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Implications of Alternate Irrigation Water Charging Policies for the Poor Farmers in Developing Asia: A Comparative Analysis

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Summary

This study forms part of the ADB funded multi-country project on 'Pro-poor intervention strategies in irrigated agriculture in Asia' implemented by the International Water Management Institute (IWMI in collaboration with national partners in six Asian countries: Bangladesh, China, India, Indonesia, Pakistan and Vietnam. These countries together account for over 51 percent of global net irrigated area and over 73 percent of net irrigated area in Asia, with most of this area located in China, India and Pakistan. In the context of on-going institutional reforms in irrigation sector in these countries, there have been much discussions on the role of irrigation charging/pricing and cost recovery for improving management of water resources. However, these discussions have focused on efficiency and resource allocation aspects with only little attention to equity dimension of charging/pricing. This study focuses on equity aspects of canal water charging/pricing and addresses two key questions: how irrigation charging is linked to irrigation performance and poverty; and what are the implications of alternate charging methods for cost recovery, equity and poverty, particularly under conditions of (in)equity in land and water distribution. The study describe in detail key characteristics of charging methods that are in practice on ground based on field level information and data from 26 irrigation systems in six countries; undertakes comparative analysis of alternate charging methods; identifies their strengths and limitations; and highlights factors influencing the choice of charging methods in particular settings.

In the studied systems, irrigation charge varies from US$ 1 to US$ 67 per ha, and the collection rate varies from 5 percent to 99 percent. In general, irrigation charge level and the collection rate is lower in the studied systems in South Asian countries than those in China, Indonesia and Vietnam. The study findings indicate that: (1) in the Chinese and Vietnamese systems studied, land and water distribution is relatively equitable. Irrigation charges are directly or indirectly linked to irrigation service delivery/ water supplies. In these systems, irrigation charges, regardless of whether based on size of landholdings or cropping intensities, tends to be relatively equitable. What is important for revenue generation/cost recovery for these systems is to increase the charge to the level where it reflects cost of supplying water and /or benefits derived from water use and to further improve on collection efficiency; (2) in Indonesia, landholdings are generally of smaller sizes, and there is element of inequity in distribution of both land and water. Under multiple criteria based charging method (as in the transferred systems) structure of charging is such that charges are linked to water supplied/used, and it accounts for poverty concerns. Here too, what is needed is to increase the level of irrigation charges and overall collection efficiency for improved cost recovery; (3) in the South Asian systems, land and water distribution across farms tends to be fairly inequitable, and charge is not linked to irrigation service or amount of water supplied, and overall charge level is very low. In such systems, not only the level of charge needs to be increased, the structure of charging also needs to be improved for improving cost recovery in more equitable and pro-poor ways; (4) irrigation charging methods in Vietnam and China are relatively better as they account for locational differences in service delivery /water supplies, and to some extent reflect cost of supplying water. On the other hand, while present charging methods in South Asian systems, are easy to administer, they lack transparency and are often inequitable and biased against the poor small farmers; and (5) quantitative analysis suggests that irrigation charge level affects system performance, which in turn, influences poverty in the systems, that is low charge level indirectly dis-benefit the poor.

In systems where irrigation charges are low, funding for the sector is often low and maintenance of the systems is neglected; there is a lack of incentives for service providers to improve on service delivery, and lack of incentives for users to demand for improved services; and accountability linkages between managers and water users are weak; there are no incentives for users to improve on water use efficiency, and low charge policy worsens income distribution especially in those settings where there is greater degree of inequity in land and water distribution (as in most South Asian systems), as large part of benefits of subsidies to irrigation sector goes to larger landholders. Overall system performance, and revenue collection and cost recovery is better in those systems where there are decentralized institutional arrangements for irrigation management. The study suggests that in China and Vietnam, the level of irrigation charge needs to be increased to reflect the cost of supplying water. In the South Asian systems, not only the level of charge needs to be increased, the charging structure needs to be corrected such that they are linked to irrigation service.

The study offers several important lessons for designing an effective charging policy. These include: (i) there are a number of charging methods in practice in the studied systems, and the choice of a charging method in a particular setting depends on a range of factors including water allocation mechanisms and water rights, characteristics of delivery systems (supply-based ore demand –based), value of irrigation water, variability in water flows and distribution losses, number of farms to be served, social objectives such as food security and poverty alleviation and other factors such as transaction cost of charge collection.; (ii) irrigation charging influences irrigation performance, which in turn, influences poverty.; and (iii) the impacts of a particular charging method on system performance depends on distribution structure of land and water. Where land and water tends to be equitably distributed (as in China and Vietnam) it is mainly the level of charge that matters for revenues and cost recovery. On the other hand, in settings where land and water distribution tends to be inequitable, both the level and the structure of charging are important not only in relation to revenues and cost recovery, but they have implications for equity in income distribution. Under such settings, indiscriminate application of low charge policy dis-benefits the poor. Also, in such settings charging structure, which is not linked to irrigation service and which does not account for landholding size, often favors the non-poor. For systems characterized by greater inequity in land and water distribution across systems and farms, as those in Pakistan, the study analyzes various policy options and suggests that flat rate or differential rate charging linked to landholding size would be pro-equity/pro-poor and would lead to increased revenues/cost recovery. The suggested options can be implemented with existing institutional arrangements. The on-going irrigation sector reforms could provide an important entry point for taking-up the suggested options.

Implications of Alternate Irrigation Water Charging Policies for the Poor Farmers in Developing Asia: A Comparative Analysis

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Introduction

It is well known that the performance of many large and medium scale canal irrigation systems in most developing countries has been generally unsatisfactory. Historically, these systems have been owned, managed and operated by government agencies. Most of these publicly managed systems are often characterized by poor management, unreliable water supplies, poor maintenance and management of infrastructure, inefficiency and inequity in water use and distribution and financial dependence on government budgets. Poor service delivery, a net outcome of these factors, results in low crop productivity and overall low returns from farming. Inappropriate institutions and management practices, and inadequate funding and inefficient spending are generally regarded as fundamental causes of the poor performance in irrigation sector. These factors reduce the benefits of investments in irrigation development and management to the societies (World Bank, 1999, Hussain and Biltonen 2002).

With growing realization of these problems, coupled with continuing reduction in public expenditures for irrigation, pressure for reforms in irrigation sector has been increasing over the past decade. The stated overall goal of the reform initiatives is to better utilize the available water resources in more sustainable, equitable and productive manner. Interventions proposed in reform initiatives have focused on four key areas: (1) formulation of policies, laws and regulations on water allocation and use; (2) development and re-organization of water management institutions (such as establishment of river basin organizations or autonomous bodies for water management); (3) participatory water management, and management transfer to user organizations; and (4) financing for water – improved cost recovery and water charging/pricing methods, with emphasis on the use of economic instruments in water management. This paper focuses on the last aspect, specifically on methods of charging/pricing for irrigation water, of reforms.

In the irrigation sector reforms, the emphasis on water charging/pricing has motivated from the perspectives of improving efficiency in resource allocation in the context of growing scarcity and competition for water, and for improving cost recovery and for reducing subsidies to the sector, with the overall goal of making irrigation sector financially self-sufficient and sustainable with minimum or no dependence on public funds. While *efficiency incentive and financial functions of water pricing/charging* (i.e. to encourage efficient use of scarce water resources, and to raise revenues to pay for cost of producing or supplying water), have been widely discussed and debated, and a significant amount of work, both theoretical and empirical, have appeared in the literature, however, their distributional function (i.e. to redistribute scarce resources across regions or socio-economic groups) have received only little attention. It is likely that a pricing/charging regime that may be efficient in terms of ensuring full cost recovery, may adversely affect the poor, and particularly so in settings characterized by inequity in land and water distribution. Where poverty is a major concern, and poverty dimension has been recognized in reform initiatives, it is important that charging and cost recovery policies be designed such that they explicitly account for such concerns. While efficiency, cost recovery and equity aspects of water pricing/charging[1] are inter-related, the study largely focuses on the distributional aspects, and to some extent relates this to the financial aspects. While efficiency aspect[2] of charging/pricing is discussed and related to other two aspects where necessary, but it is not the central focus of this study.

The key questions addressed in the paper are: how irrigation charging is linked to irrigation performance and poverty; and what are the implications of alternate charging methods for cost recovery, equity and poverty, particularly under conditions of (in)equity in land and water distribution. The study describes in detail key characteristics of charging methods that are in practice on ground in diverse settings, and their strengths and limitations, and highlights factors influencing the choice of a charging method in a particular setting. The analysis of charging methods in this study covers three main aspects: level of charge, the structure of charge (defined by how the charge is related to service delivery, water supplies, crop types, crop output, crop income, crop season, farm size and landholdings) and collection aspects of charging.

Objective

The purpose of this study is to provide a comparative analysis of irrigation water charging/pricing methods based on field level information and data from 26 irrigation systems in six countries: Bangladesh, China, India, Indonesia, Pakistan and Vietnam. The study focuses on equity aspects, analyzing implications of alternate irrigation charging/ pricing methods for the poor farmers under various socio-economic, and land distribution conditions. The aim is to suggest charging/ pricing options that improve revenues/cost recovery and are pro-equity and pro-poor.

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[1] In the literature on natural resources, particularly water resources, terms water price, water charge, water fee and water tax are often (incorrectly) used interchangeably. In a strict sense, price is a value of a commodity determined by market forces. It is a payment for a commodity or service of business character and the individual can escape the price by not purchasing the commodity or service. On the other hand, fee and charge (which mean to the same thing) are compulsory contributions or payments made by a person to cover a part or all of the expenses involved in some action or provision of service by the public authority which while creating a common benefit, also renders a specific benefit or service to a person. Fee and charge is intended to cover a part or all of the cost of the service rendered and is never more than the cost of the service. Tax is a general compulsory payment levied upon persons to cover the expenses incurred in conferring common benefits upon users of a commodity or service. It is a compulsory levy and is meant for general purpose of state revenue raising. An individual cannot expect any specific service rendered to him by state in return for the tax paid by him. Broadly speaking, price is for goods of pure private nature, charge or fee are generally for goods with both public and private characteristics, and tax is for goods of pure public nature. More appropriate term for irrigation service may be fee or charge rather than price or tax. In nutshell, price is a payment of a business character. For charge and fee, public interest is prominent, and an individual receives specific benefit or service in return for charge and fee. Tax is for common benefits, and not for specific benefit to individual tax payers. Tax and price are on two extremes of a spectrum representing a pure public good and pure private good, respectively, and charge, fee or differentiated fee is somewhere in the middle of the spectrum (with fee or charge, for example, for semi-public goods, and differentiated fee for semi-private goods). Water has characteristics of both public and private goods, and where it lies on the spectrum of public-private good depends on the context; in South Asia, for example, it may be more on semi-public good side (where terms such as fee or charge may be more relevant), on the other hand, in China, where it is more toward semi-private good side (where terms such as differentiated fee or even price may be relevant) [these distinctions are from literature on public finance, for details see Dewett and Chand 1987]

[2] Some of the efficiency related aspects are discussed in Appendix-A.

The paper is organized as follows: with brief introduction and outline of the study objectives, the next section provides an overview of various charging methods and identifies factors that influence the choice of a charging method in a particular setting, including a review of the past studies on the related issues. Section 3 provides a brief description of the study locations, data and the study methods. Section 4 outlines key characteristics of various charging methods and offers comparative analyses, and highlights their main strengths and limitations. This is followed by analysis of linkages between irrigation charge, irrigation system performance and poverty in section 5. Section 6 offers discussion on the suggestion options for irrigation charging. Last section summarizes the study findings, draw conclusions and implications of the main findings.

Overview of Charging Methods and the Factors Influencing their Choice

Seagraves and Easter (1993), Small et al (1989), Tsur and Dinar (1995), Hassan and Chaudhry (1998) and Johansson (2000) and Johansson *et al.* (2002) discuss alternate irrigation charging/pricing methods in developing countries. These may be classified into following four categories:

(1) volumetric based charges – direct charges based on measured quantities of water, suited to situations where value of water is very high and water can be measured, however, cost of water measurements and monitoring is generally high.;

(2) time based charges – charges based on per share of flow in a canal, suited to situations where water is allocated/distributed on the basis of time, water flow varies over time, this method have some characteristics of volumetric based charges;

(3) area based charges – charges based on area irrigated or cropped; this is the most commonly used method of charging for water. In a global survey of farmers Bos and Walters (1990) found that in more than 60 percent of cases water is charged on a per unit area basis; area based charges basically represent the case of fixed water charges; and

(4) output or input based charges – these are indirect charges based on quantities of outputs produced or inputs purchased.

