Water Pricing as a Demand Management Option: Potentials, Problems and Prospects

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Introduction

Agriculture is the single largest consumer of water. Agriculture accounts for more than 70 % of the total water demand globally and its share is as high as 90 % in developing countries like India. In this context, even a marginal saving in irrigation water use can release substantial amounts of water for agricultural expansion as well as for meeting the needs of other sectors like domestic water demand. Unfortunately, irrigation water is one of the most ill-managed resources, which creates a severe scarcity of water, both for drinking and irrigation, as well as environmental problems such as waterlogging in endowed regions and desertification in fragile regions. Of late, there has been great emphasis on the judicious management of water at the policy level. Pricing and institutional (user participation) approaches are suggested to overcome the strident problems. So far, even these policy changes have been limited to surface irrigation. An important segment of water resources (groundwater), which covers most of the rain-fed regions, is more or less neglected. In the absence of any effective policy measures, groundwater regions are plagued with water scarcity, inequitable distribution of water and environmental degradation. The situation seems to have aggravated during recent years, especially in the arid and semi-arid regions across the world.

For, hitherto policymaking towards water, in general, and irrigation management, in particular, is based on the philosophy of supply side management to the neglect of demand side aspects. Demand management involves increased water use efficiency, recycling, promotion of water saving technologies etc. Though supply is a major constraint in many cases, the major problem that leads to water shortages is the wastages through distributional and transmission losses, overexploitation and inequity in the case of groundwater, practices of inefficient use etc. As the wastages of water workout to be very expensive, the investments in leak detection and leak proofing may prove to be more productive than the investments in supply expansion. This, coupled with an efficient distribution network and sustainable extraction of groundwater, would not only help increase the supplies but also lead to a more equitable distribution. Even the investment required for improving the supply network is substantial and, hence, resource (both financial and natural) availability is the major constraint in this regard. In this context, demand management becomes critical for sustainable management of the resource.

In spite of the rapidly increasing value for water resources, irrigation water demand functions are totally ignored in the major policy formulations. In most of the cases the projections of irrigation water demand are in terms of crop water requirements. Therefore, the effect of price and other variables on the use of irrigation is not properly evaluated. The most important application of demand functions is in arriving at alternative projections of water use by systematically varying the factors that influence the demand for water. Moreover, the demand function provides a basis for evaluating whether specific investments in flow regulation and inter-basin transfers are justified (Thampson and Young 1973). Lacking in scientific estimation of demand functions, the estimated projections so far are based on cropping pattern and acreage projections along with their normative requirements. However, the literature on water demand estimates for other countries, mostly developed, indicate that the quantity of water demanded has been found to be significantly affected by the price of water and other socioeconomic factors in a number of studies (for a review see Reddy 1996).

Although factors influencing irrigation demand can be categorized under (i) economic, (ii) technological and (iii) environmental, the price of water falling under the economic category has received greater attention as a major irrigation demand management tool. The discussion on price as a demand management variable has been highlighted in a number of studies (see for recent reviews, Molle nd; Dudu and Chumi 2008; Johansson 2005; Tsur 2005). In fact, an unsettled controversy is still going on regarding the specification of price variables and what should comprise the water price. Whether marginal price specification is appropriate or average price specification is appropriate for estimating the water demand function is one of the key issues in this debate. Similarly, the inclusion of implementation costs is another issue. Though the arguments in support of and against these issues are very interesting, we restrain ourselves from entering into this debate and concentrate on the price as a demand management variable.

This paper attempts to explore the intricate issues that prompt the dynamics of water pricing in irrigation demand management. The focus of the paper is on the irrigation sector, both surface and groundwater, and mainly draws from existing literature and studies. It is argued that water is increasingly becoming a political good rather than an economic or a social good. Water pricing has become a political live wire mainly due to the asymmetry in information across the stakeholders. Information asymmetries are often created by the self-seeking interest groups like the water departments / bureaucrats or contractors. This is despite the fact that water bureaucracy is often involved in the reform process. The absence of a comprehensive water policy that clarifies the rights and entitlements of water resources at the central or federal levels appears to be the main bottleneck in the smooth implementation of the reform initiatives. The following section reviews irrigation water pricing policies. Section three discusses the role of pricing in irrigation demand management. Some evidence pertaining to the impact of pricing on irrigation demand is presented in section four while the conditions irrigation water pricing are discussed in section five. And the last section makes some concluding remarks.

Water Pricing Policies: A Review

There is now consensus at various levels that water is scarce and needs to be treated as an economic good. Though pricing is considered to be crucial for efficient allocation of water, allocation of water as a pure economic good is more complicated than other goods and services. This is mainly due to its public good nature and externalities associated with it. The critical linkages between water and poverty, food security brings the equity dimension in to its allocation. This has led to bringing irrigation water largely under public administration across the countries. The various problems viz., inefficiency, poor planning and enforcement, etc., associated with public administration has often ended up treating water as a social good rather than an economic good. Treating water as a social good has led to a financial burden on the state and resulted in unsustainability of the supply systems in the long run.

Financial burden of the supply agencies is reflected in the poor health of irrigation infrastructure resulting in leakages, which are estimated to be in the range of 60 % in most of the areas. A substantial portion of these losses is technical. Any improvement in the system could result in substantial gains in terms of total water supplies. And, even marginal savings (say 5-10 %) in irrigation water could release enough water to meet the needs of other sectors. Financial compulsions force price reforms and, often reforms are initiated to avert extreme crisis situation ('crisis hypothesis'). Pricing decisions are always considered as politically infeasible and, hence, avoided with the excuses of lack of willingness and ability to pay. A number of studies have shown how wrong these perceptions are. In fact, it is argued that it is 'willingness to charge' rather than 'willingness to pay' that is blocking price reforms (Reddy 1996; DFID 1999). People are willing to pay higher tariffs irrespective of resource endowments of the region (scarcity or abundant water resources).

