5

Institutional and organizational issues affecting water charging

A large number of institutional and organizational issues can affect the implementation of a charging policy. The OECD (1999) highlights the fact that agricultural water pricing policies do not occur in a vacuum but are often driven by factors outside the irrigation and agriculture sectors. Molle (2001) emphasizes that institutional and technical reform of the water sector is imperative and must often precede water pricing. Efficient, and in general, radically improved, control of water is basic to the success of water charging systems

WATER AND LAND RIGHTS

Perry (2001a) emphasizes that "…an orderly system of distributing water must be in place through some existing and respected regulatory framework for allocating water among farmers…If this is not the case – or if regulations are not observed…then there is no immediate scope for improving water distribution through pricing, and attention should first be given to clarifying and enforcing water rights and the rules of water distribution." In the developing world, water rights are insecure and often ineffective – tail-end farmers often have insufficient water, while farmers at the head take too much.

Substantial costs and effort are required to establish and protect water rights. However, until users have rights over water, they cannot make any long-term decisions regarding its use. Focus on water pricing may be premature and ineffective without prior establishment of a well-understood and legally-supported system of water rights for users. The formalization of water rights needs to be handled with great care as the rich and powerful can 'capture' traditional or customary rights from the poor. Water rights are a more contentious issue than water pricing. Therefore, governments may seek to implement pricing while avoiding the larger task of codifying water rights.

CALCULATING O&M COSTS

A systematic description should be drawn up of key maintenance processes, including a breakdown of the resources required – labour, material and equipment. For these components, unit costs are determined and adjusted annually for increases in labour, material or equipment costs. The maintenance requirements for a coming year are assessed on the basis of a status survey, which involves an inventory of damage to the system. The status survey may be carried out at local level in a joint walk-through with water users or by field engineers of the water agency. Cornish (1998) describes a method to assist annual maintenance planning and costing based on condition-assessment procedures linked to structural function and stability. However, there are some limitations to this process. First, many irrigation systems are "living infrastructure", which changes over time. New structures and canals are added, while other areas are neglected selectively – because they are no longer needed or are too difficult to maintain. Second, it is necessary to select suitable norms for adequate maintenance and define what maintenance is to achieve. Restoring assets to their original state may not be possible, or in many cases, useful. In practice, trade-offs will have to be made. A third point concerns unit costs. In Thailand, GITEC/PANYA (1998) found that different regions have very different cost structures and there is considerable sensitivity in approving and adjusting unit costs. If farmers are to pay higher water prices to meet actual O&M costs (and possibly capital costs), transparent, quantitative planning procedures will be required so that users can understand the basis for the charges.

Skutsch (1998) presents a review of the factors that contribute to ineffective maintenance regimes in irrigation systems and makes the case for higher expenditure on maintenance to avoid premature expenditure on costly rehabilitation.

Operational or service costs need to be added to the maintenance costs. Field and office management costs will be involved, including those systems where water charges are based on land area. At present, the service costs of irrigation agencies may be higher than strictly necessary for the tasks involved, owing to high levels of staffing. One way of estimating field staff needs is to factor the scheme size by the average areal responsibility of an individual. Turnover processes, under which farmers become responsible for parts, and sometimes the whole, of formerly government-managed systems, give the opportunity to examine the level of service which is to be provided in future. Often, when Water User Associations contract to a set of commitments, the irrigation agency itself does not commit to any performance standards. By contrast, in Mexico, systems were re-engineered at the time of turnover, whilst engineers and managers received training in improved operation and water management so as to improve levels of service.

Under turnover in a number of countries in Asia, total system O&M costs are shared, with government funding and managing the upper levels of the system, whilst farmers fund and manage secondary and/or tertiary canals.

Upgrading costs need to be considered separately. It is rare that WUAs are able to save sufficient funds to make a significant contribution to the costs of upgrading their schemes. Government will therefore continue to have an important role to play over the long term.

WHO SHOULD PAY, WHEN, AND FOR WHAT

In many cases, the issue of who should be responsible for the costs of irrigation development is not clear-cut. In FYR Macedonia, private landholdings are small and dispersed; owners often farm part-time or are absent. Therefore, according to Hatzius (2000), it is difficult to assign to farmers the responsibility for the O&M of the system.In practice, responsibility may be assigned but the work will have to be done by others on behalf of the owners. In Indonesia, users in one area complained that farmers outside the irrigation system were using water from the main canals but not paying an ISF (Gerards, Tambunan and Harun, 1991). In the Jordan Valley, sharecroppers pay part or all of the water charge, while the landowners generally pay the infrastructure costs.

It is often asserted that irrigators should bear the full supply costs, including capital investment, depreciation and annual O&M. However, Bakker (1999) argues that this is unreasonable as consumers have benefited by irrigation development in terms of lower cereal prices. Especially in developing countries, there are millions of indirect beneficiaries who benefit at least as much as farmers. Food prices are usually kept artificially low and urban consumers should be willing to subsidize irrigation development through taxation. On the same basis, it can be argued that those who benefit from the products of industry using electricity should contribute to the power supply bill above and beyond the costs of the products they buy. This may seem a difficult position to defend, but few governments will promote increases in the price of food to reflect its true local cost of production. Subsidy, through taxation, may well be the more attractive option.

There is also the problem that water may be used many times over. For example, in Egypt, water has a number of uses, some competing and some complementary, potentially making the pricing of water more complex. In addition to farmers, beneficiaries may include villages which receive domestic water supplies, those who benefit by flood control, and hydropower. The costs of supplying the water, as well as drainage, should perhaps be shared between them. Bakker (1999) questions whether 'users' should not include livestock owners, anglers, domestic users and brick makers. The issue becomes more complicated when one considers that farmers themselves are multiple users of water.

The simplest method of collecting payment from farmers is to do so before each irrigation delivery, thereby avoiding the need to chase for payment after each season. In Mexico, all fees are collected by the end of the season. In Shanxi Province, China, townships, as the intermediary suppliers to farmers, pay in advance for water delivery. However, in the Philippines and in the Niger Valley (where the time limit for payment can be extended to six months after the end of the season), fees are often still outstanding at the end of the season. This means that even although actual fee collection rates are high (90–100 percent), co-operatives are always operating at a loss. In some cases, this loss amounts to the fees for two seasons. The co-operatives come under increasing pressure, meaning that the element of the fee intended for savings may well be used for day-to-day running costs.

With volumetric charging, that component of the fee that is determined by the volume delivered must be billed after the event. In the Jordan Valley, bills are issued on a monthly basis and reflect the volume delivered in the previous month.

A recurring question is whether revenues should be used in the system where they were collected, flow back to the government for use in the irrigation sector, or be retained by government as tax income. It is logical to assume that farmers will be most likely to pay for irrigation if the money is used to provide services on their local scheme. However, this rarely happens in practice. The issue is of great significance to the sustainability of systems but receives no priority with governments and is merely flagged here.

GOVERNMENT, ENFORCEMENT AND REGULATORY BODIES

Political realities and vested interests affect the functioning of charging systems. For example, wealthy landowners can use political influence to avoid prosecution for obtaining water when it is not their official turn. Problems of corruption or mismanagement can face any institution handling financial resources. Financial mismanagement led to the downfall of many co-operatives in the 1960s and 1970s. The practice of paying bribes to secure irrigation supplies or to have a water bill reduced are well documented (Repetto, 1986), and the flow of bribes may create a shadow institution exerting more influence than the formal institution.

Water pricing is a politically and socially sensitive issue, in particular where economies are dependent on irrigation. Vested interest groups within government may use their power to slow the progress of institutional reforms. In addition, lack of co-operation between different government departments can create delays in implementing policies. Farmers as a group often have political weight, resisting increases in the price of irrigation services. If farm subsidies were withdrawn completely in Thailand, there would be "political and economic chaos", as farmers constitute the largest part of the population (Molle, 2001). In FYR Macedonia, "client and service orientation of water related services, transparency of water pricing and accountability of WMO [Water Management Organizations] to user organizations seem to be theoretical concepts far removed from the reality of Macedonia, where informal institutions…prevail" (Hatzius, 2000). In the Niger Valley, the government has yet to acknowledge the complexity of the farming systems where reform is being implemented and allow for this in their policies. For most farmers in the Niger Valley irrigation forms just one of many economic activities, so "their irrigation activities cannot be separated from their rain-fed and other activities, because these constrain what they can and cannot do” (Abernethy *et al.* 2000). Better focus on institutional and social issues is needed, in particular on ways to bring informal institutions into legal compliance.

There are many reasons why irrigation charges are not paid, some of which are not the fault of water users. Non-payment may be the result of poor methods of collection, incorrect billing, non-delivery of bills or other mistakes in the revenue administration. However, in most cases, non-payment stems from the absence of effective sanctions. There are three categories of sanctions: penalties, legal action, and suspension of water deliveries. In a recent global survey conducted by the International Commission on Irrigation and Drainage (ICID), 45 out of 51 irrigation providers had used at least one of these categories of sanction (Lee, 2000).