There are a number of factors that influence the choice, suitability and effectiveness of a particular charging method in a particular location. These factors can be summarized as follows:

1. *Water allocations and rights* – in most developing countries, water rights and customs relating to water allocation and distribution often have evolved over centuries. Water laws generally decree government ownership of water resources. In most situations, surface water allocations at the higher level (primary and secondary levels) are done administratively based on a number of criteria including historical water rights, canal command areas, canal capacity, overall availability and supply of water, cropping patterns and socio-political considerations. At the tertiary and farm

levels, water allocations are generally based on size of landholdings and available supplies of water; and land and water rights are generally coupled (except in China where land rights are decoupled from water rights). The administrative allocation of surface water supplies across canals or regions is controlled by the provisions of water acts and regulations. Similarly, prices are also set administratively, often based on socio-political criteria. Administrative allocation of water, coupled with administratively determined charges/prices, mean that role of charges/prices is changed. Under these conditions, price plays a role in the allocation of resources only if there is a response to price at the margin. However, the price remains important in determining the level of revenues generated by the authorities concerned. It should be noted that in water scarce areas, administrative allocation of water is basically some sort of physical rationing of water, and as Seagraves and Easter (1983) and Perry (2001) suggest that if water could be made equally scarce to all farmers (as for example under warabandi system in northwest India and Pakistan), they would have incentive to distribute it as well as it were priced.

2. *Characteristics of delivery systems* – the characteristics of a delivery system also influence the suitability and choice of a particular pricing/charging method. Delivery system may be categorized into (a) supply based systems, and (b) demand based systems. Supply based systems may be further categorized into (i) rotational systems – where water is supplied to users in turns according to some pre-arranged schedule; and (ii) continuous flow systems – where water supplies flow continuously and each farmer is free to take whatever quantity reaches his or her fields. The amount of water received generally depends on the location of farms along a canal. In the supply based systems (which characterize most large and medium scale surface irrigation systems in developing countries), water allocation and prices/charges are determined administratively. Irrigation charges are often levied based on area irrigated or area cropped. In these systems, even if water is charged on volumetric basis (as in some Chinese systems at the primary or secondary level), irrigation charges do not necessarily reflect the true value of water. On the other hand, in demand based systems (which characterize almost all groundwater systems (tubewells)), water supplies are delivered at times and in quantities as requested by users (and often prices are determined by market forces, although all social costs and benefits associated with water supply and use are not fully reflected in water prices). In these systems, user farmers have control over and make decisions over the volume of water to receive (regardless of whether volume of water is measured based on time of water flow or area irrigated). The unique characteristic of the demand based system is the flexibility in operations to match supplies with demands. The system works best where water can be measured, and volumetric pricing/charging is feasible. Appropriate control and measurement structures are important for these systems.

3. *Value of water, variability in water flows, and distribution losses* – where inter and intra seasonal flows of supplies vary widely, the value of water may also differ significantly. Therefore, pricing/charging based on value of water may needs to be frequently changed, which is practically difficult to implement. Consequently, under these conditions, water is allocated /distributed based on proportion of flow or share, that is, time based allocation and charging. Also, where value of water is low, volumetric based charging may not be feasible because of significant costs associated with water measurements, monitoring and administration.

4.*Number of farms to be served* – where number of farms to be served is very large, as is the case in most developing countries' irrigation systems, there are practical difficulties in providing highly differentiated services to individual farmers, requiring simple water allocation and charging methods.

5.*Social objectives* – such as the desire to provide subsidies to increase production or to address poverty concerns also influence the choice of charging methods.

6. *Other factors* influencing the choice of charging methods include ability to collect irrigation charges and transaction costs associated with collection.

Highlights from the Past Studies

As mentioned earlier, there is a vast amount of literature on financial and economic aspects of water on including water charging/pricing. However, much of the available literature is based on theoretical discussions, analyses from the perspectives of resource allocation efficiency and cost recovery, case studies on institutional dimensions of water financing and pricing, and on water markets. Also, most of the available related studies particularly on pricing are for non-agricultural/urban water use, with work offering detailed examination of the linkages between irrigation charging and poverty being very rare.

This section provides a very brief review and key conclusions from recent studies on general issues on irrigation water financing and pricing/ charging. For a recent comprehensive review and list of extended references see Johansson (2000) and Johansson *et al*. (2002).

Small et al. 1989 undertook a detailed review of national and international literature and case studies in Indonesia, Nepal, Philippines, and India on financing and charging methods for irrigation water. Their study discusses types of irrigation methods, institutional arrangements for financing irrigation, methods of charging for irrigation, irrigation charge enforcement mechanisms, collection costs and collection efficiencies, and water use efficiencies in the selected locations. Major conclusions of the study are that: (1) the quality of irrigation system operation and management is affected not only by the amount of resources made available to operate and maintain systems, but by the institutional arrangements under which they are provided;. (2) providing appropriate incentives to agencies responsible is important for cost effective management of irrigation. Financially autonomous agencies, raising their revenues from farmers' payments of irrigation service fees have greater incentive to provide good irrigation service compared to financially dependent agencies that receive their revenues from the national treasury. Also, decentralized financial autonomy creates financial accountability linkages between irrigation managers and users; (3) most financing mechanisms used in the case study countries do not provide incentives for efficient use of water. The main direct financing method involves irrigation service fee charged based on flat rate per unit of area, sometime differentiated for crop type and cropping intensity. The area based fees, rather than promoting efficient water use, generally provide incentives for overuse of water by those farmers able to obtain it. Efficiency of water use is related to effectiveness of agencies' control over distribution of supply to farmers, rather than the control over the demand for water through pricing mechanisms; (4) true water pricing, which requires water measurements and high degree of physical control over water distribution, is generally not found in irrigation systems characterized by large number of small farms on which rice is a predominant crop, as under such conditions water pricing is difficult to implement and costly to administer; and (5) under conditions of reasonable irrigation service fee, the incremental benefits derived by farmers from irrigation are adequate for them to pay the full O&M cost while retaining significant increase in net incomes due to irrigation.

The Expert Consultation on Irrigation Water Charges (ECIWC 1986) states, (as reported in Bos and Walters 1990) that " Water charges policies are unlikely to have any significant impact on the efficiency with which individual farmers use water except in those extreme cases where at the same time: water is scarce, the irrigation systems deliver water on demand basis (response to *ad hoc* requests), and water deliveries are measured" Further it is indicated that even if charges are levied on volumetric basis, and farmers can control the quantity of water delivered, low charges will not have any significant influence on efficiency. Bos and Walters (1990) in their global survey of farmers (covering 8.9 million ha globally) examined the relationships between irrigation charges and irrigation efficiencies. Main conclusions from their analysis are that: (1) there are no significant influence of the structure of water charges on irrigation efficiencies, and efficiencies were not high where charges were levied by volume, because charges were too low to have significant impact (charges in almost all projects were under 10 percent of net farm income); (2) irrespective of the structure of water charges, and there was a trend towards higher efficiencies with higher charges; and (3) in projects where water supply was to be lifted, the field application efficiency and tertiary unit efficiency were significantly higher and influenced by built in proportional charge, and three effects: water shortage, lift of water and higher efficiency, were interrelated.

Comparing three methods of charging for water – volumetric based charges, area based charges and time based charges in the context of Indus basin, Pakistan, Hassan and Chaudhry (1998) conclude that volumetric based charging may be efficient but is not feasible on both technical and financial grounds. Further, it is indicated that in crop area based method, irrigation charges are not linked to water use, and there are problems related to underassessment and misreporting of crop areas in this method of charging. They suggest that culturable command area (of farms) based irrigation charges (which is believed to be close proxy for volumetric charges) and time based charges, are better options than volumetric based or crop based irrigation charges in terms of efficiency of water use and cost of implementation. However, the arguments in the study are not founded by any rigorous analysis, and also, the study does not analyze equity implications of alternate charging systems.

On cost–based pricing, Rogers, Bhatia and Huber (1998) suggest that the full cost of water, including the opportunity cost of water as well as the environmental externalities, should present the context for setting prices, and that social objectives of poverty alleviation and food security should be taken into consideration.

Perry (2001) raises important issues in relation to charging for irrigation water, and discusses various options. He argues that introducing volumetric charges is difficult and unlikely to result in water savings within the politically feasible range of prices in developing countries. He indicates that lower water rates will have no impact on demand, and higher rates that will influence demand will be too high to be politically acceptable and will result in substantial profits to supplying agency. For example, the likely charge needed to cover O&M costs would be \$0.003-0.005 per m^3, while the charge required to substantially affect demand would be much higher \$0.02-0.05 per m^3. Therefore, a charge designed to recover O&M costs will have minimal efficiency impacts, and charge that will affect efficiency will be too high to be politically feasible. He highlights practical difficulties in pricing water due to complex nature of water as a natural resource (difficulty in measuring water at the farm level, water losses, and presence of externalities), as a difficult economic resource (as value of water varies across time, space and use) and as a difficult political resource (political difficulty in raising prices). He suggests that: (a) many of the assumed advantages of water pricing can be achieved through physical rationing of water, which is easier to implement, more transparent and more readily adjusted to local considerations such as groundwater conditions and salt management; and (b) set water charges to recover full O&M costs to ensure financial sustainability of irrigation systems. However, his study does not provide any analysis of equity implications of recovering full O&M costs.

As mentioned earlier, much of the available literature on water pricing/charging, is in the context of efficiency of water allocation and use, and cost recovery. While it has been recognized that cost recovery schemes and associated methods of charging have direct impacts on equity and income distribution, empirical studies on this dimension are rare. In relation to equity aspects, Rhodes and Sampath (1988), and Sampath (1992) suggest that consideration of effects on income distribution of water pricing has merit of its own when justified on ethical grounds. Tsur and Dinar (1995) indicate that the majority of pricing mechanisms have little potential effect on income distribution when farmers are homogenous, as equity effects of pricing are primarily dependent on land endowments. There are both for and against arguments in relation to irrigation charging/pricing with respect to equity. For example, sometime it is argued that consumers benefit from agricultural investments through lower food prices and so should be expected to share in covering the costs (Sampath 1983). Some even argue against water charges of any kind in less developed countries, as higher income farmers are often exempt from paying (Easter and Welsch 1986). On the other hand, it has also been suggested that water pricing may be used as effective means to re-distribute incomes especially where there are equity concerns among heterogeneous water users and sectors, and that water pricing may play a role in influencing income distribution between irrigation districts (Brill, Hochman and Zilberman 1997) as well as between farming and non-farming sectors (Diao and Roe 1998). Based on the extensive review of literature on water pricing, Johansson 2000 suggests that effect of pricing on equity and income distribution in developing countries should not be overlooked.

Study Locations, Data and Methods

This study forms part of the ADB funded multi-country project on 'Pro-poor intervention strategies in irrigated agriculture in Asia' implemented by the International Water Management Institute (IWMI) in collaboration with national partners in six Asian countries: Bangladesh, China, India, Indonesia, Pakistan and Vietnam. These are among the top few countries where substantial investments have been made in the development of large and medium scale canal irrigation systems, where irrigated agriculture provides livelihoods to hundreds of millions of rural people. According to recent FAO statistics, these countries together account for over 51 percent of global net irrigated area and over 73 percent of net irrigated areas in Asia, with most of this area located in China, India and Pakistan. For this study, 26 medium and large scale irrigation systems, were selected from the six countries. The selected irrigation systems vary in terms of size, canal water supplies, groundwater use, condition of irrigation infrastructure, irrigation management patterns, crop productivity, level of crop diversification, land quality and size of landholdings, and level and structure of irrigation charging. Location of the systems and other related characteristics are presented in Table 1 (for more details on specifics of locations and characteristics of these systems see Hussain and Wijerathne, 2003).

The study is based on both primary and secondary data. Primary data were collected from the selected irrigation systems through household level surveys. Consistent procedures were adopted for developing sampling framework and sample selection across selected systems in six countries. For each irrigation system, sample was drawn using a multi-stage sampling method. In the first stage, each selected system was purposively divided into three strata (e.g. head, middle and tail parts). In stage two, each of the strata was divided into a number of clusters (in irrigated areas, a distributary canal was taken as a cluster and in rainfed areas a village was defined as a cluster). One to two representative clusters were selected along each of the three reaches, head, middle and tail, of a system. In stage three, a sample of households was selected from each cluster. Given the differences and complexity of systems across countries, there were some minor variations in procedures adopted in each location according to local conditions, overall sampling procedures were fairly consistent across systems. Total sample size for surveys consisted of 5408 households in 26 selected systems. The selected households were interviewed with pre-tested structured questionnaire for gathering data and information on various aspects of household economies including demographics, landholdings and agriculture, irrigation, cost and returns of crop cultivation, household assets, employment and earnings from non-agricultural sector, credit, household total incomes and expenditures, and other related variables. The survey covered all cropping seasons during 2001-2002 agricultural year (for more details on data collection procedures see Hussain and Wijerathne, 2003). The study uses the following poverty headcount index for estimating income poverty across systems:

$$P_{\alpha} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z - y_i}{z}\right)^{\alpha}$$

Where y_i is the income of the individual i or household i, and z is specified poverty line, and for Headcount Index (HCI) parameter ? = 0. HCI estimates the share or proportion of the population, which is poor or whose income is below the specified poverty line. This is a measure of incidence of poverty.