Countries follow different pricing mechanisms for irrigation water though most of them do not adopt any economic principle strictly. For, the first best solutions are often complicated as far as implementation is concerned (Johansson 2005). Pricing of water has five important objectives (Boland and Whittington 2000). They are: 1) revenue sufficiency; 2) economic efficiency; 3) equity and fairness; 4) income redistribution; and, 5) resource conservation. Designing of price policies and tariff structures should take the following considerations into account in order to make the reforms feasible. These include: public acceptability, political acceptability, simplicity and transparency, net revenue stability and ease of implementation (Bolland and Whittington 2000 — p. 222). However, some of these considerations like political and public acceptability may clash with the basic objectives of pricing. For instance, for achieving economically efficient water allocation (that gives highest return to the given water resource), the price of water should be equal to its marginal cost of supply plus its scarcity value. Often, this results in the setting high tariff structures, which are acceptable neither to the public nor to the politicians.

The prevailing pricing mechanisms across nations can be grouped under three categories viz., a) volumetric pricing; b) non-volumetric pricing; and c) market based pricing (Johansson 2000). In volumetric pricing water use is measured and charged. In the case of non-volumetric pricing a number of variants are used in irrigation water (Table 1). These include flat rates, per acre rates, crop-wise rates etc. Market-based pricing follows the price determination based on demand and supply of water in a market environment. Markets can be formal or informal. In the Indian context most water markets are informal (Shah 1993; Saleth 1996). On the other hand, formal water markets require tradable property rights (Saleth 1998) in water that are conspicuous by their absence in most other countries. Water rights also help reduce poverty, improve productivity and resource conservation (Burns and Meinzen-Dick 2005). Water markets may not exist or function in scarcity conditions, as the available water is not enough to meet the needs of well owners. Water markets are also observed to shrink in the context of power regulation for groundwater extraction (Shah and Verma 2008). More importantly, water markets may not be sensitive to resource degradation and equity concerns.

Table 1. Existing irrigation water pricing mechanisms.

Pricing Scheme	Potential Efficiency	Time Horizon of Efficiency	Equity	Implementation Costs	Qualities
Single rate volumetric	First-best	Short-run	Fairness	Complex	Requires monitoring
Tiered	First-best	Short-run	Can be targeted	Complex	Requires monitoring
Two-part	First-best	Long-run	Can be targeted	Complex	Requires monitoring
Output/input	Second-best	Short-run	Can be targeted	Less complex	Requires monitoring
Per area/per crop	Second-best	Short / long run	Can be targeted	Easy	Requires data
Quotas	First-best (if tradable)	Short-run	Can be targeted but difficult.	Easy	Requires information
Water Markets	First-best	Short / long run	Difficult	Complex, especially in scarcity conditions	Requires developed water institutions and infrastructure
Private Management.	Second-best	Short-run	Difficult	Nil for government	Resource externalities

Source: Adopted with modification from Johansson (2005)

Theoretically, marginal cost pricing is the most efficient and considered the first and best option. Whether marginal price specification is appropriate or average price specification is appropriate for estimating the water demand function is being debated empirically. Though the arguments in support of and against these variables are very interesting, we restrain ourselves from entering into this debate here. There are studies using average price alone and others using only marginal price (for a theoretical exposition on long run marginal cost pricing see Munasinghe 1990), while some used both in order to test the specification bias of pricing in the water demand (for a detailed review see Reddy 1996). In fact, increasing block rate tariffs (IBT) are considered to be equivalent to marginal cost pricing though there is no agreement in this regard (for detailed exposition on this see Boland and Whittington 2000). Boland and Whittington (2000) argue that IBTs introduce inefficiency, inequity, complexity, lack of transparency, instability and forecasting difficulties. They suggest uniform pricing with rebate (UPR), which is capable of achieving the benefits of IBT without adopting a block tariff structure. And the popularity of IBT is attributed to the water professional's ignorance or neglect of the adverse effects of IBT on poor households (Boland and Whittington 2000 — p.234).

As far as irrigation water is concerned, there are wide variations in water rate structures across countries and the rate per unit volume of water consumed varies greatly for crops. In some states irrigation charges vary from project to project depending on the mode of irrigation.

The rates vary widely for the same crop in the same state depending on season, type of system etc. There are no uniform set principles in fixing the water rates, a multiplicity of principles are followed such as recovery of cost of water, capacity of irrigators to pay based on gross earning or net benefit of irrigation, water requirement of crops, sources of water supply and its assurance, classification of land linked with land revenue system and combination of various elements. In some states water cess, betterment levy etc., are also levied. There is no consistency or uniformity regarding how these factors are used in arriving at water rates.

A number of irrigation water pricing mechanisms have been adopted across the countries (Table 2). There are also variations within each country like India where different mechanisms are adopted across geographic locations. Water prices are charged according to local conditions and costs of production. In some countries like Jordan and Turkey, groundwater supplies are priced, while in others like India, groundwater is left to private management. The variations in irrigation water rates are quite substantial across the countries. Despite the adoption of volumetric and other theoretically efficient pricing mechanisms water is under priced in most of the countries (Tsur and Dinar 1997). As a result water prices neither reflect its scarcity value nor allocated efficiently.

Table 2. Pricing mechanisms adopted and irrigation water charges in selected countries.

Country	Pricing Mechanism	Water Price
USA (California)	Volumetric	US$ 5 on average per acre foot (Range: US$2–US$200 per acre foot); and US$19.32 per acre foot in some cases
Jordan	Volumetric	US$0.04 per cubic meter for the 1.5 meters of irrigation depth and US$0.08 for any additional amounts
Morocco	Tiered volumetric	US$0.019 per cubic meter of water
Spain	Compensatory tariff	US$0.128 per cubic meter of water
Turkey	Area/crop-based	US$12 and US$33 in the case of wheat for gravity and pump irrigation, respectively US$34 and US$80 in the case of cotton for gravity and pump irrigation
Chile	Tradable quotas	Range: US$993–US$2,978 per share of 1 liter per second delivery
India	Area /crop-based; Flat rates, betterment levy etc.	Varies across states. Ranges from US$0 in Punjab to US$100 in Maharastra per hectare of flow irrigation.