Suspension of water deliveries is the most powerful sanction. For example, Bos and Walters (1990) describe how fee collection by water users associations (WUAs) in Argentina only became effective after the associations were allowed to stop the delivery of water to defaulters. However, this sanction is not technically feasible in many types of system. Furthermore, withdrawal of water may be a politically or culturally sensitive issue in some countries.

The increasing involvement of the private sector in utilities such as water, telecommunications and power supply has prompted emphasis on regulatory mechanisms. Regulatory mechanisms are seen as key to managing private or public supply of a monopoly good, but there are very few examples of regulatory bodies in irrigation supply. Moreover, experience of regulatory functions in the water supply and sanitation sector indicates that it is institutionally complex and very costly to achieve effective regulation. Under turnover processes, there is an opportunity to increase oversight of institutional performance.

FINANCIALLY UNSUSTAINABLE SYSTEMS

Contrary to some perceptions, irrigation investment has been economically beneficial. World Bank post-evaluation studies indicate average rates of return of 20 percent, which are higher than for many other agricultural investments (Jones, 1995). Nevertheless, there are constraints to achieving financial sustainability in some irrigation systems. First, the price of basic agricultural commodities has fallen dramatically over the last 50 years. Thus, investments that were viable at the time of their inception may no longer be so. Irrigated agriculture has thus become a victim of its own success. Second, irrigation schemes are not built solely to benefit farmers, but to provide affordable and secure food supplies to the country concerned. While direct benefits of increased productivity may reasonably be charged to farmers, the substantial, indirect benefits of low-cost, secure food supplies may legitimately be assigned to society more generally. This may be a legitimate policy for a government placing a high value on improving the level of food security by developing production systems that are only financially viable with subsidies. Third, some systems may be needed to stabilize and benefit poor rural farmers, who would otherwise be exposed to regular drought and food insecurity (so reinforcing a trend to move to overcrowded urban areas). In this case, social benefits are critical determinants of policy. A change of government policy, away from the continuing subsidy of such schemes towards more market-driven policies – a common phenomenon in the countries of Eastern Europe and the former Soviet Union – means schemes become financially unsustainable.

Governments argue that abandoning unsustainable systems would have disastrous social and environmental consequences. However, in the present circumstances, they are finding it increasingly difficult to maintain a high level of subsidy. It is also a challenging problem to determine when a system is no longer viable. When Slovakia formed part of Czechoslovakia, irrigation systems were built to ensure food self-sufficiency rather than for economic benefit. It is particularly difficult for farmers to establish which irrigation systems are no longer sustainable as all agriculture is in decline (Cisty, 2001).

Pumped irrigation systems in Bulgaria are a further example of schemes that are no longer viable. The political and economic changes of the 1990s made pumping stations unprofitable and the area served by them has fallen by 300 000 ha, a reduction of more than 50 percent.

Svendsen (2001b) suggests that a "triage system" is needed, where irrigation systems that have potential in financial and economic terms can be separated from those which do not. Where systems fall between the two categories, governments may intervene to provide subsidies. In certain cases, the expansion of large-scale irrigation infrastructure may not be compatible with full cost recovery (OECD, 1999). It is unlikely that the eventual users of large-scale systems under construction in Portugal and Turkey will be capable of repaying all the capital costs. One of the projects, the Alqueva project in Portugal, is to be financed mainly by the EU, although the European Commission's Water Framework Directive requires full cost recovery (European Union, 2000).

Tardieu and Prefol (2002) discuss the French response to the Water Framework Directive's insistence on full cost recovery. They argue that prices that included the past financial costs of major infrastructural investment would be socially unacceptable. Instead, they argue for an intermediate or "sustainable" cost, one that covers all O&M costs but excludes the cost of past investment.

MAKING PAYMENT

Fundamental differences between irrigation systems of different sizes are reflected in the form of payment (Johnson, 2001). In small irrigation systems of 100–300 ha, such as those in Indonesia, Thailand and the Philippines, payment is often in kind and farmers carry out maintenance. Many small-scale systems cannot hire professional staff to improve the management of the system as water fees are paid in kind and no funds are generated. Larger systems of 3 000–20 000 ha. require more management, and they can collect sufficient funds to pay for professional staff and carry out adequate maintenance.

Faced with a cash economy, farmers in many small systems are making greater contributions in cash rather than in kind, e.g. in the Niger Valley, Nepal and Bangladesh. Payment in kind continues in Eastern Europe, the former Soviet Union, and Viet Nam (Nguyen, 1999). Such payment systems are either the equivalent of a fixed charge (if the crop contribution is fixed) or benefit-related (if the crop contribution is a proportion of production). Such systems do not lend themselves to any form of volumetric charging. However, under VWRAP, a current World Bank project, it is aimed to introduce in Vietnam new forms of service agreement between irrigation companies and WUAs, which will specify volumes to be delivered at defined points, though charging will not be volumetric at the outset.

It can be argued that farmers subsisting below a certain income level should not have to pay fees. However, it is necessary to define unambiguously who should be exempt from paying. Svendsen (2001 a) believes that it is preferable to use a combination of food subsidies and full cost charging for irrigation. However, del Castillo (1997) cites a World Bank Project in Peru where the irrigation infrastructure is to be handed over to users. Users will repay loans to banks and will be responsible for rehabilitation, operation and maintenance costs. If small farmers are unable to repay rehabilitation costs, they will, in effect, be subsidized by wealthier farmers. It is not clear how farmers were or will be tested for their ability to pay. Such a system will fail where the majority of farmers are unable to pay, or where wealthier farmers are unwilling to pay.

Ability to pay is not the only factor determining willingness to pay. Users must have confidence in the service delivered and in financial management. In many settings, a vicious circle exists of poor service delivery, low cost recovery, minor corruption and inadequate maintenance, leading to further decline of services and decreasing willingness to pay. There needs to be "mutual accountability" between the institutions, irrigators and service providers in order for a system to operate effectively.

Del Castillo (1997) gives a concise account of the relationship between fee collection and willingness to pay: "The record of non-payment and non-collection of fees for water is long and well-documented. It reflects two problems: weak incentives to collect fees and limited willingness to pay because services are poor. In many cases the record of poor collection can be attributed to lack of political determination to enforce collection and limited motivation of agencies to collect, since they are not required to cover their costs." In order to make the exercise worthwhile, the fees collected must be substantially greater than the administrative cost of collection.

WATER PRICING AND IMPROVED IRRIGATION TECHNOLOGIES

Where water pricing is promoted as a tool to bring about reduced water demand, it may be promoted in isolation without adequate consideration of other complementary means of achieving demand reduction at the farm level.

In Yemen, Ward (2000) believes that an increase in water prices combined with the introduction of irrigation efficiency measures is a viable option. Ward argues that if water pricing encourages farmers to use water more efficiently, they will be more likely to adopt water-saving technologies. Investment and research into water conservation techniques would complement a water pricing strategy, with support from government and donors. Ward comments that "more efficient irrigation could help relieve pressure on groundwater resources and restore, or even increase, farm incomes". However, the experience of Jordan invites caution as investment by farmers in water efficient technology has not led to any measurable improvement in water use efficiency (Box 9) at that level. System-wide improvements may be needed to get the best out of such innovations.

The Zayandeh Rud Basin in Esfahan Province, the Islamic Republic of Iran, faces problems typical of arid areas: irrigation is a prerequisite for agriculture and downstream users face deteriorating water supplies, both in quantity and quality. Potentially, increased water prices could deter farmers from purchasing additional canal water and would encourage them to invest in more efficient irrigation technology. However, water prices in the Islamic Republic of Iran would have to increase as much as twenty-fold before farmers invested in field technologies to improve water use efficiency (Perry, 2001a). At this level, water charges would be equivalent to two-thirds of gross revenues for basic field crops. Investing in improved technology could result in higher yields and a move to higher value crops. This would lead to an increase in land productivity and water consumption at the farm level (more productive crops would actually consume more water), and a decrease in return flows to drains and aquifers. Where downstream users depend on return flows, this could be detrimental.

The adoption of improved irrigation technologies in Spain does not depend significantly on water price level but on structural factors, agronomic conditions and financial constraints (Varela-Ortega *et al*., 1998). Green and Sunding (1997) endorse this finding with empirical evidence from California, the United States of America. They conclude that technology choice may be driven by water price in some locations, but mostly it critically depends on land quality and crop type. Caswell and Zilberman (1990), in their studies in California, the United States of America, demonstrate that the probability of adopting drip irrigation technologies increases with higher water prices, although land quality and environmental considerations seem to play a more important role in technology choice. Burt, Howes and Mutziger (2001) argue that adoption of drip irrigation does not necessarily lead to "water savings". They emphasize the importance of distinguishing between water diverted and water transpired by plants or evaporated from bare soil. Furthermore, effective use of drip requires a highly reliable and flexible water supply to the farm. Huppert and Urban (1999) report that the adoption of drip irrigation by many farmers in the Jordan Valley has not led to significant reductions in water diversion as farmers are aware of the unreliability of supply. They tend to over-apply water through their drip systems on the occasions when water is available, eliminating any potential water saving.