Irrigation Charging in the Selected Systems – The Context

In this section, we discuss irrigation charging methods presently in practice based on data and information collected from the selected irrigation systems. Systems studied in the South Asian countries (Bangladesh, India and Pakistan) are characterized by high degree of inequity in land and water distribution, with highest inequity in Pakistan. For example in Pakistan, 75 percent of sample households owned around 40 percent of land, and 25 percent owned 60 percent of land. The estimates of Gini coefficient for land across selected systems in Pakistan varied from 0.31 to 0.56, with average value estimated at 0.49. While average per household landholding size in Bangladesh is relatively small, its distribution is fairly inequitable. For example, in Ganges-Kobadak system, lower 71 percent of sample households owned 25 percent of land, middle 27 percent owned 32 percent of land, and upper 2 percent owned 43 percent of total land area. Similarly, in Indonesian systems, though average land size per household is much smaller, there is an element of inequity in land distribution. On the other hand, land distribution in Chinese and Vietnamese systems is fairly equitable (basically reflecting equitable land policy followed in these countries, for details see Hussain and Wijerathne, 2004a, forthcoming) though average landholding size per household is much smaller than that in South Asian countries. Agricultural productivity per ha is the highest in the Chinese systems and the lowest in Pakistani systems.

In all the systems studied, except those which have been transferred or where irrigation is managed in more participatory mode (where in most cases irrigation charges are jointly determined and assessed by the agency and WUAs), irrigation charges are set administratively by the central or provincial/state governments. Charges are set at low levels, which reflect neither the cost of supplying water nor the value/benefits derived from water use. Present level of irrigation charges, particularly in the South Asian systems, are too low to have any influence on farmers' cropping decisions or water use efficiency. In these systems, irrigation charges are not linked to the level of services, charges are levied irrespective of the amount of irrigation water received, and irrespective of the quality and reliability of irrigation supplies. In all the agency managed systems, irrigation charging, collection and spending is highly centralized. In these systems, revenues generated through irrigation charges do not even cover the required O&M costs and the systems have to depend on public sector allocation of funds. In South Asian systems, where landholdings are inequitably distributed, large part of benefits of subsidies to the irrigation sector goes to large landholders. In the transferred systems or where there are decentralized institutional arrangements for irrigation management and service delivery, charge collection and spending mechanisms are fairly decentralized and overall performance is better than that of agency managed systems.

Table 1: Salient Features and Water Charging in Selected Irrigation Systems

Country	System name	Location	Management Type	Water Charge set by	Basis of Water Charges	Annual Water Charge per hectare – local currency (US$)	Annual Water Charge as percent of GVP	Collection Rate (percent)	Land distribution
Bangladesh	G-K	South-western Bangladesh	Agency	CG	Crop area based	Tk. 1200 ($20)	4.46	5-15	skewed
	Pabna	West-central Bangladesh	Agency	CG	Crop area based	Tk. 1296 ($22)	7.51	9	skewed
India	NSLC	Andhra Pradesh/Krishnia River- Upstream	Transferred	SG	Crop area based	Rs.500 ($10)	1.91	40-50	moderately skewed
	KDS	Andhra Pradesh/Krishnia River- Downstream	Transferred	SG	Crop area based	Rs.500 ($10)	1.57	82	moderately skewed
	Halali	Madhya Pradesh	Transferred	SG	Crop area based	Rs.500 ($10)	3.09	33	fairly skewed
	Harsi	Madhya Pradesh	Transferred	SG	Crop area based	Rs.500 ($10)	4.33	21	fairly skewed
Pakistan	9-R	Upper Jehlum Canal	Agency	PG	Crop area based	Rs. 275 ($4.6)	2.94	99	moderately skewed
	10-R	Upper Jehlum Canal	Agency	PG	Crop area based	Rs.411($6.9)	2.09	99	moderately skewed
	13-R	Upper Jehlum Canal	Agency	PG	Crop area based	Rs. 635($10.6)	2.06	80	moderately skewed
	14-R	Upper Jehlum Canal	Agency	PG	Crop area based	Rs.531($8.8)	2.41	80	moderately skewed
	Kakowal	Upper Jehlum Canal	Agency	PG	Crop area based	Rs.559($9.3)	3.51	80	moderately skewed
	Phalia	Upper Jehlum Canal	Agency	PG	Crop area based	Rs. 529($8.8)	2.31	80	moderately skewed
	Lalian	Lower Jehlum Canal	Agency	PG	Crop area based	Rs. 338($5.6)	2.84	87	moderately skewed
	Khadir	Lower Jehlum Canal	Agency	PG	Crop area based	Rs. 414($6.9)	3.90	87	highly skewed
	Khikhi	Lower Chenab Canal	Agency	PG	Crop area based	Rs. 472($7.9)	1.66	94	highly skewed
	Hakra-4	Hakra System	Transferred	PG	Crop area based	Rs. 274($4.6)	1.72	91	highly skewed

China	WID-NP	Ningxia Province-Northwestern China (upper YRB)	Village cooperatives	PG	Cultivated area based	Y556/($67)	5.08	80	fairly equal
	QID-NP	Ningxia Province-Northwestern China (upper YRB)	Village cooperatives	PG	Cultivated area based	Y489/ha ($59)	5.17	80	fairly equal
	PID-HP	Henan Province-Eastern China (Lower YRB)	Village cooperatives	PG	Cultivated area based	Y279 ($34)	2.35	80	fairly equal
	LID-HP	Henan Province-Eastern China (Lower YRB)	Village cooperatives	PG	Cultivated area based	Y212 ($26)	1.83	80	fairly equal
Vietnam	Nam Duang	Red River Delta	Village cooperatives, IDMCs	PPC	Crop area based	VD917135 ($58)*	4.6	85-95	fairly equal
	Nam Thach Han	North Central Region	Village cooperatives, IDMCs	PPC	Crop area based	VD969700($61)*	6.3	99	fairly equal
Indonesia	Klambu Kiri	Central Java	Agency	WUAs	Multiple criteria	$6-11	0.8 to 1	-	skewed
	Glapan	Central Java	Agency	WUAs	Multiple criteria	$4-16	0.8 to 4.3	-	skewed
	Kalibawang	Yogyakarta	Transferred	WUAs	Multiple criteria	$13-20	0.6 to 2.2	95	fairly equal
	Krogowanan	Central Java	Transferred	WUAs	Multiple criteria	$1-7	0.2 to 0.6	-	fairly equal

Notes: IDMCs: Irrigation and Drainage Management Companies.
G-K = Ganges Kobadak; NSLC = Nagarjuna Sagar Left Bank Canal; KDS = Krishna Delta Systems; WID-NP = Weining Irrigation District in Ningxia province; QID-NP = Qingtongxia irrigation district in Ningxia Province; PID-HP = People's Victory Irrigation District in Henan province; LID-HP = Liuyuankou Irrigation District in Henan province.; CG = Central Government, SG = State Government, PG =Provincial Government, WUA= ,Water User Association, PPC =Province People's Committee;
* these figures are based on cost of full irrigation (fee for partial irrigation is lower). Average rice yield per ha (for both spring and summer crops) for Nam Duang (ND) and Nam Thach Han (NTH) systems are 8766 kg and 9241 kg, and average fee for full irrigation for ND is 209kg/ha for spring and 194kg/ha for summer (total 404 kg/year), and for NTH average fee for full irrigation is 290 kg/ha per season (total 580 kg/ha/year). Estimated average local price for paddy is VD2270/kg for ND and VD1672/kg for NTH systems. Using these values, average annual fee per ha is VD917135 for ND and VD969700 for NTH.

In the studied systems in Bangladesh, India and Pakistan, irrigation charging methods are fairly similar. The level and structure of irrigation charges is determined by the state/provincial governments. Irrigation charges at the farm level are levied based on area cultivated/cropped, crop type, crop condition, and season (Rabi/Kharif). In each season, irrigation charge assessment at the filed level is undertaken by irrigation/revenue department officials. Even, in most of the transferred systems (in Andhra Pradesh, Madhya Pradesh, Hakra-4 in Pakistani Punjab) irrigation charges are determined by public authorities while assessment and collection is either jointly undertaken by government officials and WUAs or in some cases by WUAs (as in Hakra-4 R). Within a state or province, irrigation charges are levied uniformly across canal commands, irrespective of the amount of water delivered to a canal command. For example, in Lalian and Khadir systems in Pakistani Punjab, average amount of canal water applied per ha for wheat during rabi season is estimated at 1458 m^3, and 465m^3, respectively, (with significant head to tail variations), however, seasonal irrigation charge is uniform in both systems. Groundwater contributes 55 percent and 89 percent of total water applied per ha, in the above two systems, respectively (see Hussain *et al.* 2003), and those who supplement canal water with groundwater are fully liable for canal water charges. Irrigation charges are generally higher for high water consuming crops such as rice, and low for less water consuming crops such as wheat although differences are not significantly large enough to affect farmers cropping decisions. Variations in canal water allocations are not clearly reflected in the charging structure. At present, irrigation charges are remitted to the government and there is no direct link between funds collected and funds spent on operations and maintenance. Unlike in Vietnam and China, canal irrigation charges in South Asian systems are not differentiated by location across and within canal commands, or by level of service (full or partial irrigation) or level of productivity. Overall irrigation charges are low, both because of low level of charges and/or poor collection rates, and the governments subsidizes irrigation in these countries.

While water allocation/ distribution in the South Asian systems is based on size of landholdings, irrigation charges are levied based on farm area cropped. This has implications both for income distribution and for cost recovery, particularly in systems where average landholdings are fairly large and land distribution is highly inequitable (as in almost all Pakistani systems) and cropping intensity is low. Assuming both small farm (say of 1 ha size) and a large farm (say of 20 ha size) have same water entitlement per ha (as for example, under warabandi type of systems, where water is distributed across farms such that scarcity or abundance of water are equitably shared across farms, although in practice large head-tail inequities prevail in most surface systems), and say per ha water supply is 2500 m^3 (with small farm receiving 2500 m^3 and large farm 50,000 m^3), and assuming per season cropping intensity is 100 percent for small farms and 80 percent for large farms, and average per hectare irrigation charge (crop area weighted) is Rs 100. For each hectare of land (or for each 2500 m^3) small farmer would pay Rs. 100, and large farmer would pay Rs. 80. Under such a system, large farmers are not charged for water allocated to 20 percent of landholding that was not cropped due to a variety of reasons. Since, often per ha canal water supplies are less than required, this 20 percent may be used to increase per ha supplies on 80 percent of the cropped area. Under this system, total amount collected from the two farms would be Rs. 1700 (Rs.100+Rs.1600). However, if irrigation charges are linked to size of landholdings (which is fair as water distribution is based on landholding size), total amount collected from the two farms would be Rs. 2100 (Rs.100 +Rs. 2000), an increase of Rs. 400. The current system, therefore, is not only pro-rich (or anti-poor), it reduces the total amount of funds that could be generated without any increase in irrigation charges. Also, irrigation charges are differentiated by crop type, that is, higher irrigation charges for high water consuming crops and vice versa. This type of irrigation charging structure appears to be appealing, however, there are three major issues: (1) water allocation to a farm is fixed based on size of landholdings, and not based on crop type. Under warabandi type of system, a farmer growing rice or cotton would receives an equal amount of water per hectare of farm; (2) differences in irrigation charges for various crops are generally not significant enough to affect farmers copping decisions; and (3) transaction costs of assessments of irrigation charges based on crop type, and of mis-reporting etc are often high. These issues provide justification for a more simple charging structure, that is, irrigation charges independent of crop type, and area cropped simply based on size of landholdings.

In Indonesia, multiple criteria are used in determining irrigation charges at the tertiary level including cropped/irrigated area, crop type, crop productivity, location, level of service and users' capacity to pay, especially in transferred systems (with more decentralized institutional arrangements). Variations in canal water allocations are implicitly accounted for in charging structure. Farmers using more water by irrigating more area or by growing water intensive crops or achieving higher productivity have to pay more, introducing an element of equity in irrigation charging methods. Additional criterion of farmers' capacity to pay introduces poverty concerns into the charging methods, with the poor farmers paying relatively less than the non-poor farmers. Under multiple criteria based charging method (as being practiced in the transferred systems) structure of charging is such that charges are linked to water supplied/used, and it accounts for poverty concerns. The key issue for cost recovery in these systems is the level of irrigation charges.