Source: Compiled from Tsur and Dinar (1997) and CWC (2004)

Irrigation water prices vary across states in India and prices are below working expenses in all the cases (Table 3). While Punjab has abolished water rates in 1997, water rates were last revised decades back in some states like Tamil Nadu (1962) and Kerala (1974). Similarly, no water rate is levied for agricultural purposes in most of the north-eastern states except for Manipur. In Orissa, a flat basic compulsory water rate is charged for the staple crop of paddy under the command area of major and medium projects irrespective of water used or not, while crop-wise rates are charged in the case of other crops. In West Bengal, water from minor systems is supplied only on pre-payment basis. In Jammu and Kashmir, Haryana, West Bengal and Kerala variations in water rates appear to be marginal. In most of the southern states of Andhra Pradesh (AP), Tamil Nadu (TN), Karnataka and Pandicherry water rates are clubbed with land revenue and land is assessed as wet and dry. The difference between the dry and wet assessment is taken as water rate. In most of the states public water supplies for irrigation are levied on the basis of area irrigated (in the case of surface irrigation), while water charges are levied on the basis of the number of hours of watering or volume of water (in the case of public tubewell irrigation). The rates for perennial and defussal crops are often higher than those of other crops (www.mowr.gov.in/problems/pricing.htm).

Table 3. Working expenses and range of water rates per hectare of potentially utilized area of irrigation and multipurpose river valley projects in India.

States	WE (Rs/ha) in 1999-2000	Rates for Irrigation Purposes				Status as on
		Flow Irrigation		Lift Irrigation		
		Rate (Rs/ha)	Date since applicable	Rate (Rs/ha)	Date since applicable	
AP	1,556	148.20 – 1,235.00	1996	#	NA	2003
Bihar	375	74.10 – 370 50	2001	#	NA	2003
Gujarat	4,768	70.00 – 2,750.00	2001	23.33 – 1,375.00**	2001	2001
Haryana	683	86.45 – 197.60	2000	43.23 – 98.80	2000	2003
J & K	319	19.76 – 49.40	2000	49.40 - 716.30	2000	2001
Karnataka	2,014	37.05 – 988.45	2000	#	NA	2002
Kerala	442	37.00 – 99.00	1974	17.00 - 148.50	1974	2002
M P	516	123.50 - 741.00	1999	123.50 – 741.00	1999	2001
Maharashtra	3,050	180.00 – 4,763.00**	2001*	30.00 - 495.00**	2001*	2002
Orissa	256	28.00 – 930.00	2002	129.21 – 4,990.63	1997	1998
Punjab	217	Abolished	1997	Abolished	1997	2002
Rajasthan	888	29.64 – 607.62	1999	74.10 – 1,215.24	1999	2001
Tamil Nadu	846	2.77 - 61.78	1962	#	NA	2002
U P	484	30.00 – 474.00	1995	15.00 - 237.00	1995	2002
W B	470	37.05 – 123.50	1977	#	#	2003

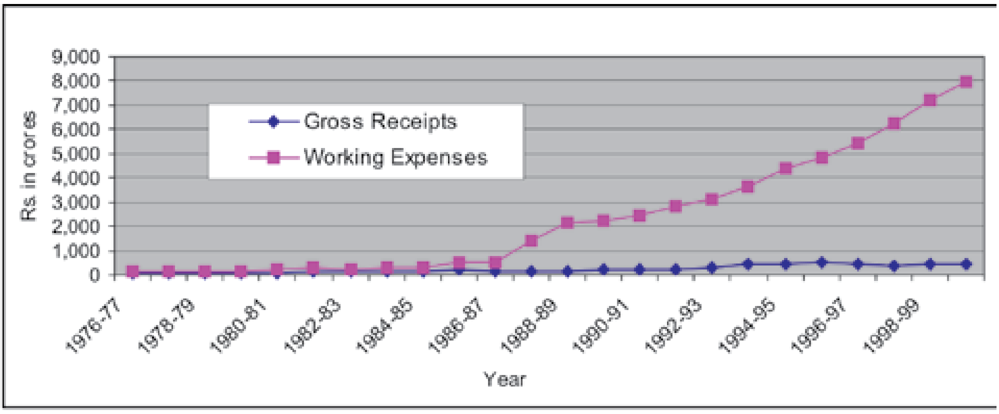
Source: CWC (2004)

Notes: WE= Working Expenses; # - No separate rate for lift was reported; * - Subject to increase at 15-20 % per annum. AP= Andhra Pradesh; J&K= Jammu and Kashmir; MP= Madhya Pradesh; UP= Uttar Pradesh; WB= West Bengal