RESOURCE NEEDS

Some countries may have insufficient economic and technological resources to deal with serious water management problems. Political and institutional reform, related to water pricing, requires significant investment of time and money, as Kemper and Olson (2000) demonstrate for Mexico and Brazil. WUAs require training in financial management, budgeting and bookkeeping to manage their own finances. Although the need is clear, it is not always apparent who would provide and pay for such training and support.

In the Niger Valley, co-operatives that are responsible for entire irrigation systems, require training in management skills, particularly communication and record keeping, to collect fees, keep track of bills, arrears and individual accounts for members. The complexity of the fee system has increased the need for training in a country where levels of education and literacy are low. The introduction of ISFs in Indonesia was dependent on a complex database (Gerards, Tambunan and Harun, 1991), to be supported with data from the field about all water users and their landholdings. In the event, the tasks proved too onerous.

Hatzius (2000) examines the potential of a new water fee system in Former Yugoslav Republic of Macedonia, where a number of factors are delaying the elaboration of a water master plan and data collection (relating to WUAs). These include institutional deficiencies and a lack of resources, staff, professional and managerial expertise, political will and participation among sectors. Either a decentralized or a centralized system of water management would require support from donor institutions, including technical assistance, training, computer hardware and software.

TERMS OF TRADE

As the pace of globalization increases, it is essential to recognize that policies outside a country can have a stronger influence than those within, and may trigger unanticipated results. For example, Nepal is reducing subsidies in agriculture gradually by various means, including the Nepal Irrigation Sector Project (NISP), supported by the Asian Development Bank and World Bank. Subsidies have been reduced on fertilizers, shallow tubewells, and electricity for pumping. However, agriculture in neighbouring India is highly subsidized, producing a direct, negative, impact on markets in Nepal, which has an open border with India. Production costs are higher in Nepal and as farmers cannot gain a good price for their crops – owing to cheap imports from India – there is no incentive for them to extend production. Farmers are deterred from producing more for sale by cheap prices that benefit the urban population. It becomes impractical to increase water fees as any increase in production costs would increase out-migration from rural areas. Similar distortions are seen in many other parts of the world, including the effects of the agricultural subsidies provided by the European Union and the United States of America on cotton and sugar growers in the developing world.

PRECONDITIONS FOR ACHIEVING EFFECTIVE IRRIGATION CHARGING

Whatever the objective of a water pricing policy, important preconditions must be satisfied before it can be implemented effectively. These preconditions include: an adequate political and legal framework; institutional and administrative resources capable of implementing and enforcing the policy; and water distribution infrastructure providing the level of control/measurement required. In addition, farmers must be

TABLE 5
Preconditions for effective irrigation charging

Aspect	Detail
Legal	Legally defined and enforceable water entitlements and basis for allocation. A clear and viable judicial and police system to ensure enforcement of agreements.
Administration	A clearly understood and agreed fee structure, to include: ➢ when fees are to be paid; ➢ penalties for non-payment or late payment of fees; ➢ how fees are computed; ➢ how the fees are requested; ➢ mechanism for fee payment (to whom, and how); ➢ whether users can refuse payment for water delivered but not requested. A specified mechanism to resolve disputes over deliveries or bills. Adequate human, technical and financial resources to implement billing and fee collection.
Infrastructure	Infrastructure permits control and measurement of volumes delivered to users or a user group. Means exist for users to verify volumes. Infrastructure permits delivery of differential volumes to neighbouring users.
Administration	A written agreement between water supplier and user defining the water delivery service: ➢ advance time to order, change, or stop flow; ➢ flexibility in the frequency, rate and duration of water delivery service; ➢ accuracy of the flow-rate measurement devices; ➢ allowable percent variation in the actual flow rate from the agreed flow rate at any time; ➢ who can make the flow rate changes (the supplier or user) at the control structure; ➢ how frequently the flow rate can be changed; ➢ how frequently the flow rate must be verified, and how; ➢ responsibility for maintenance of the measurement and control structures; ➢ penalties for the water supplier if structures are not maintained or operated as specified, or if the quality of water delivery service is poorer than agreed upon; ➢ a procedure for when, and how, any volumetric limitations are determined.

Source: Modified from Burt (2002).

ready to comply with the rules for water allocation. Institutions must measure and record effectively the parameters on which charges are based, and collect the charges. In states lacking an effective legal code or enforcing body, there must be questions about the practicality of water charging mechanisms. Table 5 provides a summary of the legal, administrative and technical preconditions for effective irrigation charging.

Many political, legal, institutional and administrative preconditions, such as the need for enforcement mechanisms, clear methods of complaint/dispute resolution and administrative transparency, are common to any pricing tool. However, volume-based, demand management tools require infrastructure capable of volumetric measurement.

Sampath (1992) observes that pricing is dependent on type of physical delivery system suggesting that volumetric pricing is only possible under demand and closed pipe systems as opposed to rotation and continuous flow systems. However Malano and van Hofwegen (1999) take a broader view and describe the classes of service delivery including all the on-request (or arranged) types of delivery. In practice there is a wide range and mix of delivery services and service standard negotiation. The extent to which different service modalities are arranged in such projects as VWRAP, cited above, indicate the complexity of the issue. However. even though there may well be potential for changed patterns of water delivery, volumetric pricing to farmers does not appear suitable on the vast majority of surface irrigation systems in developing countries – including all those where rice is grown. In the case of VWRAP, it is anticipated that at the level of the water user associations, there will be contracts specifying volumetric deliveries, but no volumetric pricing a such. The primary emphasis is on delivering an agreed level of service and building the capacity of the service provider to do so by modernizing management and infrastructure.

SUMMARY

Many social, political, economic, cultural and geographical factors affect pricing and production, highlighting the diversity of irrigation systems in general. Thus, various commentators emphasize the need to take diversity into account when implementing water pricing. Molle (2001) points out that economists could come to face similar criticism to engineers for being too discipline-oriented and unrealistic. Ahmad (2000) emphasizes: 'There is not a general strategy or model to adopt for a specific water pricing policy of a country. Every country has to develop its own strategy.' There is a danger of pursuing a 'one-model-fits-all approach' because administrators find such an approach easier to implement. Therefore, there needs to be a change of attitude within agencies implementing reforms.

Chapter 6

Principal findings

Based on recent literature and case studies, this document has reviewed the range of theoretical and observed objectives and impacts of irrigation water charging. Much of the literature focuses on theoretical aspects of water charging – especially the objectives and details of pricing policies. A smaller part of the literature presents information on water charging as applied in the field, often snapshot data on water charges or prices, levels of fee recovery and the extent to which O&M and capital costs are recovered. Little guidance is available on the practical aspects of designing and implementing an irrigation water charging policy. Issues of interest would include: methods for calculating appropriate current and future costs and thus determining charges; managing different agencies' responsibilities for levying and collecting fees; calculating the costs of fee collection; establishing the frequency and timing of billing; and enforcement and sanctions.

This chapter presents a summary analysis of the issues arising from the review and case studies.

DRIVERS FOR CHANGE

Four key factors have led to the recent focus on water charging in irrigated agriculture:

- ➢general trends towards management turnover and private sector involvement in previously public services – with consequent attention to revenues and financial viability
- ➢signs of water shortage in many countries, and the need for demand management in situations where supply augmentation is no longer feasible
- ➢current high levels of subsidy to irrigation, in parallel with under-funding of maintenance and deterioration of infrastructure.
- ➢the Dublin declaration that water should be treated as an economic good, and subsequent policy statements at the Second World Water Forum and the Bonn International Conference on Freshwater

Taken together, these factors have driven the debate on water charging policies, first in the water supply and sanitation sector and more recently in the irrigation sector. However, while there are apparently compelling reasons why water charging and pricing should be used as economic and management tools in the irrigation sector, there are numerous theoretical and practical constraints that arise when the issues are examined in more detail.

OBJECTIVES OF CHARGING

Literature on irrigation charging includes a number of theoretical objectives for levying charges on irrigation water, such as taxing benefits to improve equity in society, imposing restraints on pollution, and creating incentives to help direct water to its highest economic use. In practice, there are three common concerns, of which two are dominant:

- ➢recovery of costs;
- ➢management of demand for water
- ➢reallocation of water from lower to higher priority uses.

It is commonly found that commentators and irrigation authorities expect a single system of charging to meet all these objectives. However, it is clear that it is essential to match the charging tool with the objective – one size does not fit all.

In order to design an effective charging system, it is imperative to define and prioritise objectives.