In the Chinese and Vietnamese irrigation systems studied, landholdings are though small, their distribution is highly equitable. Water distribution across farms and across head and tail reaches tends to be relatively more equitable in these systems than those in South Asian systems. At the system level, water is allocated based on command area, cropping patterns, canal capacity etc, and irrigation charges are related to water allocated to a system, and irrigation charges vary by system. At the farm level, water is distributed based on size of landholdings, and irrigation charges are based on area cropped. Since average landholding size is small, overall cropping intensity is high across farms (for example, average cropping intensity across systems in China varies from 152 to 198 percent; in Vietnam it varies from 198 to 209 percent, see Hussain and Wijerathne 2003 for details). Because of small sizes of landholdings, entire farm areas are cultivated intensively and cropping intensities tends to be similar across farms. In a season, land use intensity (i.e. cultivated area/farm are) and cropping or cultivation intensity (i.e. cropped area/cultivated or farm area) tend to be similar. Given that land use intensities and cropping intensities tend to be similar, it does not make much difference if irrigation charges are based on size of landholdings or land use or cropping intensity. Also, since water distribution across head, middle or tail tends to be equitable within a system, application of uniform irrigation charges within a system seems plausible. What is important for cost recovery in these systems is the level of irrigation charges.

In the Chinese systems studied, level and structure of irrigation charges is determined by the local water resources bureaus under the guidelines from the provincial governments. At the field level, irrigation charge is based on area irrigated and in some cases time period to irrigate the fields. Irrigation charge appears to be related to the cost of O&M and overall cost of supplying water. In those Chinese systems, where water can be measured at primary or secondary levels, water is charged on volumetric basis, with same charge per unit of water for each user group in a canal command. Variations in canal water allocations are clearly reflected in charging structures, that is, amount paid for irrigation charges is directly proportional to amount of water received.

In the studied systems in Vietnam, irrigation is charged based on the level of output produced, charges vary across systems, and are differentiated by the level of service, that is, households receiving partial irrigation service pay less. IDMCs and cooperatives sign water delivery and water fee contracts, and charging and spending is partially decentralized.

At the lower/tertiary level, in both Vietnamese and Chinese systems, water is charged based on area cropped/irrigated, season, location and level of service (full or partial irrigation). Those users receiving full irrigation pay more than those receiving only partial irrigation. Similarly, those growing more water intensive crops generally pay more than those growing less water intensive crops. Implicitly, irrigation charges are linked to amount of water received/used, both directly at primary or secondary level (volumetric) and indirectly at the tertiary level. Partly, this is due to more decentralized irrigation charging systems. Overall, there is an element of equity built in irrigation charging method. Detailed characteristics of charging methods in practice in the studied systems are outlined in Tables 2 and 3.

Table 2:Characteristics of Water Charging Methods in Selected Systems in Asia and South

Studied Systems	Characteristics of Water Charging Methods
South Asia (Bangladesh, India and Pakistan)	? Level and structure of irrigation charges is determined by state/provincial government. ? There is no volumetric based charging. ? Irrigation charges are based on area cultivated/cropped, and differentiated by crop type, crop condition and crop season (dry/wet). Charges are generally higher for high water consuming crops such as rice, and low for less water consuming crops such as wheat. ? Irrigation charges are uniform across canal commands within a province or state, irrespective of the target amount of water delivered to a canal command. ? A crop irrigated partially from surface water and partially from groundwater is fully liable for canal irrigation charges. ? Level of irrigation charges is generally too low to affect farmers cropping decision. ? Level of irrigation charges is low and government provides subsidies. ? Irrigation charge collection and assessment is undertaken by

	government officials. ? Irrigation charges constitute 2 to 7 percent of gross value of production per ha. ? Collection rate varies across systems, with lowest rate of 5 to 15 percent in Bangladeshi systems, 20 to 80 percent in Indian systems, and 80 to 99 percent in Pakistani systems. ? Collected amount is deposited in treasury, and O& M funds are allocated from annual budgetary allocations for the sector. ? Irrigation charges are not linked to O&M cost or cost of supplying water ? Irrigation charges are not linked to level of service, charges are levied irrespective of amount of water received, and regardless of full irrigation or partial irrigation, quality and reliability of water supplies ? Within systems, uniform charges are applied to all locations in a system, and for all socio-economic groups. ? In the transferred systems, WUAs still depend on government budgetary allocations ? Irrigation charge system is highly centralized, especially in systems managed by agencies. ? In the transferred systems (India and Pakistan), 40 to 50 percent of funds collected through irrigation charges are to be given to WUAs for maintenance. However, in most systems, this mechanism is yet to be implemented.
Indonesia	? Level and structure of irrigation charges is jointly determined by the agency and WUAs. ? In the transferred systems, WUAs, and WUAF play greater role in determining the level and structure of irrigation charges. ? There is no volumetric based charging. ? Irrigation charges are based on area cropped/irrigated, cropping intensity, crop type, availability of water supply and its reliability, O&M requirements, farmers satisfaction and farmers capacity to pay. ? Interestingly, irrigation charges are also differentiated by location (head, middle and tail), with lower charges in low productivity areas. ? Irrigation charges consist of several components including irrigation service fee (around Rp.15000/ha/year), development fee, material and labor. ? If amount collected is insufficient, government provides the required funds. ? Irrigation charges are collected by WUA staff from farmers individually or during WUA meetings. ? Administrative cost of irrigation charges collection varies from 5 to 15 percent. ? Amount collected is deposited to WUAs treasure and WUAs bank account. ? In the transferred systems, WUAF plays important role in the collection of irrigation charges and use of collected funds at the secondary canal level. ? Irrigation charges are partially linked to O&M and level of service. ? In the transferred systems, overall collection rate is higher. For example in Kalibawang system, collection rate has increased

	from 59 percent in 1998/99 (before transfer) to 79 percent in 1999/00 (after transfer) and further increased to 90 percent in 2000-01. ? In the transferred systems, where WUAs are functioning well, such as in schemes in Kalibawang system, collection rate is 95 to100 percent. ? Overall, irrigation charging system is fairly decentralized.
Vietnam	? Level and structure of irrigation charges is determined by provincial government. ? There is no volumetric based charging. ? Irrigation charges are based on crop type, cropping season (spring/summer), and crop output. ? Irrigation charges are also differentiated by level of service i.e. partial or full irrigation, with households receiving partial irrigation paying less charges. ? Irrigation charges vary across systems. IDMC and cooperatives sign water delivery –water fee contract. In Nam Duang system, for example, irrigation charge is set as follows: - 209 kg of rice /ha for spring rice for full irrigation, - 181 kg/ha for spring rice for partial irrigation, - 195 kg of rice/ha for summer rice for full irrigation, - 146 kg/ha for partial irrigation, and - 80-90 kg of rice/ha for upland crop. ? Cooperatives collect irrigation charges, and administrative cost of fee collection is 5-6 percent. ? Collection rate is fairly high (85 to 99 percent). ? Amount collected through irrigation charges is main source of incomes for IDMCs, where amount collected is generally not sufficient for O&M, provincial government provides funds. ? In a way, irrigation charges are partially linked to O&M costs and level of service. ? Irrigation charge system is partially decentralized.
China	? Level and structure of irrigation charges is determined by local water resources bureaus (county/township) under the guidelines provided by the provincial and central governments. Consequently, there is significant spatial variation in level and structure of irrigation charges. ? In some systems, volumetric based irrigation charges are implemented at the main canal level (where water can be measured). ? At the farm level, irrigation charges are mostly based on area irrigated or in some cases based on time period to irrigate a filed, or in few cases based on a number of members in a household. ? In Ningxia province, three part irrigation charging system is in practice: (1) first part is volumetric water price measured at outlets of the main or branch canals and is set at a level that is supposed to cover the variable costs associated with the supply of water (including staff salaries and operation and maintenance of main and branch canals) – and since 2000, this is set equal to 0.012 yuan/m^3; (2) second part consists of local water maintenance and management fee set at 6 Yuan/mu (which cannot exceed 90 Yuan/ha) [1 ha=15 mu] ; and (3) third part is labor discounted fee (used for irrigation districts maintenance

	work) set at 4 Yuan. ? Amount collected on volumetric basis (first part) is deposited to the irrigation district's government and is used for O&M of main canals and staff salaries. Of the amount collected through local maintenance and management fee (second part), 40 percent goes to County Water Resources Bureau, and 60 percent to Township Water Resources Bureau, and is used for facility maintenance and staff salaries at these levels. ? In Ningxia, fee collection procedures vary across villages: farmers to village collectives (or water user associations where they exist or contractors) to township governments and then to irrigation district government. In some cases, water user associations and contractors collect fee from farmers and directly deposit to irrigation districts. ? On the other hand, irrigation charges in Henan province are based on cropped area: Paddy areas – 22 Yuan/mu; dry and gravity irrigation areas – 12 Yuan/mu; and lift irrigation areas – 7 Yuan/mu. ? Irrigation charges are differentiated by location. Water charges are generally higher in upper reaches of the systems (where share of rice area is higher) than in the lower reaches. Since water charge for rice is higher than that for dry crops, overall water charges are higher in the upstream areas. ? In the studied systems in Ningxia and Henan, water charge collection rate is over 80 percent. Collection rate is higher where private contractors and WUAs are operating at the local level, as they tend to cut deliveries in case of non-payment of charges. ? Irrigation charges appear to be related to cost of O&M, and overall cost of supplying water, and relative water scarcity. Irrigation charges in Ningxia (located upstream of YRB, with more water supplies, and relatively less cost of supplying water) are lower than in Henan province. ? In the systems, where water management reforms are being implemented through formation of WUAs or by bringing private contractors/managers, performance of systems is generally better. ? Overall irrigation charging methods are fairly decentralized in the studied systems.

Each of the irrigation charging methods described earlier has its own set of strengths and limitations. Some of the identified strengths and limitations of charging methods in the studied systems are outlined in Table 3. As is clear from the table, crop-based charging in the South Asian systems have few strengths with many limitations. Output-based charging in Vietnam, and two part-charging in China, through relatively better than crop based charging, also have their own limitations.

Table 3: Strengths and Limitations of Alternate Water Charging Methods

	Method -1 Cropped/cultivated area based irrigation charges – differentiated by crop type and cropping season [**South Asia**]	**Method – 2** Cropped area-cum-output based irrigation charges – differentiated by crop type and cropping season [**Vietnam**]	**Method -3** Multiple Criteria based irrigation charges – crop area, productivity, location, level of service, farmers' capacity to pay [**Indonesia – transferred systems**]	**Method – 4** Two/multi-part charging system Part 1 – Volumetric based irrigation charges – based on per cubic meter at the main canal level Part 2 – Crop/cultivated area based charges at lower levels [**China**]
Strengths				
1. Irrigation charges are differentiated by type of crop grown, higher water charges for high water consuming crops	+	+	+	+
2. Irrigation charges can be differentiated by season, with higher charges in dry season	+	+	+	+
3.Transaction cost of seasonal irrigation charge assessment and collection is lower in transferred systems where these responsibilities are entrusted to WUAs	+	+	+	+
4. The charging method is only partially flexible		+		
5. The charging method is fairly flexible (in transferred systems)			+	
6. The charging method only partially accounts for farmers capacity to pay		+		
7. The charging method fully accounts for farmers capacity to pay			+	
8. Implicitly, irrigation charges are not uniform across systems. It accounts for locational differences in productivity that may be due to differences in locational availability and access to		+	+	+

water				
9. Irrigation charges reflect benefits derived from water use		+	+	+
10.Seasonal assessment of crop areas and productivity can be made based on last five year average of crop outputs		+		
11.Administrative cost of irrigation charge assessment and collection is low in the transferred systems			+	
12. The charging method helps generate funds for management and maintenance of systems at primary level as well as at secondary level				+
13. The charging method can facilitate development of markets for canal water, canal water wholesaling at the main canal level				+
14. The charging method encourages local level authorities/ organizations to save water, given the incentives to managers or contractors				+
15. Easy in implementation, and cost of monitoring and administration is low	+			
Limitations (-)				
Transaction cost of seasonal assessment of areas cultivated/cropped and of irrigation charge collection is generally high.	-			
The charging method is complex as it requires seasonal assessments and large amount of record keeping.	-			
It is easily subject to abuse through underestimation of areas cropped, and	-			

mis-recoding of the crop type.				
It penalizes farmers who supplement surface supplies with groundwater as in Pakistan.	-			
Variations in canal water allocations are generally not reflected in charging structure.	-			
Irrigation charges are administratively set, generally at low level, which do not reflect value of water or the cost of supplying water.	-			
Irrigation charges are uniform across locations (head, middle and tail), charges are levied irrespective of level of service provided.	-			
The charging method does not account for locational differences in productivity that may be due to locational inequity in water distribution.	-			
The charging method does not account for farm or landholding size or socio-economic groups, which may have strong equity implications.	-			
Irrigation charges are not linked to amount of water supplied or quality of water, and do not provide any incentive for efficiency in water use.	-			

Irrigation charges are not linked to farm income, productivity level, or O&M costs.	-			
Irrigation charge does not induce efficient use	-	-	-	
The charging method does not account for farm or landholding size or socio-economic groups, which may have strong equity implications.	-	-		
Irrigation charges are not linked to amount of water supplied or quality of water, and do not provide any incentives for efficiency in water use.	-	-		
Administrative cost of water charge assessment and collection is high in non-transferred agency managed systems	-		-	
Volumetric based irrigation charges can be implemented only where water measurements can be easily done				-

As shown in Table 1 and further discussed in Table 2, in the South Asian systems studied, the level of irrigation charge varies from US$4.6/ha to US$22/ha. While the charge level is the highest in Bangladeshi systems, collection rate is very low (5-15 percent). Irrigation charges in the Indian systems have recently been increased to US$ 10/ha (which constitute 1.6 to 4.3 percent of gross value of product), with collection rate varying significantly across systems from 21 percent to 81 percent. In Pakistani systems, irrigation charges vary from US$4.6/ha to US$10.6/ha (constituting 1.7 to 3.9 percent of gross value of product), and overall collection rate is higher (80-99 percent) than that in Bangladeshi and Indian systems. In Indonesia, irrigation charges vary from US$1/ha to US$20/ha, and collection rate is fairly high, especially in the transferred systems. On the other hand, irrigation charges in China and Vietnam are much higher than those in Indonesia and South Asian systems. In China, irrigation charges vary from US$26 to US$67/ha (1.8 to 5.2 percent of gross value of product), with average collection rate of 80 percent. Similarly in Vietnam, where irrigation is charged based on crop output, the charge level is fairly high at US$58 to US$61/ha, (constituting 4.6 and 6.3 percent of gross value of product), and overall collection rate is also high (85 to 99 percent).