** - Subject to increase at 15 % per annum

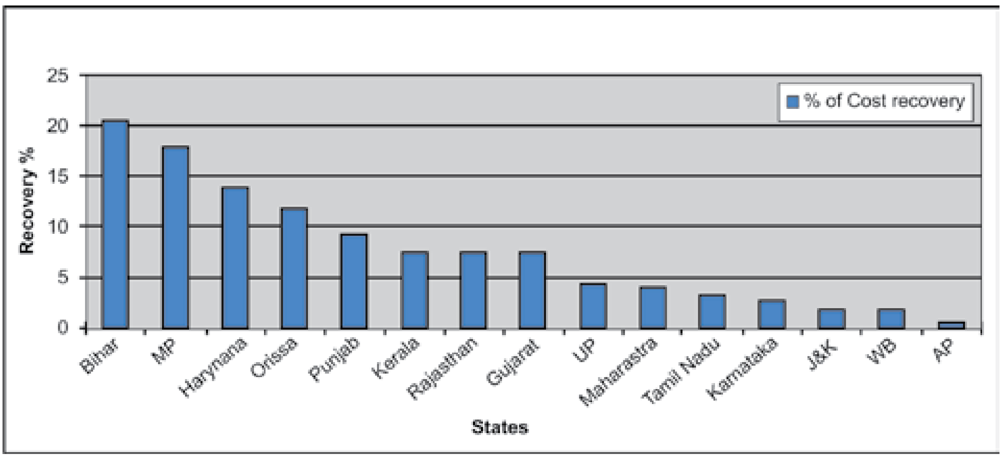
A cursory look at the economic performance of the water sector across the states in India reveals the poor status of the sector. All the states are overburdened with the financial gap (measured as the difference between expenditure on and recovery from the sector) and resorting to heavy borrowings from private sector and multilateral agencies. None of the states are covering the operation and maintenance (O&M) cost, which in itself is an efficiency indicator in most developing countries. Scarcity or incentive gap is the difference between the scarcity value of water and the actual value of water.[1] In the case of irrigation, the price gap is substantial and widening in all the states. (Figures 1 and 2).[2] Operation and maintenance cost recovery in irrigation is less than 5 % in the majority of the states (Figure 2).

Figure 1. Gross receipts and working expenses of irrigation and multipurpose river valley project in India (1976-1977; 1999-2000).



Source: CWC (2004)

Figure 2. Percentage of cost recovery of O&M in irrigation and multipurpose river valley projects in selected states (1999-2000).



Source: CWC (2004)

[1] For an excellent treatment of water sector assessment see Saleth and Dinar 2004.

[2] The sudden increase in the gap between gross receipts and working expenses after 1986-87 is due to the change in the O & M costing methodology (Narayanamoorthy and Deshpande 2005).

Water Pricing and Demand Management

Theoretically demand for any normal good is inversely related with its price, and positively related with individual income, ceteris paribus. All the studies testing these two hypotheses have revealed ample evidence supporting the theoretical propositions, though the magnitude of their estimates varies among the studies (Dudu and Chumi 2008). Pricing of water on cost basis is essential because it not only helps in resource (financial) generation but also results in the efficient usage of water and discourages wastage of water. It is often observed that the decision-makers, in the event of resource constraints, opt for permitting shortages and allocating water by non-price means of supply regulations when the existing capacities are on the verge of full utilization. Though this has become a norm in most of the developing countries, supply regulation is considered to be an unsatisfactory permanent policy. Often pricing policies are thwarted with the excuse that farmers are unwilling to pay for irrigation water. Contrary to this general belief users are willing to pay substantially higher prices for improved water supplies. On the other hand, users tend to pay more than the actual cost of water in the event of supply regulation under a flat rate pricing mechanism (Reddy 1998). Therefore, willingness to pay is not a bottleneck for charging higher prices. In fact, it is the willingness to charge, which is the main obstacle.

While pricing could be an effective tool of demand management, we do not have many instances of getting the prices right to the level that results in efficient allocation of water, as the price does not reflect the scarcity value of water and also does not include the implementation costs in the case of volumetric pricing. Implementation costs could be very substantial in the case of volumetric pricing where metering and monitoring costs are quite high. Though volumetric pricing is implemented in the USA and Australia, the prices do not include these transaction costs (Molle nd). In other countries like Jordan where volumetric pricing mechanism is adopted, irrigation water is under priced by the authorities for the reasons of social welfare and equity (Tsur and Dinar 1997). Often one finds that the impact of volumetric prices on irrigation water demand operates only at the margin, as they do not reflect the real prices. The threshold level prices are quite high when scarcity values and implementation costs are included, making the public administration weary of imposing high prices. Such high prices could adversely affect the social welfare function of water pricing due to its social acceptance and equity concerns.

Efficient allocation takes place as long as prices affect demand. Most of the pricing mechanisms appear to fulfill this condition (Tsur and Dinar 1997). Volumetric pricing based on marginal cost-pricing achieves the first and best efficiency in the absence of implementation costs and scarcity value of water. In the event of under reflection of the actual value of water, volumetric or marginal cost-pricing of irrigation water does not prove to be efficient when compared to other pricing mechanisms like area-based or crop-based or quota systems (Tsur and Dinar 1997). Public administrators opt for quota or regulatory mechanisms, which are easy to adopt, to address scarcity issues. Pricing is never used to regulate irrigation water demand. While setting the right prices is very difficult, implementing the price policy is equally challenging. Pricing cannot operate in a vacuum. Proper implementation of pricing policies requires institutional arrangements for enforcing the price mechanisms.

However, under the existing institutional arrangements, pricing on a cost basis may not lead to sustainability of the water systems in terms of efficient allocation of water or financial viability. In the given institutional set up in the Indian irrigation systems, for instance, recovery rates are very low and declining. Percentage of recovery at the all India level (ratio gross receipts and working expenses) has declined from 92.9 % in 1976-1977 to 5.7 % in 1999-2000. When the interest on capital outlay is included, the recovery rates have declined from 36.4 % in 1976-1977 to 5.7 % 1999-2000 (CWC 2004). The story is no different even at the state level, as the average recovery is less than 5 % in most of the states. In addition, the gap between demand and actual collection of irrigation charges is quite substantial in a number of states. Except in the case of Punjab and Haryana, collections are less than the demand in all the states – ranging from 34 % in West Bengal to 92 % in Uttar Pradesh (Deshpande and Narayanmoorthy 2006). Given the political and institutional conditions it is unlikely that higher water rates would lead to better recovery. This point has been proved in the case of Andhra Pradesh, where increased water rates are accompanied by declining recovery rates despite the advent of institutional changes at all levels (Reddy 2003). Absence of devolution of powers to water user associations (WUAs), in terms of assessment and fee collection etc., are observed to be the main reasons for this trend. Given this background, adoption of first best solutions like volumetric pricing based on marginal cost calculations appears to be a far cry.