Recovery of O&M costs is widely agreed to be a basic objective essential to the sustainability of system functioning. This should generally not prove onerous to farmers, except for the poorest individuals and the poorest countries, where special policies may be needed. Nevertheless, farmers' dissatisfaction with levels of service and weak procedures for assessment, billing and enforcement commonly result in low levels of fee recovery which often leads to the vicious circle of under-funded infrastructure performing poorly and leaving irrigators more dissatisfied.

The use of charging to try to impel farmers to use less water is a quite distinct and more controversial objective. Without exception, systems that commentators have considered to demonstrate price-limited demand are actually limited by quotas on total water use – with an incentive to avoid waste within the quota through water pricing. Pricing then usually serves to affect farmers' decisions about issues such as which crop to plant and whether to invest in improved technology – which paradoxically may not assist the problem of water scarcity if water consumption rather than diversion is the problem.

Macroeconomic problems of resource allocation between sectors are a growing concern, but these are seldom addressed through pricing. Rather, volumetric entitlements and, in some cases, the possibility of trading those entitlements, are used to achieve such inter-sectoral allocation.

DESIGN OF A CHARGING SYSTEM

Where the objective of pricing is to reflect the cost of a service, it is necessary to define the service in sufficient detail to decide on the scale of costs and which elements should be included. A broad range includes:

- ➢ capital infrastructure – at either current or historical cost;
- ➢ routine O&M;
- ➢ rehabilitation;
- ➢ system improvements;
- ➢ planned replacement of major facilities;
- ➢ unplanned expenditures caused by extreme events.

Beyond these costs, a range of less tangible costs have sometimes been put forward:

- ➢ impacts on affected downstream users (irrigators, households, fishing communities and ferries);
- ➢ environmental impacts;
- ➢ social impacts;
- ➢ impacts on food security and prices;
- ➢ opportunity cost – the economic value of water in its highest value alternative use.

Where the objective is to recover a specific level of the service cost, 'simple' non-volumetric pricing mechanisms can be used, typically a charge per hectare of land owned or irrigated. Non-volumetric methods are simpler to administer than volumetric methods as extensive measurement infrastructure and continuous field recording are not needed. However, cost recovery may not be easy merely because it is based on simply-assessed parameters. Political, economic and institutional factors can lead to very low levels of fee collection and cost recovery.

Where the objective is to limit demand, there are two distinct approaches: volumetric water pricing, and defined water allocations or quotas. In practice, volumetric charging is often applied in conjunction with an allocation. In such cases, the volumetric charge is designed to meet the cost recovery objective, while the allocation is used to limit demand to the supply that is available. Nowhere is volumetric charging used directly as the means to bring supply and demand into balance. Thus, in Jordan, Israel and Morocco, all countries facing extreme water shortage, water pricing is used to recover service delivery costs. Volumetric water allocations rather than water price are used to ensure that M&I sector needs are met. In all of these countries, water is priced on a volumetric or quasi-volumetric basis to indicate its value to users and discourage profligate use. However, there is no attempt to use pricing to achieve the balance between supply and demand from competing sectors. This distinction between signalling the value of water – and therefore discouraging wasteful use by farmers – and the goal of allocating water between sectors, based on free-market prices, is very important. The first appears logical, but it should not be assumed that simply because farmers place a value on water they will reduce their consumption to the extent that resource planners may wish. It is telling that even the most water-short nations of the Near East, many with advanced conveyance and distribution infrastructure, have not sought to direct either intra- or inter-sectoral allocation of scarce water resources by means of pricing. In such cases, defined water rights (allocations) appear a more practical option.

Markets in tradable water rights are more practicable than water pricing as a means of achieving allocation efficiency. Where poor farmers are allocated a tradable water right, its sale may provide them with an income comparable to that obtained through farming. Formal markets for large transactions between sectors require a well-defined legal and regulatory framework. In such cases the rule of law has to be respected and all stakeholders need to accept the impartiality of those defining allocations. Australia, the United States of America and Spain are commonly cited as countries that are using tradable water rights to manage the use of an increasingly scarce supply.

EFFECTS OF CHARGING ON WATER SAVING

In many countries, the price of water charged to farmers is well below the level required to recover system O&M costs, let alone that needed to exert a material influence on demand for water.

It is logical to suppose that farmers' responses are influenced by the relative magnitudes of the cost of water and its value to them. In some of the case study countries, the current cost of water is equivalent to a small percentage of their net crop income. However, in the Tadla scheme, Morocco, fees for surface water are some 15 percent of average net income, yet farmers will sometimes pay additionally for groundwater to supplement their quota. Therefore, it appears that water prices may need to be of the order of at least 20 percent of net income in order to have a significant impact on water use.

Even if it were feasible to supply water volumetrically to large numbers of individual small farmers growing cereals on Asian canal systems, there would remain the serious political and social difficulties of raising charges by something like an order of magnitude, which is what would be required in order for the charge to have any significant impact on demand.

The agriculture sector is seen as a profligate user of water because 75 percent of the water diverted to a surface scheme may not reach the crop. However, a high proportion of the immediate loss often returns to an aquifer or surface water body, and is therefore available to downstream users or groundwater users. There may be penalties involved in reuse in terms of a reduction in water quality or energy costs in recovery of supply from groundwater but, the overall water balance is not affected as severely as the scheme efficiency figures may imply.

It is also particularly relevant that pricing deterrents cannot reduce the high proportion of scheme water losses that occurs in canals outside the control of farmers (50 percent or more).

IMPLEMENTING CHARGING POLICIES

Even the straightforward objective of recovering all annual O&M costs has been difficult to achieve in practice. Annex 1 shows that a few of the wealthier member countries of the OECD, including Japan, France, Australia, Spain and the Netherlands, achieve full recovery of annual O&M costs plus some recovery of capital costs in certain schemes. However, in the overwhelming number of cases, water charging does not cover even annual O&M costs. Among the nations of the OECD, subsidy of irrigated agriculture by governments is still widespread.

The institutional and political factors that can hamper full supply cost recovery include:

- lack of political will to impose higher costs on farmers;
- unwillingness to reduce costs by slimming down overstaffed government agencies;
- lack of motivation on the part of agencies charged with fee collection, as fees return to the treasury and recovery is not linked to funding;
- a vicious circle of low O&M expenditure leading to poor performance and increasing reluctance on the part of farmers to pay when they see no benefit;
- insufficient resources (time, money and training) for planning and implementing effective charging mechanisms;
- failure to enforce pricing policies;
- failure to improve infrastructure, operation and service delivery;
- failure to promote more profitable agriculture.

The widespread policy of irrigation management transfer does not necessarily ensure full recovery of supply costs. While turnover can lead to an immediate increase in levels of cost recovery, revenues are still generally insufficient to cover full supply costs, as tariffs are set too low and higher prices may be politically unacceptable. Where systems then deteriorate under poor maintenance regimes, collections invariably fall.

If volumetric charging is to be applied to limit consumption, delivery must be measured and controlled. The nature of most irrigation systems in developing countries, often serving thousands of small farmers, means that measured supplies can only be delivered to a body, on behalf of farmers (the townships in China or WUAs in various parts of the world). Below that point, supply to individual farmers has to be made on the basis of area and crop.

Despite these serious obstacles to greater use of economic instruments, important changes are occurring. Many governments are actively considering the issues of increased cost recovery, reduction of hidden subsidies, and the potential of pricing as a tool for demand management. It is increasingly recognized that irrigation infrastructure and service provision must be paid for either through charges levied on users or through a transparent government subsidy that is quantified and publicly justified. An OECD report on agricultural water pricing (OECD, 1999) recognizes that the goal may not always be to eliminate subsidy but to achieve reform and greater transparency.

It is important to separate cost recovery and water demand management as two distinct objectives that require different types of intervention. Whatever the objective in view, the introduction of a water charging policy should not be viewed as a universal remedy. Rather, water charging should be seen as part of a larger package of measures. Allocation through legally recognized rights in water use and the use of tradable water rights are other potential elements in such a package.

Mexico is frequently cited as an example of a country that has achieved a substantial reduction in the levels of subsidy going to the irrigated agriculture sector, where many irrigation districts now achieve financial self-sufficiency. However, this position was reached only after wide-scale reform of the agriculture sector (Kloezen, 2002), including:

- privatization of state-owned agricultural input supply services.

- major reform of land tenure law.
- a new water law, which defined rights and allocation mechanisms.
- transfer of responsibilities for system O&M to newly formed WUAs together with transfer of plant and equipment.
- restructuring of the line agencies overseeing irrigation with major reductions in staff numbers.
- Modernization of the irrigation systems.
- Retraining of engineers and managers in service delivery.

These far-reaching measures were appropriate to the situation in Mexico, but other countries will require different actions. What is clear is that water charging measures must be designed according to the particular situation and desired outcome in any given country.