Irrigation Charging, Irrigation Performance and Poverty

In this section, we examine how the level of irrigation charge is linked to irrigation performance and poverty. Further, we demonstrate with empirical evidence on how charging structure matters under conditions of inequitable land and water distribution. We first look at the reasons on why irrigation charges are kept at low levels (particularly in the South Asian countries) and then analyze their implications for system performance and poverty.

Irrigation Charge Level

Quite often four reasons are put forward as justifications for keeping irrigation charges at low level. These are:

a) *affordability and willingness to pay* – in the South Asian systems where there is relatively higher incidence of poverty and food insecurity, it is often assumed that most small and poor farmers cannot afford to pay for irrigation, therefore, charges should be set at low levels;

b) *political sensitivity* – raising irrigation charges is generally considered to be politically difficult;

c) *positive externalities of irrigation impacts* – it is generally perceived that large part of benefits of irrigation are enjoyed by the society as a whole, therefore, consumers (in addition to producers) of agricultural produce should also contribute or in other words, sector should continue receiving public sector subsidies, and finally

d) *public good nature of irrigation water* – that is, irrigation water is viewed as public good, implying that the public sector should have greater role in provision of irrigation, including in financing for irrigation. These concerns continue to dominate perceptions of those who support low irrigation charges.

On the other hand, low charges are often criticized on the argument that they tend to create financial dependence of the sector and have negative influence on irrigation system performance. The following points summarize the major grounds and the basic reasons on why and how low charge level adversely affects irrigation performance and service delivery and how it could be disadvantageous to the poor. Low irrigation service charges leads to:

a) *Inadequate funding and neglect of maintenance*: when irrigation charger are low, revenue and funds available for irrigation management are low, and the sector have to depend on financial allocations from the public sector which are often inadequate to carry out necessary operations, maintenance and management. Consequently maintenance is neglected, infrastructure condition deteriorates, and overall availability and access to water is reduced;

b) *Lack of incentives to improve on service delivery*: Managers and service providers, receiving large part of funds from central agencies/treasury, have little or no incentives to spend funds efficiently, and deliver high quality services; users paying low charges feel they have little entitlement, and there are little incentives for them to demand for improvements in service delivery; and accountability linkages in terms of spending and service delivery between managers/ service providers and users remain weak. As a result, irrigation service delivery continues to be poor and system performance in terms of water use efficiency and productivity remains low. In turn, poor irrigation performance reduces access to water, particularly of the poor farmers and those having locational disadvantages, with adverse impacts on their livelihoods. In other words, poor service delivery and low irrigation charge create vicious circle of poor irrigation performance, and reduces anti-poverty impacts of irrigation (see World Bank (1999), Hussain and Biltonen, 2002 for details)

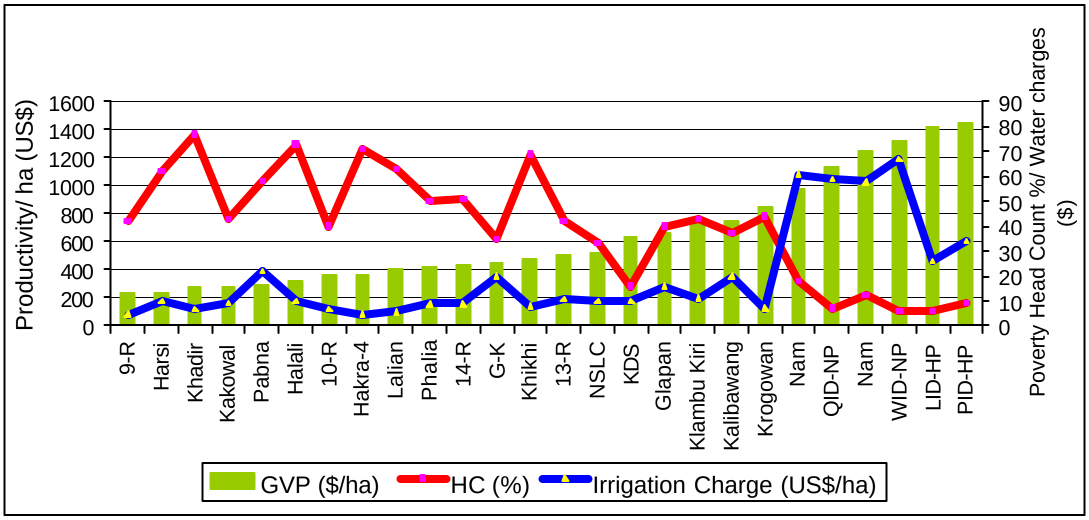
c) *Lack of incentives to use water efficiently*: When irrigation charges are low, there are no incentives for users to use water efficiently and avoid wasteful use of water, resulting in reduced overall availability and access to water. Those having locational advantage tend to grab more than their due share (especially in settings where water rights are not clearly defined and/or effectively enforced), not only they use it in unsustainable manner, they deprive others, particularly the poor and the weaker. On the contrary, where irrigation charges are high, farmers use water carefully and benefit from each drop of water. For example, in most Chinese systems, irrigation charge is fairly high, and at the farm level water is used relatively effectively and the productivity per drop of water is also high.

d) *Low charge policy worsens income disparity*: In settings where there is greater inequity in distribution of land and water (as in most South Asian systems), low charge policy applied uniformly to all socio-economic groups worsens income and resource disparity between the poor and the non-poor as large part of the benefits of subsidise to the sector goes to large landholders.

e) *Other aspects*: Low charge policy and financial dependence on public sector agencies may also affect collection and spending efficiencies. It should be noted that, for irrigation charge policy, not only the level of irrigation charge is important, the structure of charge, and the collection and spending mechanisms and associated institutional arrangements are also equally important.

We examine here whether some of the reasons outlined above are supported with field level data and information. As shown in Figure 1, in those systems where irrigation charges are low, overall performance of the systems in terms of productivity per ha and water use efficiency is also low. For example, water use efficiency (defined as the ratio of crop water requirements and total inflow into the canal system) in Pakistani systems varies from as low as 28 percent to 71 percent. In general, in the low performing systems where agricultural productivity is low, the incidence of poverty is high. On the other hand, where systems are well managed and overall performance is high, the incidence of poverty is also low. Of course, poverty is an outcome of many complex factors, but agricultural productivity is one of the key determinants of poverty, particularly so in those settings where households and communities depend for their livelihoods mainly on agriculture. Low level of irrigation charges, leads to overall poor system performance, and reduces the anti-poverty impacts of irrigation.

Figure 1. Productivity/ha, Poverty (%) and irrigation Charge (US$/ha)



Further, we quantify the relationships of irrigation charge level, irrigation performance, and poverty, through econometric estimations. We model irrigation performance and poverty in the following equations, where irrigation charge level is linked to poverty indirectly through its impacts on system performance which is one of the key parameters in poverty equation. In equation 1, performance of irrigation systems is modeled as a function of management type and irrigation charge level. In equation 2, poverty headcount is modeled as a function of irrigation performance, share of non-crop income in household's total income, land distribution structure and family size. The results of the estimated equations are presented below.

$$PERF = \underset{(4.08)}{303.94} + \underset{(1.96)}{217.26}\, MGT + \underset{(4.17)}{12.01}\, CHRG \qquad (1)$$

[n = 26, def = 23, and $R^2 = 0.62$]

$$POVI = \underset{(3.57)}{81.94} - \underset{(-2.24)}{0.0196}\, PERF - \underset{(-3.071)}{0.49}\, SNCI - \underset{(-1.84)}{5.36}\, LDIST + \underset{(2.03)}{3.72}\, FSIZE \qquad (2)$$

[n = 26, def = 21, and $R^2 = 0.94$]

where PERF = performance of irrigation is defined in terms of gross value of product per hectare [$/ha];
MGT = management type dummy [0= agency management and 1 = transferred/participatory management] ;
CHRG = level of water charges [$/ha]
POVI = poverty headcount Index (income based) [%]
PERFe = estimated value of productivity in equation (1) [$/ha]
SNCI = average share of non-crop income in total income [%]
LDIST = land distribution index (index varies from 1 to 6, with 1 indicating skewed land distribution and 6 indicating fairly equitable distribution)
FSIZE = average family size [number].

Figures in parenthesis are t-values. The estimated coefficients indicate the significance of variables affecting performance and poverty. The coefficients of all the specified variables carry expected signs, and are significant. Management type and level of irrigation charges are significant positive determinants of irrigation system performance, indicating that performance of the systems is better where institutional arrangements are decentralized for participatory irrigation management and where irrigation charges are higher compared to those systems which are agency managed and where irrigation charges are low. Impact of irrigation charge level on performance is even greater than that of management type. Performance, in turn, as expected, is a significant negative determinant of poverty i.e. poverty incidence is low in systems with better performance and vice versa. Negative and significant coefficients of household non-crop income share and land distribution variable, and positive significant coefficient of family size indicate that these variables influence poverty in a significant way. The implication of the above analysis is that irrigation service charge level influences system performance, which in turn, adversely affects the poor and overall poverty in the systems[3].

[3] We also modeled irrigation performance, management type, irrigation charge and poverty relationships (a) in a Recursive modeling framework using estimated values of system performance variable (from equation 1 into equation

However, the magnitude of adverse impacts on poverty varies depending on the distribution structure of land and water resources. In those settings, where there is relatively greater inequity in land and water (as in the South Asian systems), low irrigation charges and lower than required operation and maintenance (O&M) of the systems and the resulting poor performance of the systems greatly affect the poor small farmers. Under these settings, not only the level of irrigation charges is important, the structure of irrigation charges has strong implications for revenue generation and income distribution.

Irrigation Charging Structure

Further, we provide an empirical evidence on the implications of charging structure for the poor for systems characterized by high inequities in land and water distribution using data from Pakistani systems. The analysis here is based on data collected through household level surveys from 891 farm households from 10 distributaries in four large surface irrigation systems in the upper Indus basin (namely, Upper Jehlum Canal, Lower Jehlum Canal, Lower Chenab Canal and Hakra systems). The survey covers the period 2001-2002 agricultural year.

As shown in Table 4, average cropping intensity varies significantly across farm size categories, with highest cropping intensity of 181 percent on smallest farm size category and lowest cropping intensity of 115 percent on largest farm size category. Overall, average cropping intensity for all farm size categories is 148 percent, and it varies inversely with farm size categories. There are only marginal differences in average cropping intensities across poor and non-poor groups in aggregate terms. However, disaggregated analysis shows that average cropping intensities for the poor small farmers are relatively less than that of non-poor small farmers. Also, note that

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3 below), and (b) in a single equation using irrigation charge variable directly into poverty equation (equation 4) but excluding performance variable as performance and charge level are highly coordinated (as shown in equation 1). The estimation results are presented in equations 3 and 4. All estimated coefficients carry expected signs and almost all are significant. The general conclusion from all the four estimated equations is that irrigation charge has positive relationship with performance and negative relationship with poverty.

$$POVI = \underset{(3.29)}{85.11} - \underset{(-1.01)}{0.0097\,PERFe} - \underset{(-2.49)}{0.47\,SNCI} - \underset{(-2.88)}{8.25\,LDIST} + \underset{(1.78)}{3.63\,FSIZE} \quad \ldots\ldots(3)$$

[n = 26, def = 21, and $R^2 = 0.85$]

$$POVI = \underset{(3.29)}{76.96} - \underset{(-1.01)}{0.21\,CHARGE} - \underset{(-2.49)}{0.42\,SNCI} - \underset{(-2.88)}{7.69\,LDIST} + \underset{(1.78)}{3.78\,FSIZE} \quad \ldots\ldots(4)$$

[n = 26, def = 21, and $R^2 = 0.93$]

where PERF = performance of irrigation defined in terms of gross value of product per hectare [$/ha];
MGT = management type dummy [0= agency management and 1 = transferred/participatory management] ;
CHRG = level of water charges [$/ha]
POVI = poverty headcount Index (income based) [%]
PERFe = estimated value of productivity in equation (1) [$/ha]
SNCI = average share of non-crop income in total income [%]
LDIST = land distribution index (index varies from 1 to 6, with 1 indicating skewed land distribution and 6 indicating fairly equitable distribution)
FSIZE = average family size [number].

landholdings size and poverty are inversely related, and the probability of small farmers of being poor is significantly high compared to that for large landholders.