Groundwater management is the most challenging part of the water-pricing reforms. Hitherto, groundwater policies are in the lines of encouraging overexploitation. These policies are in the nature of providing incentives for groundwater development such as subsidized credit, and for groundwater exploitation such as subsidized power or diesel / kerosene. While these policies helped in promoting groundwater development in the regions where groundwater development was below potential, they have led to an overexploitation of the resource in fragile resource regions. The first victims in this process are the poor (small and marginal farmers). While small and marginal farmers own mainly open wells, medium and large farmers dominate the ownership of bore wells. As a result of degradation majority of small and marginal farmers have lost or are loosing access to water, as the water tables go down. Even when they own bore wells they can't compete with medium and large farmers in deepening their wells (Reddy 2005). As a result, these farmers are denied of their genuine share in the common pool resources. It is observed that groundwater markets will take care of the equity problems to a large extent (Shah 1993). But, evolution of water markets is possible only in the regions where groundwater is available in sufficient quantities. Markets do not evolve when there is not enough water to share or sell (Reddy 1999). This is true in many regions where groundwater markets do not operate, as the available water is not enough to irrigate the well owner's land. Pricing of groundwater has a greater potential for achieving equity and resource conservation objectives. Being the single largest source of irrigation and domestic water supplies, reforms in groundwater governance assumes importance and urgency.

In general, communities perceive that the improved availability of water for irrigation significantly enhances their livelihood security. The poverty goal necessitates a focus on the specific needs of the poor, especially women and landless and land-scarce families. The latter group often includes rain-fed farmers. The issue of how to secure the rights and entitlements of poor people to access water resources needs to be resolved. Unfortunately, there are no policies so far that address the equity and management aspects of water, in general, and groundwater, in particular. Though there are regulations on groundwater exploitation they are inadequate and ineffective. Even the so-called water reforms are in the lines of regulation rather than designing innovative policies that would integrate market and institutional dimensions of resource management. The water sector reforms in some of the states have failed to address the real issues and take the hard decisions. These reforms are often limited to half-baked institutional reforms, where new institutional structures were created without devolving powers. As a result, pricing of water has always taken a back seat in the reform agenda.

Water pricing has become hackneyed and ritual. Everybody supports but nobody implements. While some progress has been made in the case of domestic (urban) water, very little is being done in the case of irrigation (especially canal). Even in the reforming states like Andhra Pradesh (India) very little is done in this direction. Artificially kept low water prices fail to provide any incentive to improve the systems, technically or institutionally, as the economics of transaction costs go against it. Present prices do not even cover the O & M costs in many cases. On the other hand, some argue that pricing based on O & M may amount to penalizing the farmers for the inefficiencies of the department i.e., escalation of working expenses (Deshpande and Narayanamoorthy 2001). The second irrigation commission has suggested that the water rate should relate to the benefits accruing to the farmers rather than the costs incurred by the department (GoI 1972). In any case, the main bottleneck is the lack of political will to take the hard decisions though the constraints for taking hard political decisions may ease when water rates are fixed on the basis of returns.

Often pricing policies are thwarted with the excuse that farmers are unwilling to pay for irrigation water. Contrary to this general belief, farmers are willing to pay substantially higher prices for improved water supplies (Reddy 1998). Hence, willingness to pay is not a bottleneck for charging higher prices. Therefore, rational pricing of water on the basis of benefits accruing to the farmers is essential because it not only helps in resource generation but also enables the efficient usage of water while discouraging wastage. For example, paying for water on a cost basis could be as low as the O & M costs, which are beyond the control of the farmers. And these costs are always increasing irrespective of the returns to farming or efficient delivery of water, due to salary and other components (Deshpande and Narayanamoorthy 2001). It is often observed that the decision-makers, in the event of resource constraints, opt for permitting shortages and allocating water by non-price means of supply regulations when the existing capacities are on the verge of full utilization. Though this has become a norm in most of the developing countries, supply regulation is considered to be an unsatisfactory permanent policy.

While pricing can result in an efficient allocation of irrigation water perfectly at the theoretical level, impact of prices on irrigation in the practical world operates only at the margin. This is mainly due to the distortions in pricing coupled with lack of institutional mechanisms to support the high threshold levels of pricing. While the high prices that reflect the scarcity value of water and implementation costs could prove to be unviable and iniquitous, they may also adversely affect the social welfare objective. Inter- and intra-regional inequities in access to water have made water a political good rather than an economic good. The approach is to meet the demand for water at any cost. This does not make economic sense but makes enormous political sense. In a number of cases, where irrigation development is based on political consideration, the cost of irrigation provision is too high to make agriculture viable. Implementation of such high prices is neither politically feasible nor helpful in ensuring food security. For, at such high prices water has to be reallocated to more productive sectors, e.g., industry. One way out is to improve water productivities in agriculture.

Similarly, groundwater pricing does not reflect its scarcity value. Often groundwater use is regulated through power pricing. While, cost-based power tariff is useful in checking overexploitation, adding a scarcity of water rent to the tariff would be more appropriate. A pre-condition for this is to minimize the risk and uncertainties in groundwater and power availability. Large-scale public investments towards replenishing mechanisms like renovating traditional tanks, rainwater harvesting structures, etc., are necessary. These investments could be cross-subsidized from the revenues generated in the canal command areas. More importantly, institutional arrangements such as making groundwater a real common pool resource and exploiting it on a community basis are critical for equitable distribution and sustenance of the resource.