KNOWLEDGE GAPS

Much material has been published on water pricing theory but there is little to guide practical implementation of effective assessment and collection mechanisms. In many countries, the issue is not principally how to determine the level of water charges, but how to enforce the charging policy. Without action to improve revenue collection and enforcement systems, policies may remain theoretically sound but unmanageable and ineffective in practice. These issues need wider investigation and honest reporting.

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Annex 1

Water charging for irrigation – data from the literature

NOTES ON WATER PRICING DATA

Many factors in water charging practices change rapidly over time, e.g. prices charged, recovery rates and price structures. The data presented in Table A1.1 reflect the information provided by the cited source but there is no certainty that the information is still current.

Where the source has provided price information in a local currency this is expressed in Table A1.1 in US dollars using an average exchange rate for the year the source was published or the year cited in the text.

General trends: Because of the factors noted above, it may be misleading to apply too rigorous an analysis to the figures and other information presented in Table 1. Nonetheless, the following general observations can be made.

Country/region

There can be important differences in water charges within a single country. Such differences may reflect different objectives, different water sources, different degrees of water scarcity and irrigation schemes with different technologies, farm types or socio-economic objectives. Therefore, it is often not possible to make a simple statement describing irrigation water charging at a national level.

Charging basis

Many different formulations for charging are reported. These include:

- irrigated area: may vary with crop or season;
- water volume delivered: constant rate per cubic metre, and rising block tariff;
- two-part tariffs: fixed per area + volume.

Price per 1 000 m^3

The range in volumetric price is very great. Very high prices are reported for the following countries:

Country	US$/1 000 m^3	Notes
Israel	180 – 290	Prices rise through this range according to what fraction of a water allocation is consumed.
Netherlands	1 330	Price for water drawn from municipal supply network.
Spain	160	This high price paid only where water is pumped from groundwater.
Tanzania	420	Tariff applied for municipal supply used for irrigation.

Leaving these few very high prices aside, there is still no neat and narrow band in which volumetric prices fall. Canada and Romania report prices below US$1/1 000 m^3 but this represents the lowest extreme. A price of about US$20/1 000 m^3 is probably indicative of the “average” volumetric price charged for irrigation water.

Price per hectare

Where irrigated area is used as the charging basis, there is again a very great range in the prices reported. Here comparisons are more difficult as it is not always clear in the literature whether the figures quoted are seasonal or annual. The highest prices are reported for:

Country	US$/ha	Notes
Bangladesh	150	Value in a proposed strategy – may not be applied in practice.
China	50–150	Johnson (1999)
Greece	92–210	National average, cited by OECD (1999)
Japan	246	National average, cited by OECD (1999)
Niger	124/season	
Tunisia	124–538	

US$40–50/ha/year is closer to an "average" price in more developed countries but in India many states charge no more that US$10/ha/year, and Mohtadullah (1997) says that the Revenue Department in Pakistan receives approximately US$0.33/year.

Collection efficiency

Many sources give no information on this aspect of water charging. Where information is provided, it again indicates huge variation both within and between countries. Thus, on the surface irrigation schemes of Bangladesh, collection rates are no more than 10 percent of the billed revenue, but on deep tubewells there is "almost full collection of revenues due". Of the countries where information on collection efficiency is reported, Mexico achieves the highest level with a national figure of 92 percent reported by Svendsen *et al.* (1997).

Proportion of costs recovered

There is more information available on this than on collection efficiency. The wealthier member countries of the OECD stand out as the few entries in Table 1 where there is reported to be full recovery of annual O&M costs and some recovery of capital costs. These include Japan, France, Australia, Spain and the Netherlands. However, in the overwhelming number of cases, water charging does not cover annual O&M costs.

TABLE A1.1

Water pricing for irrigation – data from the literature

Country/region (year)	Charging basis	Price per 1 000 m^3 (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
Algeria							
National average (1995)[1] (1995 US$)	Two-part tariff (fixed charge + volume)	20–30 (vol. charge)	4–8 (fixed charge)			Not clear. "Govt. pays many of costs, particularly for capital equip."	Salem (1997)
Argentina							
National average (1997)	Area		"70/year"	70%	Govt. and irrigation associations (IAs)[2]	12% O&M	Svendsen *et al.* (1997)
Australia							
N.S. Wales, Queensland (1995)	Volume	1.2–7.39	-			100% O&M (+CD[3] in some cases)	Musgrave (1997); cited in OECD (1999)
Southern Murray Darling (1991-92)[4]	Volume	10.16	-			60% O&M[5]	Musgrave (1997); cited in OECD (1999)
Victoria (1995)	Volume	4.36	-			Nearly all O&M	Musgrave (1997); cited in OECD (1999)
Bangladesh							
Six major surface water schemes (Bangladesh Water Development Board – BWDB) (1998 US$)[6]	Fixed rate per cropping season	-	0.43–3.01	3–10% (1994–98)[7]		"Inadequate"	Govt. of the People's Republic of Bangladesh (2000a and 2000b)
Meghna-Dhonagoda and Pabna (BWDB) (assuming 1998 US$)		-	7.65–21.25			Schemes involve pumping; price covers 12–25% of full O&M costs	Govt. of the People's Republic of Bangladesh (2000a and 2000b)
Average price farmers pay Shallow Tube Well (STW) water sellers for boro irrigation[8] (assuming 1998 US$)		-	148.77–191.29[9]				Govt. of the People's Republic of Bangladesh (2000a and 2000b)
Barind Multipurpose Development Authority (BMDA) Deep Tube Wells (DTW) (electric) (assuming 1998 US$)	Per hour of pumping	1.59 per pumping hour	-	"Almost full collection of revenues due"		Full O&M costs; admin. overheads not covered, nor replacement costs.	Govt. of the People's Republic of Bangladesh (2000a and 2000b)
Barind Multipurpose Development Authority (BMDA) DTWs (diesel) (1999)[10]	Well leased to farmer groups on yearly basis[11]	206–274 (per year) (+ farmers pay pumping costs)	-				Govt. of the People's Republic of Bangladesh (2000a and 2000b)

Country/ region (year)	Charging basis	Price per 1 000 m^3 (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
North Bengal DTW Project (BWDB) (1998)	Crop/season	-	63/ha			Approx. 65% of O&M costs; no replacement costs.	Govt. of the People's Republic of Bangladesh (2000a and 2000b)
Brazil							
Selected state irrigation projects[12] (1995)	Two-part[13]	3.08–33.84	3.69 (per ha per month)				Azevedo (1997)
Bulgaria							
National average (assuming 2001 US$)	(Mainly) volume[14]	-	45.54 per ha (maize) for two irrigations[15]	85% for volumetric water charges (1994) 32% for irrigation tax (1994)	Branches of Irrigation Systems Company (ISC).[16]		Halcrow (2001)
National and Regional Irrigation Systems (average) (1996-98)[17] (ISCs (Irrigation Systems Companies) or WUAs use differing methods to calculate the irrigation water price)	Area or volume (varies according to crops) + water abstraction fee (state revenue)[18]	10–85	5.88[19] (permanent maximum price)	40% for Regional Irrigation Systems (State) 70-100% for Irrigation Water Users' Associations	Branches of Irrigation Systems Company (ISC)	Varies from < 60% O&M to full O&M (+ part of CC)[20] Average annual costs per 1 000 m^3 for irrigation water from the Regional Irrigation Systems vary from 120–170 US$ (1996-1998).[21]	Bardarska and Hadjieva (2000); European Commission-DG Environment (2000); Öko Inc. (2001)
Canada							
British Columbia (1988)	Area	-	90			<100% O&M	Cited in OECD (1999)
British Columbia (1988)	Volume	0.16–0.2	-			<100% O&M	Cited in OECD (1999)
National average (1996)[22] (1996 US$)	Two-part	1.7–1.9	6.62–36.65			100% O&M	Dinar and Subramanian (1997); cited in OECD (1999)
China							
Guanzhong Plain, Shaanxi Province (no year given)	Complex. Volume and crop (also includes national & local management fee)	27–49.5	50–150	90+	75% to Irrigation Depts. 25% for local management.		Johnson (1999)