Table 4: Cropping Intensity, Water Charges for canal Water and Groundwater, and GVP by landholding size and for Poor and Non-poor Farmers

Land size Category	Cropping intensity (%)	Average cost of canal water irrigation/ha /year (charge/ abiana) (Rs.)	Average cost of groundwater irrigation/ha/ year (Rs.)	Total cost of irrigation/ha/ Year (Rs.)	GVP/ha/ year (Rs.)	Annual canal water cost as % of GVP	Annual ground water cost as % of GVP	Ratio of Groundwater cost to canal water cost
< 1 ha	181	440	4555	4995	19262	3.32	30.1	10.35
1.1 to <3 ha	156	439	4038	4477	21552	2.63	22.0	9.21
3.1 to <5 ha	148	432	3549	3980	22156	2.41	17.9	8.22
5.1to < 10 ha	133	385	3209	3594	22198	2.25	16.5	8.34
10 ha and above	115	367	2779	3146	25013	2.18	15.3	7.58
All	**148**	**420**	**3707**	**4127**	**21909**	**2.53**	**20.2**	**8.83**
Poor	145	404	3748	4152	19802	2.63	22.1	9.28
Non-Poor	152	439	3657	4096	24485	2.41	17.8	8.33

Source: Based on filed level primary data, 2001-2002

Notes:

1. Farm cropping intensity is calculated as: (cropped area of $farm_j$ /total cultivated area of $farm_j$)
2. Annual canal water charge per hectare is calculated as :sum(crop area of $crop_i$ on $farm_j$*charge for $crop_i$ on $farm_j$)/total cropped area of $farm_j$.))
3. GVP is gross value of product per hectare calculated as: sum (crop area of $crop_i$ on $farm_j$*Yield of $crop_i$ on $farm_j$ *Price of $crop_i$ on $farm_j$) /total cropped area of $farm_j$.)
4. Poor are defined as those whose income is below national poverty line of Rupees 730/capita per month.

Average annual irrigation charge per ha (area weighted) is Rs. 420/ha. Average per ha irrigation charge is inversely related to land size categories; landholders between 1 to 5 ha pay significantly more than the overall average, and those with greater than 10 ha pay less than the overall average. This is due to differences in cropping intensities, as cropping intensities are higher on smaller size farms (why?). As mentioned earlier, smaller size farms, constrained by the size of land tend to use their plots more intensively, making greater use of available family labor (and other inputs), and, importantly, they make greater use of groundwater. As shown in column 4 of Table 4, average groundwater cost per ha is inversely related to farm size categories, with smaller size farms using more groundwater and incurring higher costs and vice versa. Since under the present irrigation charging method, crop area that is partially irrigated with canal water and partially with groundwater, is fully liable for canal irrigation charges, small farmers are penalized for relatively greater use of groundwater. On average, poor farmers incur Rs. 56 more in annual total per ha cost of irrigation than the non-poor. Overall, cropping intensity based irrigation charging is pro-large landholders, and it dis-favors small farmers and those poor farmers who make greater use of groundwater to increase their cropping intensities.

Despite recent increases in irrigation charges, the overall charge level in Pakistani systems remains low, constituting only 2.5 percent of GVP. As indicated earlier, such low charges are often defended for considerations such as food security, poverty, and farmers financial capacity to pay. As is clear from data in Table 4, poor small farmers incur significantly higher cost per ha through greater use of groundwater, which is around 9 times more expensive than the canal water. Average groundwater cost per ha constitutes over 20 percent of GVP per ha (compared to only 2.5 percent for canal water), and groundwater cost as a proportion of GVP per ha decreases with increase in size of landholdings. The above analysis suggests that the major beneficiaries of the present charging system, both structure and the level, are large landholders and the non-poor.

We present here three policy options and analyze their implications for revenue generation/cost recovery and income distribution. The analysis here is based on filed level primary data. Our sample is 891 households with total land area of 4172 ha. Average landholding size is 4.68 ha/household, with average size varying from 0.61 ha for the smallest land size group to over 17 ha for the largest land size group. Similarly, average land size of the poor farmers is smaller (at around 2 ha) than that of the non-poor farmers. Land distribution is highly inequitable. Around 71 percent of farm households own around 35 percent of total land, and 29 percent own 65 percent of total land area[4]. In developing the policy options, we assume the following conditions will hold in the medium to long term:

1. canal water allocation will continue to be based on current method of physical rationing, rather than through market forces [it can be argued that in water short environments as in Pakistan, physical rationing achieved through say warabandi system may be as effective as price based allocation, because " all farmers are water short, they experience directly the true value of their water ration and strive to save every drop and maximize productivity" (Perry 2001)]
2. canal systems will continue to operate as supply based systems, as it will be very costly to convert them into demand based systems (due to institutional and infrastructure constraints, such as cost of installing meters for water measurements, and cost of monitoring).
3. it may be difficult for authorities to adopt opportunity cost based pricing or marginal social cost based pricing due to lack of data and information especially on un-priced adverse and beneficial effects of water supply/use, and inherent difficulties in estimating such costs.
4. social objectives such as food self-sufficiency, food security, and poverty concerns will continue to be among dominating considerations in setting irrigation water charges; major increases in water charges may not be politically feasible.
5. however, given the pressure on public funds, and the urgent need to improve O&M of most systems, small to moderate increase in irrigation charges, that is sufficient to cover O&M, may be politically feasible.
6. small to moderate increase in irrigation charges might not influence farmers' cropping decisions (so as to affect present GVP/ha) but may result in some efficiency gains in water supplies due to improved O&M with availability of increased financial resources.

[4] Land distribution in lower Punjab and other provinces is even more inequitable compared to the situation in our study area. For Pakistan as a whole, as per official statistics, 81 percent of farm households own less than 39 percent to total farm land and 19 percent own over 61 percent of total farm land in the country.

7. also, small to moderate increase in irrigation charges, that is just sufficient for reasonable O&M, will not significantly influence cost of production or profitability of farming, or farmers ability to pay.

Policy Options

Option -1: Present policy – no change in the structure and level of irrigation charges; charges are based on cropped areas and cropping intensities;

Option – 2: Flat rate per unit of land based on land size, independent of crop type and cropping intensities, applied uniformly across all farm size categories; and

Option – 3: Differential rate per unit of land based on land size, applied differentially across various farm size categories – progressive rate structure (similar to increasing block rate charging in the domestic water supply sector). Lower irrigation charge for the first two hectares, applied uniformly to all land size categories, and charge increases progressively with increase in size of holdings above 2 hectares, by Rs. 50 per ha for each successive category of land size, as shown in the following equations and Figure 2:

BL1 = *(R1*L1)* where L1 = 2ha, and R1 = Rs. 350 (basic rate)
BL2 = *(R1*L1)+(R2*L2)* where L1+L2 = 3ha; L1=2 ha; and L2= 1 and R2=Rs. 400
BL3 = *(R1*L1)+(R2*L2)+(R3*L3)* where L1+L2+L3 = 5 ha and L1=2 ha and L2=1ha and L3=2ha, and R3=Rs. 450
BL4 = *(R1*L1)+(R2*L2)+(R3*L3)+(R4*L4)* where L1+L2+L3+L4 = 10, and L1=2 ha and L2=1ha and L3 =2 ha and L4 = 5; and R4=500

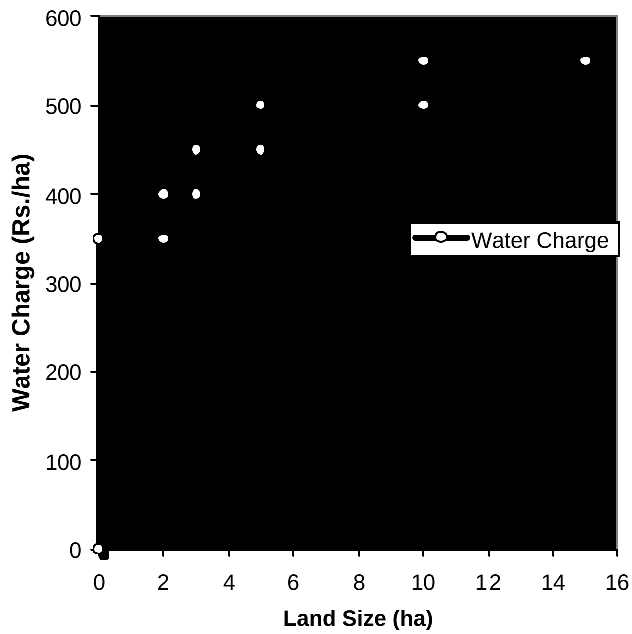
BL5 = *(R1*L1)+(R2*L2)+(R3*L3)+(R4*L4)+(R5*L5)* where L1+L2+L3+L4+L5 >10, and L1=2 ha; L2=1ha; L3 =2 ha; L4 = 5 and R5=Rs. 550

BL_i is a seasonal bill for water user category i; L_i is land size category (as in column 1 of table 4); R_i is watercharge/rate in Rupees, and i = 1 to 5.

What is the reasonable O&M cost per ha. There is no precise answer to this question. O&M costs vary across space and time, and depend on a number of factors including condition of infrastructure, efficiency in management, and local costs of inputs. Actual, minimum and desired O&M costs may differ significantly. We assume that under efficient O&M regime (i.e. under autonomous decentralized financial arrangements), the current level of irrigation charges, which is roughly US$7/ha, is more or less adequate to carry out minimum O&M assuming 100 percent collection rate. [Note: Hassan and Khatri (1998) estimated annual average per ha O&M cost for Pakistani Punjab for 1997-98, where culturalable command area of province is 8.429 million ha and total O&M budget demand is Rs. 2336.35 million, at Rs. 277.17. By adjusting these figures to 2001-2002, using upper bound estimate of 11 percent increase in costs per year, total O&M

budget demand would be roughly Rs. 3547 million or Rs. 420.8/ha[5] (or US$7/ha), which is equal to current level of charges. In India, actual average annual O&M expenditure per ha in Andhra Pradesh was US$5 in 2001, which was increased from US$2/ha prior to 2001]. Similarly, in four irrigation systems in Java in Indonesia, average O&M expenditure varies from US$4.5/ha to US$16.5/ha].

Figure 2 Differential Rate Charging Based on Landholdings



As discussed earlier, under the present policy (option – 1), average irrigation charge per ha is Rs. 420, and small farmers (first three landholding categories in Table 5) pay more on per ha basis compared to large landholders. With 100 percent collection rate, total revenue (from 4172 ha) is Rs. 1.632 million. Under policy option – 2, i.e. flat rate charge based on size of landholdings using current average rate of Rs. 420 per ha, total revenue would increase to Rs. 1.752 million. However, total payment by small farmers will decrease by Rs. 19952 or by Rs. 31.7 per farm household or by Rs.13.5/ha. On the other hand, total payment by large landholders (next two categories) would increase by Rs. 140082 or by Rs. 536.7 per farm household or by Rs. 51.5 per ha. On average, per ha irrigation charge would be 3.3 percent of GVP per ha. Option- 2 is better than option 1 both from revenue and equity perspectives, but it may not be pro-poor (as average charge per ha for poor farmers will increase from Rs. 404/ha under option – 1 to Rs. 420/ha under option – 2). Under option – 3, total revenue will further increase by Rs. 134054 to Rs. 1.766 million. Total payment by small farmers would decrease by Rs. 93053 or by Rs. 147.7 per farm household or by Rs. 64/ha. On the other hand, total payment by large landholders would increase by Rs. 227108 or by Rs. 870.1 per farm household or by Rs. 83.5 per ha). Overall, average

[5] These figures are adjusted using roughly 11 percent increase in costs per year.

charge per ha would be lower at Rs. 384, which would be 3.0 percent of present level of GVP per ha. Clearly, option – 3 is better than option – 1 and option – 2 from both revenue and equity perspectives. Option – 3 is pro-poor, as per ha water charge for the poor would be less than that for the non-poor, and would be significantly less than that in option -1 and option -2 (see last two rows in Table 5).