Technologies are often given little importance in the demand side management of irrigation water. This is mainly because of the reason that the area covered under water saving technologies is negligible. One reason for this is the distorted water tariff structure (Repetto 1986). Of late, more and more area is being brought under these technologies in order to tackle the scarcity conditions. The most important among the irrigation water saving technologies are sprinkler and drip irrigation techniques, also known as micro-irrigation systems. Of late, these technologies are spreading to a diversity of crops instead of being limited to horticultural crops as was the case in the past. In Gujarat, farmers use micro-irrigation systems on various crops such as wheat, bajra, maize, groundnut, cotton, castor and vegetables in addition to horticultural crops (Kumar et al. 2004).And in Maharastra, drip systems are used even on water-intensive crops e.g., sugarcane (Narayanamoorthy 2006).

It is estimated that micro-irrigation systems save 48-67 % in terms of water, 44-67 % in terms of energy and 29-60 % in terms of labor. Farmers have also reported a low incidence of pest attack, reduced weed growth, improvement in soil quality and increased yields. As a result net incomes have increased substantially. Farmers are interested in investing on their own without any subsidy (Kumar et. al. 2004). Cost-benefit analysis of drip irrigation in Maharastra revealed high economic viability for banana, grapes and sugarcane (Narayanamoorthy 1997 and 2006). The economic viability seems to hold good even in the case of smallholdings of just one hectare (Narayanmoorthy 2006). Despite the high economic viability the spread of these technologies is limited due to high initial cost and lack of awareness. The rationale of subsidies for these technologies is valid not only for spreading of these technologies but also due to the reason that social returns are far in excess of private returns accruing to drip investors (Dhawan 2000). Besides, there is a need for strong extension support for better adoption rates (Narayanamoorthy 2006).

Provision and clarity in water rights is expected to result in efficient use of water. Water rights are seen from many perspectives viz., riparian, federalist, formal law, civil society, stakeholder, human rights, environment and economic (Iyer 2003). The best way to deal with water rights would be the integration of all these perspectives. However, converting this theory to practice is going to be rather difficult. For instance, right to use of water is tied to the ownership of land along rivers and groundwater aquifers. As a result common pool resources are used as private property. This is the root cause of all the problems related to equity and sustainability. Furthermore, rights on water use are not clearly defined thus allowing for indiscriminate exploitation. The existing riparian rights while ensuring the natural right of people on water thwart the main objective of equity and sustainability. On the other hand, water rights from an economic perspective would adversely affect the interests of those whose ability to pay is minimal. There is a need to find a middle path that would ensure equity and sustainability of water resources. The recent water policy of South Africa is an interesting case in point.

South Africa (SA) has effectively abolished the riparian system, as it was racially biased (GoSA 1998). In SA the state has become the custodian of all the water bodies in the country. No ownership of water is allowed. Water rights are provided to individuals / firms on a 5-year contract basis (to a maximum of 40 years depending on the use). The rights are allocated by the State. However, water for basic needs and environmental sustainability is given as a right. All other uses will be subject to a system of allocation that promotes optimality for achieving equitable and sustainable economic and social development. This would have an important bearing on the equity, sustainability and efficient use of water, as water allocations keep altering users and uses across locations depending on the scarcity conditions.

On the whole, pricing has the potential to achieve efficient allocation of irrigation water, but its effectiveness in the real world depends on a number of other factors. These include: a) proper valuation of water resources (i.e., use value + scarcity value + existence value); b) institutional mechanisms like water user associations to support implementations of pricing policies,; c) technologies to enhance water productivity as well as viability of agriculture and; d) property rights in water so that water is tradable and reallocated for other productive uses.

Water Management through Pricing: Some Evidence

Volumetric pricing is expected to be effective in conserving water and improving water use efficiency. However, volumetric pricing is followed in very few cases (Table 4). This is mainly due to the high costs associated with fixing water meters and monitoring them. Even in the few cases where volumetric pricing is adopted, water is often under priced with little impact on water demand. In other words, as long as volumetric pricing is not equated with marginal cost pricing, pricing is not going to be an effective tool of demand management. This is mainly due to two reasons: (i) that marginal cost based pricing is often found to be politically unacceptable; and (ii) it may also impose undue burden on the marginal sections of the farming community.

Table 4. Impact of pricing on water demand.

Country	Price Mechanism	Impacts on Water Demand
Israel	Block rate tariff	7 % decline in average water use and 1 % reduction in output
Israel	Tiered system of pricing	Regulates water demand at the margin
India	Price induced water scarcity	Farmers are responsive but water allocation is not efficient
Spain	Arbitrary pricing	Differential impacts due to regional, structural and institutional conditions
Sri Lanka	Arbitrary pricing	Not effective
Turkey	O&M cost recovery pricing	No improvement
Mexico	O&M cost recovery with tradable bulk water rights to WUAs	No improvement at the farmer level. But overall improvement in water use efficiency due internal trading
China	Volumetric pricing at the WUA level	No incentive at the farmer level as the price at the farm level is based on the area
France	Full financial cost recovery	Managers only discourage water use beyond a subscribed amount
Peru	Volumetric pricing	Not used to reduce water demand
USA	Volumetric pricing	Quotas were more effective in times of scarcity

Source: Compiled from Molle (nd.); Dudu and Chumi (2008) and Johansson (2005)

In the absence of volumetric pricing water pricing on the basis of acreage is found to be the easiest way of implementation administratively. As far as the impact on water use and efficiency are concerned, evidence across the globe indicates that quotas are more effective in regulating demand when compared to other pricing mechanisms. Similarly, supply regulation is observed to be more effective in controlling demand. Supply regulation though found to be inefficient in the long run, it happens to be the most preferred option among the administrators. Quotas or supply regulation arises due to resource shortages. Less water is distributed equally among all the farmers in the years of water scarcity. In the case of groundwater it is often the shortage of electricity that prompts supply restrictions and reduced exploitation of water. The mixing of power pricing with supply regulation is found to be effective in groundwater management. During the drought years between 2001 and 2004 the Krishna Delta farmers in Andhra Pradesh were provided with 40 % less supply of water when compared to normal years. Farmers not only managed with low supplies of water but also reported 20 % higher yields. This reveals the extent of water wastage and inefficiencies during normal years. Hence, quotas lead by shortages are more preferred to volumetric or marginal cost based pricing.