Country/region (year)	Charging basis	Price per 1 000 m³ (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/ timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
Colombia							
5 irrigation districts (1995)	Area + volume	1.3–17.5 (volume)	12.6–65.7 (area)	67–95%	WUA[23]	Financial self-sufficiency[24]: 53%–115%	Vermillion and Garcés-Restrepo (1998)
National average (1996)	Area/crop (fixed + volumetric fee in pump schemes)	-	52/year	76%	“Financial burden of O&M has been shifted to users”	52% O&M No clear govt. policy on responsibility for rehabilitation	Svendsen *et al.* (1997)
Croatia							
	No charges[25]						Ostojic Z and Lukšic M (2001)
Egypt							
	No charges					Some cost recovery for infra. improvements 60–75% subsidy on capital investments	Perry (1995); cited in Ahmad (2000);
France							
Adour-Garon W.A. (1997)	Volume	5.27	-			100% O&M	Cited in OECD (1999)
Adour-Garon W.A. (1997)	Fixed (equiv. prices)	4.6	-			100% O&M	Cited in OECD (1999)
Rhôn-Med. Cor. W.A. (1994)	Fixed (equiv. prices)	3.1 Surface water 6.5 Groundwater	-			100% O&M	Cited in OECD (1999)
Greece							
Crete (OADYK) (1997)	Surface	21–82	-			100% O&M	Cited in OECD (1999)
National average (1997)	Surface	-	92–210			60–75% O&M	Cited in OECD (1999)
Hungary							
National[26] (assuming 2000 US$)[27] (no year specified)	Area and/or vol. (+ water abstraction fee)	3.67–31.19 (variable fee)	5.19–31.19 (fixed fee)			O&M + part or all of CC[28]. 20% of all costs. Farmers also have to invest in and maintain some infra.	Öko Inc. (2001)
Eastern Hungarian River Basin Authority[29] (1999 US$)[30] Water authority selling directly from rivers (or without “main objects”)	As above	3.16	No fixed charge	Lack of mechanisms for collecting financial data			European Commission-DG Environment (2000); Fucskó and Hermann (2000)
India							
Water canal rates vary by state[31]: (US$ 1989–1990)[32]	33			“Inadequate”		In nearly all states, actual receipts fall short of full O&M costs	Saleth (1997)

Country/region (year)	**Charging basis**	**Price per 1 000 m³ (US$)**	**Price per ha (US$)**	**Collection efficiency (%)**	**Notes on collection (type/timing of payment. Fee retaining body, etc.)**	**Actual recovery**	**Reference**
Bihar	Area + crop	-	1.80–9.49				Saleth (1997)
Gujarat			2.40–49.85				
Maharashtra			3.90–60.06				
Madya Pradesh			0.90–17.84				
Rajasthan			1.20–8.59				
Andra Pradesh	Area + crop	-	5.95–22.22		Revenue dept. (RD) collects fees		Saleth (1997)
Haryana			1.02–5.95				
Karnataka			2.22–33.39				
Orissa			0.36–11.11				
Punjab			0.84–4.86				
Tamil Nadu			0.36–3.90				
Utter Pradesh			0.42–19.64				
West Bengal	Fees vary by season	-	4.44–35.62		RD collects fees		Saleth (1997)
India national (2001)	Area (varies by crop)	0.4–1.6 (vol. equiv.) 1.5 (vol. equiv.)	2–8 30 (sugar cane)				Perry (2001)
Israel							
Mekorot (Israel's Water Company) (assuming 2002 US$)	Multitiered[34]	Per 1 000 m³: US$180 first 50% of water quota; US$220 for next 30%; US$290 for final 20%[35]				Average cost of water supply per 1 000 m³ for agri. use is US$290. Marginal cost of supplying 1 000 m³ may be US$500.	Yaron (1997); Becker and Lavee (2002)
Italy							
Nurra-Serdegna (1994)	Two-part (citrus)	-	250			Not available	Cited in OECD (1999)
Nurra-Serdegna (1994)	Two-part (drip)	-	62.4			Not available	Cited in OECD (1999)
Nurra-Serdegna (1994)	Two-part (melon)	-	125			Not available	Cited in OECD (1999)
National average (1996 US$)	Area	-	20.98–78.16				Dinar and Subramanian (1997)
Japan							
National average (1997)[36]	Surface (rice)	-	246			100% O&M + part of CC	Cited in OECD (1999)
Jordan							
National (1999)[37]	Volume[38]	21.13				Approx. 50% of O&M costs[39]	Huppert and Urban (1999)
National (1997)	Varying tariff	8.5–49					Cited in Ahmad (2000)
Kazakhstan							
National average (1997) (1997 US$)[40]		0.4[41]		28% (1995–96 from rural water district committees)	Farmers pay a monthly bill	Rates specified in Final Resolution below levels needed to recover basic operating costs. No link between water charges and costs.	Burger (1998)

Country/region (year)	Charging basis	Price per 1 000 m^3 (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
Lebanon							
	No charges						Cited in Ahmad (2000)
Mexico							
National average (1997)	Surface	-	60			68-80% O&M	Cited in OECD (1999)
Cortazar (1997)	Surface	-	33			73% O&M	Cited in OECD (1999)
Irrigation District:					In most modules, users pay before they receive water[42]	100% O&M costs of Water Users and CNA (National Water Commission) staff. Districts normally have no reserve fund.	Johnson (1997)
Bajo Río Bravo (1993-1994) (1993 US$)	Area	-	42.09	Approx. 100%	See above WUAs/CNA retain fees		Johnson (1997)
Various IDs	Volume[43]	2.25–7.79		Approx. 100%	See above WUAs/CNA		Johnson (1997)
Alto Río Lerma District (1995-1996) (1994 US$)	Area	-	7.31–11.96 (per season)	Most modules had a fee collection rate higher than 100%[44]			Kloezen *et al.* (1997)
National	Area/crop	-	40/ha/year (average for 1996)	92% (1997)	Irrigation Associations/ Govt. retain fee	85% O&M costs (1997)	Svendsen *et al.* (1997)
Morocco							
		20 surface 30–40 G/ water	-				N.L. Haouari (personal comm., 2002)
Namibia							
(no year specified)	Fixed levy per ha per year + fee per area irrigated + charge rising with consumption	Unit charge of between 4–32.7[45]	15.6 per ha per year (board levy) + 40.4 per ha per year for first 15 000m^3 of water		Fixed levy used to support the irrigation boards		Heyns (1997)
Netherlands							
National average (1998)	Surface + groundwater	1440	-			> 100% O&M	Cited in OECD (1999)
New Zealand							
Lower Waitaki (1997)	Area	-	11–27.5		Irrigation companies[46]	100% O&M (running costs) + emergency capital expenditures	Scrimgeour (1997)
Niger							
Niger Valley Irrigation Schemes (Jan.–June 1995 US$)	Area – price adjusted each season	-	124 per ha per season (rice)[47]	90–100	Mainly crop, some cash. Payment at end of season – can be delayed. Cooperative retains fee.	Not clear.[48] Coops unable to generate savings	Abernethy *et al.* (2000)

Country/region (year)	Charging basis	Price per 1 000 m³ (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
Pakistan							
National (1986–1991) (1995 US$)	1. Vol. 2. Irrigation output + class of land (most common) 3. Flat rate (area)	-	0.3–0.36[49] (revenue per ha)			20–22% O&M for canals, tubewells and others	Mohtadullah (1997)
Rechna Doab (July 1995 US$)		19 (average selling or buying price) (diesel) 9 (electric)	-				Cited in Perry and al Hassan (2001)
Purchased groundwater (July 1995 US$)		17	-				Cited in Perry and al Hassan (2001)
Chishtian pump (2000 US$)		13 (diesel) 11.8 (electric)	-				Cited in Perry and al Hassan (2001)
Philippines							
National	Area/crop/ source	-	77/year (average 1997)	58% (1995)	National Irrigation Agency	46% O&M (1995) "Govt. no longer subsidises maintenance"	Svendsen *et al.* (1997)
Poland							
	No charges from 2000			Lack of mechanisms for collection of financial data			European Commission-DG Environment (2000); Lorek (2000)
Portugal							
Sorraia (1991) (Public system)[50]	Volume (rice)	9.89	-			Charges rarely cover O&M costs[51]	Cited in Castro Caldas (1997)
Sorraia (1991) (Public system)	Vol. + area + crop (maize)	12.31	-			As above	Cited in Castro Caldas (1997)
Sorraia (1991) (Public system)	Vol. + area + crop (tomatoes)	15.63	-			As above	Cited in Castro Caldas (1997)
Romania							
National (assuming 2000 US$)[52, 53]	Volume	0.37	-		National Company Apele Romane	"Costs covered by State"[54], "Romanian prices are established irrespective of costs"	Öko Inc. (2001)
National (1999)[55]	Price for raw water (for fisheries and irrigation)	0.65	-			WUAs can set tariffs for water supply (based on volume and area, O&M, drainage and an annual contribution)	Popovici (2000)
National (1997)[56]	Water abstraction fee for irrigation and fisheries	0.11 (inland rivers) 0.02 (Danube) 0.39 (g/w)	-	Lack of mechanisms for collection of financial data	National Company Apele Romane		Popovici (2000)