Implications at the Province and Country Level

What are the revenue and equity implications of the above figures at the province and country levels. Table 6 provides basic data on number and area of smaller and larger size farms for Punjab province and for Pakistan as a whole, and implications of three policy options for total revenues and income increases or transfers across farm size categories. In Punjab province, policy option – 2 (flat rate charge at present level of average water rate) would result in annual gains for small farmers through reduced costs by Rs. 74.45 million, and cost to larger farmers would increase by Rs. 326.77 million, and total revenues will increase by 5.3 percent. Policy option – 2 is better than policy option – 1 in terms of equity and revenues. Under policy option – 3, smaller farmers, as a result of reduced costs, would gain annually by Rs. 346.88 million, and larger farmers would contribute more towards costs by Rs. 529.76 million, and overall revenue would increase significantly by 21.8 percent. With policy option – 3, Rs. 876 million would be re-distributed with significant amount in favor of small and poor landholders in Punjab.

For country as a whole, policy option – 2 would result in annual gains for small farmers through reduced costs by Rs. 130.06 million, and cost to larger farmers would increase by Rs. 605.97 million, and annual total revenues will increase by 5.6 percent. Under policy option – 3, smaller farmers, as a result of reduced costs, would gain by Rs. 519.65 million, and larger farmers would contribute more towards costs by Rs. 842.45 million, and overall revenue would increase significantly by 22.7 percent. With policy option – 3, over Rs. 1362 million would be re-distributed largely in favor of small and poor landholders in Pakistan. The findings suggest that the existing irrigation charging policy in Pakistan favors larger landholders, and disfavors small and poor farmers. Policy options 2, and particularly 3 would result in annual redistribution of significant amount of funds in favor of small and the poor landholders.

Table 5: Implications of Alternate Policy Water Charging Policy for Various Land Size Categories and for the Poor and Non-poor.

						Policy Option -1 (Present Policy – crop based charge)			**Policy Option-2 (Flat Rate based on Land Size)**			**Policy Option -3 (Differential Rate based on Land Size)**		
Land Category	Average land size (ha)	GVP/ ha /year Rs.)	Cropping Intensity/year (%)	No. of farms	Total Land	Canal water charge/ha /year (Rs.)	Total revenue (Rs.)	Water charge as percent of GVP	Canal water charge/ha /year (Rs.)	Total revenue (Rs.)	Water charge as percent of GVP	Average Canal water charge/ha /year (Rs.)	Total revenue (Rs.)	Water charge as percent of GVP
	3	1	2	4	5=4*3	7=6*2	8=5*7	9=7/1	10	11=10*5	12=10/1			
<1 ha	0.61	19262	181	97	59	440	25270	3.3	420	24809	3.7	350	20675	3.1
1.1 to <3 ha	1.98	21552	156	351	696	439	302913	2.6	420	292215	3.2	355	247805	2.7
3.1 to <5 ha	3.83	22156	148	182	698	432	301878	2.4	420	293093	3.1	383	268528	2.9
5.1 to <10 ha	6.74	22198	133	168	1132	385	428589	2.2	420	475566	3.3	423	482150	3.3
10 ha and above	17.06	25013	115	93	1587	367	573338	2.2	420	666443	3.5	465	746885	3.8
All	**4.68**	**21909**	**148**	**891**	**4172**	**420**	**1631988**	**2.5**	**420**	**1752127**	**3.3**	**384**	**1766042**	**3.0**
Poor	3.86	51026	145	490	1893	404	705942	2.6	420	794951	3.5	379	779485	3.2
Non-Poor	5.68	111499	152	401	2279	439	926046	2.4	420	957176	3.1	391	986557	2.8

Source: based on primary data 2001-2002.

Table 6: Implications of Alternate Policy Options for Small and Large Landholders at Province and Country Level, Pakistan.

Punjab	**Basic data**		
Total number of farms up to 5 ha (Million), smaller farms	2.35		
Total number of farms above 5 ha (Million), larger farmers	0.61		
Total number of farms - all (Million)	2.96		
Total area of farms up to 5 ha (Million ha)	4.36		
Total area of farms above 5 ha (Million ha)	6.61		
Total area of farms –All (Million ha)	10.97		
Policy Implications	**Policy Option -1**	**Policy Option- 2**	**Policy Option -3**
Total revenue from smaller farms (Rs. Million)	1902.36	1832.81	1824.24
Total revenue from larger farms (Rs. Million)	2471.94	2774.67	3501.82
Total revenue from all farms (Rs. Million)	4374.3	4607.48	5326.06
Increase in smaller farmers income in Rs. Million (reduced total payments) with option -1 as base	-	74.45	346.88
Increase in large farmers contribution to costs in Rs. Million (increased total payments) with option -1 as base	-	326.77	529.76
Pakistan	**Basic Data**		
Total number of farms up to 5 ha (Million), smaller farms	4.10		
Total number of farms above 5 ha (Million), larger farms	0.97		
Total number of farms - all (Million)	5.07		
Total area of farms up to 5 ha (Million ha)	7.43		
Total area of farms above 5 ha (Million ha)	11.72		
Total area of farms –All (Million ha)	19.15		
Policy Implications	**Policy Option -1**	**Policy Option- 2**	**Policy Option -3**
Total revenue from smaller farms (Rs. Million)	3240.87	3122.09	3103.72
Total revenue from larger farms (Rs. Million)	4374.22	4920.76	6237.13
Total revenue from all farms (Rs. Million)	7615.09	8042.85	9340.85
Increase in smaller farmers income in Rs. Million (reduced total payments) with option -1 as base	-	130.06	519.65
Increase in large farmers contribution to costs in Rs. Million (increased total payments) with option -1 as base	-	605.97	842.45

Source: calculations based on landholdings data from Agricultural Statistics of Pakistan, Ministry of Food, Agriculture and Livestock, Islamabad (2000-2001), and figures from analysis in the paper.

Discussion

The main points from the discussions and analyses earlier sections can be summarized as follows: (a) in the Chinese and Vietnamese systems studied, land and water distribution is relatively equitable. Irrigation charges are directly or indirectly linked to irrigation service delivery/ water supplies. In these systems, irrigation charges, regardless of whether based on size of landholdings or cropping intensities, tends to be relatively equitable. What is important for these systems is to increase the charge to the level where it reflects cost of supplying water and /or benefits derived from water use and to further improve on collection efficiency; (b) in Indonesia, landholdings are generally of smaller sizes, and there is element of inequity in distribution of both land and water. Under multiple criteria based charging method (as in the transferred systems) structure of charging is such that charges are linked to water supplied/used, and it accounts for poverty concerns. Here too, what is needed is to increase the level of irrigation charges and overall collection efficiency for improved cost recovery; (c) in the South Asian systems, land and water distribution across farms tends to be fairly inequitable, and charge is not linked to irrigation service or amount of water supplied, and overall charge level is very low. In such systems, not only the level of charge needs to be increased, the structure of charging also needs to be improved for improving cost recovery in more equitable and pro-poor ways; (d) irrigation charging methods in Vietnam and China are relatively better as they account for locational differences in service delivery /water supplies, and to some extent reflect cost of supplying water. On the other hand, while present charging methods in South Asian systems are easy to administer, they lack transparency and are often inequitable and biased against the poor small farmers; and (e) quantitative analysis suggests that irrigation charge level affects system performance, which in turn, influences poverty in the systems, that is low irrigation charges indirectly dis-benefit the poor. Detailed analysis of charging structure for Pakistani systems demonstrates that under conditions of inequitable land and water distribution, inappropriate charging structure may also directly dis-benefit the poor.

For systems as in Pakistan, the study offers two options: flat rate or differential rate charging based on size of land holdings. While both options would result in improved cost recovery, flat rate[6] [which is relatively straight forward and easy to administer] would be equitable and

[6] On 10 June 2003, the Punjab government has taken a historic decision to change canal irrigation charging policy from crop area-cum-crop type based charging to crop area based flat rate charging. Under crop area-cum-crop type based system, irrigation charges were levied based on area cropped and differentiated by crop type, crop condition and crop season. Charges were generally higher for high water consuming crops such as rice, and low for less water consuming crops such as wheat (for example, per hectare crop based irrigation charges prior to June 10 were Rs. 37 for fodder, Rs. 148 for wheat, Rs. 222 for cotton, Rs. 297 for rice, Rs 432 for sugarcane). Under the new flat rate system, per hectare irrigation charges are to be fixed for Rabi and for Kharif seasons regardless of the type of crops grown in each season (new rate per hectare are Rs 124 for Rabi and Rs. 210 for Kharif crops, regardless of the type of crops grown). Several factors have led to this change. These include: (a) the crop based charging system was considered obsolete and not in line with changing water and irrigated agriculture situation; (b) it was thought to be often manipulated by the influential farmers and revenue officials (such as mis-reporting and mis-recording of crop types and crop areas, e.g. charging for fodder rates when high water rate crops such as rice or sugarcane were cultivated); (c) as the water charge assessment was based on the discretion of the revenue officials, it is generally perceived that it has lead to creating an environment for rent seeking behavior; (d) crop based charges were considered advantageous to large farmers and disadvantageous to small farmers that constitute majority in the farming community; and (e) old system has lead to increased pressure on public funds resulting from widening gap between irrigation expenditures and

differential rate would be pro-poor. The suggested differential rate method (which is also straightforward to administer and has an advantage of having a pro-poor dimension) is similar to increasing block rate charging for domestic water supplies and electricity. In the domestic water supply sector, where water can be measured, increasing block rate charging is applied partly because of equity and poverty concerns where low charge is applied to certain basic amount of water, that is, for basic needs for low volume consumers, and charge is increased progressively for high-volume consumers (i.e. generally the rich consumers using water for luxurious purposes such as for swimming pools etc). In the irrigation sector, where water measurement at the field level is difficult (due to technological/administration/cost constraints), charge can still be linked to water supplies based on landholding size (as land and water are coupled in South Asian systems). Policy change towards suggested flat rate or differential rate would result in significant increase in revenue generation/cost recovery and improved benefits to the poor; and it is something that is doable. Either of the suggested options 2 or 3 are feasible, and could be implemented with existing institutional arrangements in place, and as such do not involve any costs. Land ownership records available at the revenue department and at the water user association level could be used for levying charges. Importantly, electronic data base/ computerization of land records is presently underway in Pakistan, that could further facilitate implementation of the suggested policy interventions. Major benefits with such a policy change would include:(1) more funds available for O&M, that can be expected to result in improved O&M leading to increased efficiency in irrigation supply and improved system productivity; (2) benefits in terms of reduced costs to small and poor landholders; and more importantly, it would be a step forward to reversing existing inequities not only in irrigation charging but in overall benefits of investments in irrigation.

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revenue collection [e.g. in recent years total revenue collected through irrigation charges in the Punjab province accounted for 31.4 percent or Rs.1.6 billion of the total expenditures of Rs. 5.1 billion. Also, the estimates suggest that the Punjab government has been spending three rupees for every one rupee of water charge collected]. Reaction to this policy change has been mixed. While there are many supporters of this change who see this as a welcome development, some continue to resist and criticize this policy change.

There are three key issues in relation to this policy change. First, in the newly introduced flat rate system, the charge is based on the farm *area cropped* during Rabi and Kharif seasons (i.e. flat rate per hectare of area cropped in each season) and not based on farm *area owned* or farm area having water entitlement or area receiving water. Under warabandi type of systems, water allocation is made based on the size of farm landholdings. In aggregate terms, large farmers receive and use more canal water than small farmers. On per hectare basis, if we assume that small and large farmers receive similar amount of water, small farmers who generally have higher cropping intensity will end up paying more in per hectare irrigation charge than large farmers. As in the past, under the new policy, area irrigated partially from surface water and partially from groundwater would be fully liable for canal water charges. Those who make more use of groundwater and other inputs to increase their cropping intensity would have to pay more in per hectare water charges. It is important to note that it is the farm size that forms the basis of water allocation, regardless of the proportion of farm area cropped. Therefore, it makes sense to levy flat rate charge based on farm size or farm area having water entitlement. The new crop area based flat rate policy, though does not account for intra-seasonal crop differences, it accounts for inter-season crop differences and, like old system, irrigation charges are levied based on area cropped and cropping intensity during a season. So, while the new system would help in addressing the crop type-misreporting issue, but it would not resolve the problem of crop area mis-reporting. The flat rate per unit of land based on land size, independent of crop type and cropping intensities would be better option to address both of these issues.

Summary, Conclusions and Implications

In recent years, there have been much debate and discussions on the role of water charging/pricing and cost recovery in the context of reforms for improving management of water resources. Review of the past studies suggest that much of the empirical work on water charging/pricing have focused from the perspectives of efficiency in resource allocation with mounting concerns over ever increasing scarcity and competition for water, with little attention to equity, income distribution and poverty implications of charging/pricing tools.