Irrigation reforms in Andhra Pradesh, India are among the few success stories. Water sector reforms in Andhra Pradesh were also aimed at financial sustainability of irrigation systems through price reforms. Though water rates were increased initially by three times, they are still short of O&M expenditure. Though user contribution of 15 % is inherent / included in the Participatory Irrigation Management (PIM) Act, there is no evidence of any contribution from farmers. In fact, there are no efforts to collect this contribution. On the contrary, it is indicated that often only 60 % of the irrigated area is reported for the collection of water charges, and the officials take 20 % of the charges on the area as their share. Effectively, the farmer will be paying only for 80 % of the area irrigated by him. This is a mutually beneficial arrangement. These arrangements are widespread in the regions where WUAs are not strong. In fact, it was observed that in some cases the irrigation department has not yet revealed the details of the command area under each WUA. There is a widespread feeling that the department is not keen in strengthening the WUAs, as their continuation will go against the department's interests. In some regions WUAs have turned into mere political entities. Moreover, in the majority of cases contractors have turned into WUA presidents. As a result, WUAs have become money-making ventures (Reddy 2003).

Though some benefits in terms of increased area under irrigation in canal systems and improved quality of irrigation are evident, the sustainability of these benefits is rather uncertain in the absence of efficient institutional structures. While it appears that an opportunity to build stronger and sustainable irrigation institutions has been floundered, the opportunity is not totally lost, as the WUAs are still in place. It is observed that formal institutions are too rigid and rule-bound. Equity in the management and distribution of water is not addressed. No proper incentive (positive and negative) structures were designed and placed to support rule compliance (Reddy and Reddy 2005).

In Rajasthan, though more than 800 WUAs were constituted and elections were conducted almost 5 years back, the progress is very tardy. Water rates were revised only once during 1999. So far no devolution of powers has taken place, though the irrigation department appears to be keen in devolving the powers. These associations should be made autonomous, under the guidance of the irrigation department, and should be entrusted with rights and responsibilities of water distribution, O&M, fixing of water prices, collection, etc. Unless

WUAs are fully evolved in these aspects they remain ornamental. Conducting of regular elections is one way of keeping them alive. But, they should not be made dependent on external funds (Reddy 2006).

The Government of Orissa aims to handover the irrigation projects to 'Pani Panchayats' in a phased manner under the scheme started in 2002. So far 801 thousand hectares of irrigated command areas have been handed over to 13, 284 Pani Panchayats registered under the Registration of Societies Act. The government claims that the PIM program allows farmers to take decisions regarding distribution and management of water resources. In reality, however, the program has created a divide between the large, and small farmers and the landless. The landless are not even members of the Pani Panchayat. The rotation of canal water use resulted in poor farmers being able to harvest their rabi crop only once in 2 years. Consequently, people rebelled against the program and the model has collapsed, but not before causing much misery (Das 2006). Therefore, the experience and evidence on the impact of pricing on irrigation demand even in an institutional context is marginal. This is mainly due to the ineffective or lopsided functioning of the formal institutions.

In the context of groundwater, the water demand is controlled mainly through electricity. Though electricity pricing on cost basis is difficult politically, groundwater demand is often curtailed through regulation of the power supply. It is observed in the case of Gujarat, that increase in the flat rate of power has reduced the subsidy burden of the government though power is still subsidized (Shah and Verma 2008). While the threshold level of the power price that would reduce water demand is quite high, regulation of power supply could be used as an effective demand management tool. It is argued, "…effective rationing of power supply can indeed act as a powerful, indeed all powerful, tool for groundwater demand management" (Shah and Verma 2008 — p.66). Similarly, metering of the power supply has shrunk the water markets, thus reducing the amount of water extraction. The combination of metering with regulation of supply seems to be more effective in managing groundwater demand.

Conditions for Effective Water Pricing

There is no 'silver bullet' for making and implementing appropriate water pricing policies. There is a need for an integrated approach of markets, institutions and policies. The effectiveness of market mechanisms like full cost pricing, marginal cost pricing, etc., depends on the existing institutional and policy environment. Often price policies are adopted due to compulsions rather than due to conviction. For instance, in order to tide over the increasing financial burden, a number of states in India have initiated price and institutional reforms. In most of the cases these initiatives are induced rather than germane. Conditions for water pricing are determined by policy environment, institutional environment and technological options available.

Perpetuation of the supply-side approach has often prompted the exploration of possibilities of meeting the increasing demand for water through enhanced supplies from far off places at huge costs. In the absence of financial self-sufficiency of the supply agencies, they resorted to external funding. These funds, especially from the international agencies, often come with conditionalities in order to ensure repayment. World Bank, Asian Development Bank, DFID, European Commission, etc., are among the important agencies that are pushing reform agendas in some of the states. World Bank is the largest lender in the water sector covering both drinking as well as irrigation water. Although India is the second most important borrower from the World Bank, its investments in the sector account for only 10 % of the total investment (Pitman 2002). Of late, most of the lenders and donors are following the sectoral approach rather than the project approach. Sectoral approach takes an integrated view of the entire sector and initiates corrective measures instead of focusing on specific projects in specific areas. But, state governments are not very enthusiastic about the sectoral approach, as they are happy tinkering with small or little changes rather than embarking on major reforms like adopting a comprehensive water policy, providing legal rights and entitlements to water and establishing enforcement mechanisms, etc. Despite the best efforts of some of the donors, sectoral reforms are getting a lukewarm response and are adopted in a piecemeal manner at best.