Country/region (year)	Charging basis	Price per 1 000 m^3 (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
Saudi Arabia							
National (1997)	No charges						Cited in Ahmad (2000)
Slovakia			-				
National (1999) (1999 US$)[57]	Volume (surface water)	0–48.94 (incl. 10% VAT) 32.98 (without VAT) (average)		Lack of mechanisms for collection of financial data	River Basin Administrator – branches of the Slovakian Water Management Enterprise retain fee	25–30% of costs. Ministry of Soil Management subsidizes agri. coops – up to 70% of irrigated water and electricity (or fuel)	Öko Inc. (2001); Thalmeierova-Jassikova (2000)
Spain							
Andalucia. Gen-Cab, Valencia Novelda, Genil-Cabra (Córdoba) (WA – Water Association), San Martin de Rubiales (Burgos) (WA) (1995)	Two-part	27–133	90–129			100% O&M (+ CC in some cases) (+ energy costs in Córdoba)	Cited in Maestu (1997); cited in OECD (1999)
Andalucia. Viar (1995) Valencia Ac. Real (1995) Castille. Retencion (1995)	Surface	-	90–142.92			100% O&M	Cited in OECD (1999)
Castille. Villalar (1995)	Volume (+ energy)	70	-			100% O&M	Cited in OECD (1999)
42 irrigated areas (1995)	Varies	-	8.3–266 (per ha per year) 84.7 (average per ha per year)				Cited in Maestu (1997)
Water Associations (WA)	Varies	8 - 160[58]	60–1 200 (equivalent price in per ha per year)				Cited in Maestu (1997)
Sudan							
Irrigation schemes (1995–96):[59, 60]	Area + crop		15.8–28.1 (cotton) 11.8–21.1 (other)[61]		Farmers tend to pay charges after each season. Irrigation Water Corporation (IWC) retains fee.	Each scheme sets its charges to cover actual O&M costs.	Adam (1997)
Syrian Arab Republic							
National (1997)	Fixed (sometimes with crop component)		50 (per year)				Cited in Ahmad (2000)
Large-scale water users (Al Hoss Mountains – AHM) (1995)[62]	Fixed + crop (wheat)	16 (cost per 1 000 m^3 if at least 4 000 m^3 delivered)	65.93 (cost)			O&M costs could exceed US$110 per ha	Cited in Waughray and Rodríguez (1998)
Small-scale water users (AHM) (1995)		20 and 30[63]					Cited in Waughray and Rodríguez (1998)

Country/region (year)	Charging basis	Price per 1 000 m³ (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
Taiwan Province of China							
National (1997)	No charges since 1992					Govt. subsidizes irrigation	Hsiao and Luo (1997)
Tanzania, United Republic of							
National Urban Water Authority's tariff structure for Dar es Salaam (Irrigation) (1996)[64]	Unclear	420.13					Mujwahuzi (1997)
Thailand							
	No charges						Molle (2001)
Tunisia							
Groundwater (1993)	1. Fixed per ha (annual) 2. Hourly charge						Slim *et al.* (1997)
Kebili, Gueliada and Souk el Biaz oases (1993)			124–538 per year			21–44% O&M costs + depreciation costs	Slim *et al.* (1997)
Selected governorates (1994)[65]		20–78				54–183% O&M	Slim *et al.* (1997)
Turkey							
Mediterranean (1998)	Area (cotton)	-	49.5 (surface) 96.5 (pumped)			70% O&M	Cited in OECD (1999)
SE and Central Anatolia (1998)	Area (wheat)	-	19.8 (surface) 44.0 (pumped)			70% O&M	Cited in OECD (1999)
National average (1995)	Area/crop		25/year	72%+ (1995)		Most O&M – govt. subsidizes maintenance	Svendsen *et al.* (1997)
United Kingdom							
Wales and Northumbria (1997)	Volumetric	13–28	-			100% costs	Cited in OECD (1999)
United States of America							
N. Sacramento River (CA) (1997)	Volume	4.9	-				Cited in OECD (1999)
		+ 11 (vol. up to 80%)				100% O&M	
		+ 14 (vol. up to 80–90%)				100% O&M	
		+ 16 (vol. up to 90–100%)				100% O&M + CC	
Tehama. Col. Cl (CA) (1997)	Volume	4.9	-				Cited in OECD (1999)
		+ 25 (vol. up to 80%)				100% O&M	
		+ 48 (vol. up to 80–90%)				100% O&M	
		+ 71 (vol. up to 90–100%)				100% O&M + CC	

Country/region (year)	Charging basis	Price per 1 000 m³ (US$)	Price per ha (US$)	Collection efficiency (%)	Notes on collection (type/timing of payment. Fee retaining body, etc.)	Actual recovery	Reference
Pacific North West							
		13.4 (average)	-			17% of total costs.	Cited in OECD (1999)
Yemen							
National (1998)		20–40 (Farmer to farmer price)	-			“Price would have to be increased to US$50–100 per 1 000 m³ to cover economic costs of extracting and delivering water”	Ward (2000)
Spate irrigation	Law allowing water charges to be levied has been passed					Govt. considering involving user groups in O&M – with a view to handing over schemes to users	Ward (2000)
National (1998)	Varying tariff	20–1450[66]					Cited in Ahmad (2000)
Zimbabwe							
Large-scale water users (Chivi District, Masvingo Province, SE Zimbabwe) (1996 US$)		22.3[67]				In an agreement with govt., sugar estates’ capital contributions will ensure access to a defined share of dam water for first 40 years at O&M only.	Cited in Waughray and Rodríguez (1998)
Small-scale water users (Chivi and Zaka Districts, Masvingo Province, SE Zimbabwe) (1996)	Annual community fee US$50–205 per year (+ one-off lump sum of US$477) towards O&M of the schemes[68]				Payment system on seven pilot schemes (one water point per scheme)		Cited in Waughray and Rodríguez (1998)

Notes:

1. Irrigation water prices are expected to rise further to ensure the financial viability of irrigation water suppliers.
2. IAs are public NGOs with full legal authority, including the power to tax.
3. Cost of delivery.
4. Since 1992, real changes have risen by 11 percent.
5. Estimated that charges would have to increase by 80 percent to cover all costs.
6. Exchange rates in 1998, US$ = 47.05 Bangladeshi Taka.
7. As of 1997–98, water rates were charged in only 6 of the 15 schemes (GK, Chandpur, Karnaphuli, Manu River, DND and Buri Teesta), although proposals exist to extend the system by another 6 and raise existing rates substantially.
8. Boro is the main irrigated crop under normal crop sharing conditions.
9. This value appears high – in 2002, farmers were paying TK 1250 per acre (+ fuel costs at approximately US$7 per acre) (J. Skutsch, personal communication, 2002). This equates to approximately US$8 per ha (+ US$3 per ha fuel costs) (based on exchange rates for Jan.–April 2002 , US$ = 59.48 Bangladeshi Taka).
10. In 1999, US$ = 49.19 Bangladeshi Taka.
11. As part of this arrangement, BMDA pays up to one-third of the DTW repairs and maintenance, up to an annual limit of one-third of the rental amount.
12. The current water charging system for public irrigation projects is inconsistent. Tariffs are allocated to the sponsoring agency and distributed to the irrigation districts.
13. K1 reflects capital costs and is paid per ha; K2 is designed to cover O&M costs – and is estimated as a function of the volume of water used and is paid per 1 000 m³.
14. Does not include annual tax for irrigation and drainage (collection of irrigation and drainage taxes reportedly suspended since 1999).
15. Exchange rate in 2001 (no year specified), US$ = 1.12 Euros.
16. Income of ISC changes from year to year owing to changing demands for irrigation water.
17. Less than 10 m³/day inside “proper land” (landowners) is free of charge (for groundwater and surface water). For individual farms with 0.2 ha arable area outside the “proper land”, free (surface water) is allowed for irrigation up to 3 000 m³/ha/month. All other users have to pay a fee for water abstraction by surface water or groundwater by January 2001.