In this regard, the study addresses two key questions: how irrigation charging is linked to irrigation performance and poverty; and what are cost recovery, equity and poverty implications of alternate charging methods under conditions of (in) equity in land and water distribution. The study describes in detail key characteristics of charging methods that are in practice on ground based on field level information and data from 26 irrigation systems in six countries: Bangladesh, China, India, Indonesia, Pakistan and Vietnam; undertakes comparative analysis of alternate charging methods; identifies their strengths and limitations; and highlights factors influencing the choice of charging methods in particular settings. The analysis covers three main aspects of charging: the level of charge, the structure of charge and collection aspects. The study focuses on irrigation charging in large and medium scale surface irrigation systems in the study countries.

In South Asian systems, level of irrigation charges varies from US$4.6/ha to US$22/ha. While irrigation charge level is highest in Bangladeshi systems, collection rate is very low (5-15 percent). Irrigation charges in the Indian systems have recently been increased to US$ 10/ha, with collection rate varying significantly across systems. In Pakistani systems studied, irrigation charges vary from US$4.6/ha to US$10.6/ha, and overall collection rate is higher (80-99 percent) than that in Bangladeshi and Indian systems. In Indonesia, irrigation charges vary from US$1/ha to US$20/ha, and collection rate is fairly high, especially in transferred systems. On the other hand, irrigation charges in China and Vietnam are much higher than those in Indonesia and South Asian systems. In China, irrigation charges vary from US$26 to US$67/ha (1.8 to 5.2 percent of gross value of product), with average collection rate of 80 percent. In Vietnam, where irrigation is charged based on crop output, water charge level is fairly high (US$58 to US$61/ha), constituting 4.6 and 6.3 percent of gross value of product, and overall collection rate is also high (85 to 99 percent).

The study findings indicate that: (1) in the Chinese and Vietnamese systems studied, land and water distribution is relatively equitable. Irrigation charges are directly or indirectly linked to irrigation service delivery/ water supplies. In these systems, irrigation charges, regardless of whether based on size of landholdings or cropping intensities, tends to be relatively equitable. What is important for revenue generation/cost recovery for these systems is to increase the charge to the level where it reflects cost of supplying water and /or benefits derived from water use and to further improve on collection efficiency; (2) in Indonesia, landholdings are generally of smaller sizes, and there is element of inequity in distribution of both land and water. Under multiple criteria based charging method (as in the transferred systems) structure of charging is such that charges are linked to water supplied/used, and it accounts for poverty concerns. Here too, what is needed is to increase the level of irrigation charges and overall collection efficiency for improved cost recovery; (3) in the South Asian systems, land and water distribution across farms tends to be fairly inequitable, and charge is not linked to irrigation service or amount of water supplied, and overall charge level is very low. In such systems, not only the level of charge needs to be increased, the structure of charging also needs to be improved for improving cost recovery in more equitable and pro-poor ways; (4) irrigation charging methods in Vietnam and China are relatively better as they account for locational differences in service delivery /water supplies, and to some extent reflect cost of supplying water. On the other hand, while present charging methods in South Asian systems, are easy to administer, they lack transparency and are often inequitable and biased against the poor small farmers; and (5) quantitative analysis suggests that irrigation charge level affects system performance, which in turn, influences poverty in the systems, that is low charge level indirectly dis-benefit the poor.

Detailed analysis of charging structure for Pakistani systems demonstrates that under conditions of inequitable land and water distribution, charging structure that does not link the charge with irrigation may also directly dis-benefit the poor. Using primary data from the selected system in Pakistan, the study analyzes three policy options: (1) present policy, where charges are based on cropped areas and cropping intensities; (2) charges based on flat rate per unit of land, applied uniformly across various farm size categories; and (3) charges based on differential rate per unit of land based on land size, applied differentially across various farm size categories, lower irrigation charge for the first two hectares, applied uniformly to all land size categories, and charge increases progressively with increase in size of holdings above 2 hectares, by Rs. 50 per ha for each successive category of land size. The results of the analysis indicate that option – 1 (current policy) is pro-large landholders and penalizes poor small farmers whose cropping intensity is generally higher due to relatively greater use of groundwater and other factors. Option – 2 is better than option – 1, but it is not pro-poor. Option – 3 is better than both option – 1 and option – 2 from both revenue and equity perspectives. Option – 3 is pro-poor, as per ha irrigation charge for the poor would be less than for the non-poor, and overall revenue would be more than that in the first two options.

Analysis at the province level (Punjab) indicate that policy option – 2 (flat rate charge at present level of average water rate) would result in gains for small farmers through reduced costs by Rs. 74.45 million, and annual total revenues will increase by 5.3 percent. Under policy option – 3, smaller farmers, as a result of reduced costs, would gain annually by Rs. 346.88 million, and larger farmers would contribute more towards costs by Rs. 529.76 million, and overall annual revenue would increase significantly by 21.8 percent. With policy option – 3, Rs. 876 million would be re-distributed each year, with significant amount in favor of small and poor landholders in Punjab. For country as a whole, policy option – 2 would result in annual gains for small farmers through reduced costs by Rs. 130.06 million, and cost to larger farmers would increase by Rs. 605.97 million, and total revenues will increase by 5.6 percent. Under policy option – 3, smaller farmers, as a result of reduced costs, would gain annually by Rs. 519.65 million, and larger farmers would contribute more towards costs by Rs. 842.45 million, and overall revenue would increase significantly by 22.7 percent. With policy option – 3, over Rs. 1362 million would be re-distributed each year with significant amount in favor of small and poor landholders in Pakistan.

While both options would result in improved revenues/cost recovery, flat rate [which is relatively straight forward and easy to administer] would be equitable and differential rate would be pro-poor. The suggested differential rate method (which is also not too difficult to administer) is similar to increasing block rate charging for domestic water supplies. In the domestic water supplies, where water can be measured, increasing block rate charging is applied partly because of equity and poverty concerns where low charge is applied to certain basic amount of water, that is, for basic needs for low volume consumers, and charge is increased progressively for high-volume consumers (i.e. generally the rich consumers using water for luxurious purposes such as for swimming pools etc). In the irrigation sector, where water measurement at the filed level may be difficult (due to technological/administration/cost constraints), charge can still be linked to water supplies based on landholding size. Either of the suggested options, flat or differential rate, are feasible and could be implemented with existing institutional arrangements in place, and as such do not involve any costs. Major benefits with such a policy change would include:(1) more funds available for O&M, that can be expected to result in improved O&M leading to increased efficiency in irrigation supply and improved system productivity; (2) benefits in terms of reduced costs to small and poor landholders; and more importantly, it would be a step forward to reversing existing inequities not only in irrigation charging but in overall benefits of investments in irrigation.

Main lessons leant from the study can be summarized as follows: (a) there are a number of charging methods in practice in the studied systems, and the choice of a charging method in a particular setting depends on a range of factors including water allocation mechanisms and water rights, characteristics of delivery systems (supply-based ore demand –based), value of irrigation water, variability in water flows and distribution losses, number of farms to be served, social objectives such as food security and poverty alleviation and other factors such as transaction cost of charge collection.; (b) irrigation charging influences irrigation performance, which in turn, influences poverty.; (c) the impacts of a particular charging method on system performance depends on distribution structure of land and water. Where land and water tends to be equitably distributed (as in China and Vietnam) it is mainly the level of charge that matters for revenues and cost recovery. On the other hand, in settings where land and water distribution tends to be inequitable, both the level and the structure of charging are important not only in relation to revenues and cost recovery, but they have implications for equity in income distribution. Under such settings, indiscriminate application of low charge policy dis-benefits the poor. Also, in such settings charging structure, which is not linked to irrigation service and which do not account for landholding size, often favors the non-poor.

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Appendix – A

Efficiency Related Aspects of Water Pricing/Charging

In the perfectly competitive markets, pricing mechanism endogenously performs efficiency incentive and financial functions. An economically efficient outcome is achieved when the marginal value product of a resource is identical across alternative uses, and is equal to its marginal cost of production – marginal benefit is equal to marginal cost. Overall, an economic efficiency in resource allocation is achieved such that it is not possible, through further reallocations, to increase the welfare of society [that is, in a strict sense, resource allocation is efficient if it is impossible through further reallocations to make one person better off without making someone else worse off (also called Pareto efficient allocation)]

However, unlike other (pure private goods) whose allocation is determined by prices (such as fertilizers), unique characteristics of water limit the effectiveness of price system to allocate water as under free market conditions – due to market failures – where market mechanism fails to achieve an efficient allocation of resources. The major sources of market failures for water are as follows:

1. Lumpiness of investments such as in irrigation systems.
2. Massive economies of scale [7] in the production or distribution of water. Because of the economies of scale, average cost of production declines over a broad range of output levels. Lumpiness of investments and presence of economies of scale means that one firm can produce the entire output more cheaply than multiple firms could, and monopoly arises naturally. Water supplies are, therefore, provided by public authority in natural monopoly position.
3. Externalities, both positive and negative, associated with provision and use of water. For example, land salinization caused by rising water tables or canal seepage causing negative externality in production. Similarly positive externality, for example in consumption, may occur from indirect or secondary benefits of water use in production of commodities, which are not accounted for by market forces. In the presence of externalities, the opportunity cost[8] or social cost[9] of water is often unknown or costly to determine.

Public sector provision of water is often justified on account of the above unique characteristics of water. This is particularly so in developing countries where most large and medium scale surface systems are operated and managed by the government or semi-government authorities. Points 1 and 2 above mean that there is a case of natural monopoly in the provision of water, that is average costs decrease over a broad range of output levels. In the absence of any regulation, a monopolist will chose to produce that output for which marginal cost is equal to marginal benefit (or marginal revenue). With downward sloping demand curve, market price will exceed both marginal revenue or marginal cost at the output level produced by the monopolist. A regulatory

[7] Production involves economies of scale if, when all input quantities are doubled, the quantity of output is more than doubled. Economies of scale occur due to factors which cause long run average cost of production to decrease as the firms' output increases. Thus firm's long run average cost is negatively sloped in the presence of economies of scale.
[8] Opportunity cost of water is generally defined as the value of water in its next best use.
[9] Social cost of water includes both the cost of supplying water and costs or benefits associated with un priced adverse or beneficial effects related to provision and use of water.

agency may set a lower price, which is equal to marginal cost of producing the expanded level of output (as demand would increase at lower price level). The objective of marginal cost pricing here may be to induce the monopolist to expand output to the optimal level (to reduce the cost of monopoly to the society). However, because of the declining nature of costs, price which is equal to marginal cost will fall below average costs. Therefore, with the regulated price, which is lower than the market price, monopoly would be operating at loss, which would require that either the monopolist abandon the use of marginal cost pricing or the government subsidizes the monopoly for loss. Average cost pricing and price discrimination are commonly used instruments to address these problems.

In the presence of externalities (positive or negative or both), an efficient outcome that maximizes the social welfare would require that marginal social benefits of water in alternative uses are equalized, and these are equal to marginal social costs. Water price can be set equal to marginal net social cost (accounting for both social benefits and social costs), which includes cost of providing water and all important social effects associated with production, supply and uses of water. However, in the presence of externalities, social benefits or costs with water supply or use may differ widely over space, time or across users, and price based on marginal social costs and marginal social benefits will have to be different for each user, which present difficulty for real world application of marginal social cost/benefit based pricing. These and other related issues mean that more simple methods be used for pricing/charging for water in real world situations.

Table: Average Price/Charge for Agricultural Water in Selected Countries

Country/Location	Water Price/Charge	Reference Year	Pricing Charging Structure	Source
Pakistan	1.49 – 5.80 $/ha)		Depending on crop type and region	Ahmad (2000)
Pakistan (Punjab)	4.6-10.6 ($/ha)	2002	Depending on crop type and cropping intensity	This study
India (Andhra Pradesh and Madhya Pradesh)	10 ($/ha)	2002	Depending on crop type and region	This study
Bangladesh (South- western and West-central Bangladesh)	20-22 ($/ha)	2002	Depending on crop type and region	This study
Sri Lanka	0.00	2002	-	
China (Henan and Ningxia Provinces)	26-67 ($/ha)	2002	Depending on crop type and region	This study
Vietnam (Red River Delta and North Central Coast)	58 – 61 ($/ha)	2002	Depending on crop type, crop output and region	This study
Indonesia (Central Java)	1 – 20 ($/ha)	2002	Depending on crop type, region and farmers capacity to pay	This study
Jordan (Jordan Valley)	0.009/m3 ($/m3)	1993	Volumetric Pricing	Tsur and Dinar (1995)
Egypt	0.00			Ahmad (2000)
Algeria			Per liter per second per hectare	Ahmad (2000)
Saudi Arabia	0.00			
Sudan	4.72-11.22 ($/ha)		Depending on crop type and region	Ahmad (2000)
Syria	50.0 ($/ha)			
Morocco	0.013 – 0.037 ($/m3)	1994	Volumetric pricing	Tsur and Dinar (1995)
Nigeria	15-100 ($/ha)	1987	Area based charging	Tsur and Dinar (1995)
Mexico Alto Rio Lerma Irrigation district)	0.0039 ($/m3)	1997	Area based	Kloenzen (1998)