18. By January 2001, the water abstraction fee should be US$0.46/1 000 m³ for surface water and US$2.3/1 000 m³ for groundwater (Bardarska and Hadjieva, 2000).
19. Based on 1996–98 exchange rate, US$ = 0.85 Euros.
20. No subsidy for private sector, state subsidies for Irrigation Systems Company.
21. Difference in price/costs covered by subsidies and other activities of the Regional Irrigation Systems.
22. According to OECD (1999), this is the most representative figure.
23. Districts have gained almost complete control over management.
24. Of the five districts, only RUT established an equipment replacement fund. No district has set up a capital replacement fund for basic infrastructure.
25. In view of the poor condition of the agriculture sector, the low percent of irrigated land and the very low collection efficiency in the past, the State Water Directorate decided not to levy water user fees on irrigation water (Ostojic and Lukšic, 2001).
26. In 1999, irrigation water use decreased to one-third of the 1998 amount; but climate (high precipitation) was more responsible than a price increase.
27. In 2000, US$ = 1.09 Euros.
28. Capital costs.
29. Prices of a sample of suppliers under supervision of an Eastern Hungarian River Basin Authority were obtained – prices as such are not available in any public material. Agricultural water prices are unregulated; it is a free price system. Control over prices is exerted via a process of tender (if supply is put to tender). There is no official requirement to collect price data and any information collected is confidential.
30. In 1999, US$ = 237.4 Hungarian Forint.
31. Most states impose other levies on canal water in addition to water charges (cited in Saleth, 1997).
32. In 1989–1990, US$ = Rs16.65 (Saleth, 1997).
33. In West Bengal, water rates vary only by season and in Kerala, rates are based only on irrigated area. In all other states, the area-based water rates are highly differentiated, not only by crop and season but also by category of project, irrigation type (flow or lift), category of user (private parties, cooperatives, government lift schemes) and other factors (cited in Saleth, 1997).
34. Israel is now working on recommendations whereby water charges vary according to water quality (depending on salt content). Also being discussed is pricing "reclaimed" wastewater and pricing to reflect the quantity and quality of water in aquifers, as well as the location of an aquifer (Yaron, 1997).
35. Farmers using more water than the quota provides pay much more for the excess (Yaron, 1997).
36. According to OECD (1999), this is the most representative figure.
37. In 1999, US$ = 0.71 Jordanian Dinar.
38. The Jordan Valley Authority have stopped their programme of repairing water meters.
39. Water prices would have to be tripled to achieve full cost recovery (cited in Huppert and Urban, 1999).
40. In 1997, US$ = 75 Tenge.
41. This is the water charge set for agricultural users by the Govt. Resolution of Aug. 1997. In addition to the water charge, farmers also pay a service charge for the release and delivery of irrigation water by local water management authorities – US$6.67–66.67 per 1 000 m³.
42. Where users pay a flat rate for water per season per hectare – in some cases, users are allowed to irrigate prior to payment, or they pay part of fee with an agreement to pay the rest of the fee after the end of the season.
43. Idea of charging the districts on a volumetric basis seems logical, but it assumes that the districts will always have water.
44. his was possible because modules could often provide more irrigation sessions over and above the amount upon which the planned collection target was based.
45. US$4 per 1 000 m³ for consumption between 15 000 and 20 000m³/ha; US$10.7 per 1 000 m³ between 20 000 and 25 000m³/ha; US$21.8 per 1 000 m³ between 25 000 and 30 000m³/ha, and US$32.7 above 30 000m³/ha.
46. Irrigation companies do not receive subsidies from the government and must collect sufficient revenues from users to at least cover operating costs.
47. Derived from a value of PPP US$425 in text, using PPP exchange rate for Jan.–June 1995, 1FCFA = 0.68 US cents, 1FCFA = 0.01French francs, and US$ = 5.04 French francs for same period.
48. Government aim – cooperatives should be responsible for O&M costs, part of initial capital cost, some of costs of government's supervisory agency and savings towards repair and renewal.
49. Revenue per hectare – includes water rates, drainage and miscellaneous receipts.
50. In 1991, US$ = 144.58 Portuguese Escudo.
51. Historically, in Portugal prices of irrigation water have been set to provide subsidies for the cultivation of particular crops or to support agricultural prices.
52. Introduced in 1991, water charges in Romania are imposed on direct consumption or use, as well as on discharges according to their quantity and quality. Crops may be grown in cases where their value is less than the real cost of water used to irrigate them. Economic difficulties have decreased farm prices and consequently the demand for irrigation water (which has also benefited from the absence of recent droughts).
53. In 2000, US$ = 1.09 Euros.
54. Costs of electricity for pumping from high-pressure pumping stations to hydrants or rice fields and the costs of maintenance and repairs under land reclamation arrangements will be taken over by the newly established Irrigation Water Users Associations, and will be supported by the state for five years after their formation.
55. In 1999, US$ = 15383.69 Romanian Leu.
56. In 1997, US$ = 7187.75 Romanian Leu.
57. In 1999, US$ = 0.94 Euros.
58. The higher charges are paid by associations obtaining water from groundwater sources that need pumping or from major water transfers. Observations show that farmers in some associations pay nothing. Others may pay US$500/1 000 m³ in times of drought or for occasional or emergency water.
59. In 1995–96, the government founded the Irrigation Water Corporation and reduced subsidies significantly.
60. In 1995–96, US$ = LS 900 (Adam, 1997).
61. Other crops are sorghum, groundnuts, wheat and sunflowers.
62. Using exchange rate in 1995, US$ = SL 45.5 (cited in Waughray and Rodríguez, 1998).
63. Financial costs of extracting groundwater from a shallow and deep well, respectively. Farmers also recycle domestic wastewater through simple splash irrigation techniques.

64. In May 1996, US$ = Tsh606 (Mujwahuzi, 1997).
65. The Commissariats Regionaux de Développement Agricole use three types of water charges: a lump sum per hectare where metering is not available, a per-cubic-metre tariff for perimétres publiques irriguées with meters, and a two-part tariff with a fixed per-hectare component and a volumetric component.
66. Price in water markets.
67. Implied price of water from the Tokwe-Mukorsi Dam that producers will face.
68. A conventional rural water supply project in Zimbabwe estimated recurrent O&M costs to donor agency to be US$90 per water point per year.

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Annex 2

Analysis of irrigation charging objectives and their realization in the case studies

A full description of the cases studies is included in Cornish & Perry (2003).

Table A2.1 summarizes the analysis of the six 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 is a non-monetary instrument that avoids some of the implementation problems associated with demand management through price. The table summarizes whether selected preconditions, specific to that tool and objective, are in place in the country concerned. The table does not consider 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.

The following example shows how to interpret Table A2.1. In Haryana, it is government policy to recover O&M costs. This aim is achieved, but capital costs are not recovered. The level of current irrigation charges is adequate to meet the objective, and the collection of charges is satisfactory. Volumetric pricing is not practised; the infrastructure does not allow volumetric supply to individuals. Current water charges (if converted to a volumetric equivalent) would have minimal effect on demand. A formal system of water allocation is established, based on proportional distribution.

TABLE A2.1

Case study summary

	Cost recovery				Demand management					
	Objective/ achieved		Means		Tool Volumetric price	Precondition		Tool Allocation	Precondition	
Country	O&M	Capital	Charge level	Level of collection		Infra-structure	Price level		Water right	Measure-ment
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	N[4]	Y	N[5]	N[6]	N	N
Former Yugoslav Republic of 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 – canal	Y/N	N	N	N	N	N	N	N	N	N
Pakistan	Y/N	N	N	N	N	N	N	N	N	N

Notes:

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).

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 for 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.
3. 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.
4. 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").
5. If electricity prices were set 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.
6. Under the Indian Constitution, land owners own the water resources beneath their land – so that control of overdraft is not generally possible.
7. Former Yugoslav Republic of Macedonia aims for full cost recovery (O&M plus capital, including past debts of irrigation projects). The projected budget for Tikvesko Pole Kavardaci Water Management Organization (WMO) 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.
8. The decline in irrigated area in Former Yugoslav Republic of Macedonia means that the water available currently exceeds demand.
9. Moroccan policy is to recover all O&M costs plus a proportion (40 percent) of index-linked capital charges.
10. The authorities use a combination of volumetric charges (to discourage waste and encourage productive use) and fixed allocations to ensure that surface water use matches the available supply.
11. Current charges cover O&M costs, but do not fully fulfil the aim 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.
12. 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. The farmer can take either the full volumetric quota, or a lesser amount.
13. Indications are that the current, very high, charges for water (and the shortage of canal water) are impelling farmers to use groundwater. Aquifers are already substantially overdrafted, focus is needed on establishing groundwater rights. The result of high pricing is to cause farmers to change their source of water, though probably not their overall consumption.

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FAO WATER REPORTS

Water charging in irrigated agriculture

An analysis of international experience

During the last decade, the concept of water demand management has received increasing attention from both academics and development agencies and banks. In the face of rising costs for supply augmentation and concerns over the apparently inefficient use of water in agriculture, managing demand appears a priority means of mitigating water scarcity problems. Economists, in particular, have used theoretical frameworks to argue for the use of "economic instruments" to provide incentives that may lead to water saving or enhancing economic efficiency.

However, it has become increasingly clear to many practitioners and researchers that evidence from the field shows that the impact of economic tools has fallen short of expectations and promises. Based on an extensive review of the literature and six commissioned case studies, this document demonstrates that there are few examples in which the introduction of water pricing in irrigation schemes has successfully induced water savings. It also shows that there is often confusion over the different justifications for water pricing.

The objectives of cost recovery and demand management must be understood and addressed separately as their realization requires the use of different charging mechanisms. In most situations farmers could pay the levels of charge required to meet ongoing operation and maintenance and future replacement costs. The widespread failure of farmers to pay is often due to dissatisfaction with the level of service provided, lack of confidence in the legitimacy of the charging process and the lack of resources invested in establishing effective and transparent charging mechanisms.

To bring about any significant change in water use requires that users be charged volumetrically at prices many times greater than those required to cover costs. These issues present important technical and political challenges that must be recognized.

The document underscores these important differences in objective and indicates the type of charging mechanism or other economic tool that may be appropriate to each.

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