The new initiatives in the irrigation sector are mainly institutional in terms of participatory irrigation management (PIM). Under this, some states in India (viz., Andhra Pradesh, Rajasthan, Orissa, etc.), have brought in legislations making water user associations (WUAs) mandatory for managing the public irrigation systems. One of the main objectives of PIM is to enhance the financial sustainability of the irrigation projects by ensuring parity between expenditure and revenue. Water user associations, through their involvement in planning, management and assessment in their locations are expected to smooth out the cost recovery process and move towards volumetric pricing in the long run. Though these reforms are having wider political support, in most of the states the progress regarding implementation of the reform components is not only tardy but also raising doubts regarding the overall sustainability of these initiatives in the long-run. In some cases these new institutional arrangements have fallen prey to the ‘elite capture’ (Reddy and Reddy 2005), in others the inequity in the distribution of water has led to rebellion and abandoning of the reform (Sainath 2006). On the whole the performance of these initiatives is not satisfactory. As per the World Bank evaluation based on aggregate project performance indicator combining the individual ratings for outcome, institutional and sustainability, (Pitman 2002). And irrigation sector is the worst among all the water sector projects, as only 40 % of the irrigation and drainage projects had satisfactory outcomes.

The fault, however, does not lie in the policies per se. The problem is lack of conviction at the policy-making and implementation levels. The new initiatives somehow are not fitting into the overall framework of self-seeking interests of various stakeholders like political entrepreneurs, bureaucrats, contractors etc. High subsidies and poor quality of delivery seems to serve their self-interests better. The gap between demand and actual collection of water charges is increasing even in reform states due to laxity in enforcement. As per the committee on the pricing of irrigation water during the 1980s, the gap between assessment and collection was in the range of 27 to 70 %. Accumulated arrears were found to be three to four times those of the annual demand in several states (Vaidyanathan 2003). This trend seems to be continuing, as evident in the field studies. The gap is as high as 60 % in the Chambal command of Rajasthan (Reddy 1996). In Andhra Pradesh, the increase in water rates has led to collusion between farmers and officials, with little impact on recovery rates.

Institutions or institutional reforms are critical for the success of irrigation water pricing. It is often argued that the reason for the ills of irrigation management is the alienation of farmers from the process of planning and implementation. Maintenance and management of irrigation systems through user societies and participatory process is expected to bring in efficient and equal distribution of water resources. But such processes often remained at the micro-level as experiments, and were often found to be difficult to replicate. Of late, participatory irrigation management is being scaled up at a wider scale in countries like India. Though flow of funds is the main factor in generating such a response, it is necessary to support the ailing systems in order to generate trust among beneficiaries. For, over the years, farmers have lost faith in the government and are in not inclined to respond to the false promises. Therefore, the initial boost was necessary to regain the lost credibility and build confidence. Once this is in place, implementation of institutional reforms from the top becomes smooth and much easier. But it is necessary to understand the direction in which the reforms are progressing. This direction would ultimately determine the strength and sustainability of the reforms.

Inequity in the distribution of water is the main cause of conflicts. Conflict is pervasive mainly due to historical reasons i.e., some regions are endowed with rivers and others are not. While it is difficult to avoid conflict altogether, it can be minimized through prioritization of the resource distribution. Water pricing also should take the equity concerns in to account. Discriminatory pricing policies would help overcome equity issues to a large extent. The much acclaimed electricity and groundwater management program in Gujarat (Gujarat's Jyotigram Scheme) also encountered equity problems. The scheme that helped reduce power subsidies, water demand and incidence of water markets has, however, adversely affected small and marginal farmers. Metering of power has led to the shrinking of water markets that were instrumental in providing groundwater access to small and marginal farmers (Shah and Verma 2008). This is mainly due to the bundling of water and land rights and the lumpy nature of capital requirements for groundwater exploitation. Discussion on legal aspects of water rights is crucial. De-linking of water rights from land rights would go a long way in addressing the equity issues in the distribution of groundwater. Allocating the rights to the community under the supervision of PR institutions could be a feasible option in this regard. Scarcity regions should be guaranteed with minimum levels of water in the case of regional allocations.

One of the main reasons for the chequered performance of the water sector in India is the absence of scientific information on the status of water resources. In the absence of such information there is widespread misunderstanding about access to water resources and constraints on using them. This is more so in the case of groundwater where farmers tend to mine groundwater in the absence of information on the availability of groundwater in their specific location. Similarly, farmers in the canal commands tend to misuse water and farmers in the dry regions presume that water can be brought from any distance, as they are not aware of the costs of irrigation development. Awareness campaigns should focus on presenting a realistic picture and future consequences if the present trends continue.

Water auditing and budgeting are crucial in minimizing the misconceived notions about water. Though water budgeting needs to be carried out at the village level, to start with, this exercise should be initiated at the watershed or river basin level following a holistic approach. For this purpose, integration of departmental expertise (groundwater, drinking water, irrigation, agriculture, animal husbandry etc.,) at the district level is recommended in providing a blue print on the ecological and livelihood potentials and constraints. The information should include the extent of irrigation that is possible (surface and groundwater), suitable cropping patterns, possibilities for livestock development, non-farm livelihood options, cost of provision, available water saving technologies and the benefits from their use etc. This message should be made transparent, simple and understandable to the people by displaying the information in prominent places like village panchayat office and should be disseminated in a campaign mode.

However, campaigning alone may not be effective unless fostered with the intended policy changes. An aggressive campaign on pricing should be followed by price hikes. Similarly, advocacy on cropping pattern changes should be accompanied by removing the distortion in output prices. For, ultimately it is the price that brings in the behavioral change. A campaign only helps in understanding the situation and prepares the communities for change. In other words, it facilitates a smooth transition in to the structural adjustment. The campaign should be carried out in a professional manner, i.e., preparing different modules for multiple stakeholders and resources. And it should be planned to ensure long term sustainability (at least 10 years).

The bottom line for water management is privatization of water resources or commodification of water; pricing of water use. This is another extreme of the South African (SA) model, which treats water as a public good. While there is no clear agreement in this regard, privatization of water, especially sources, would have a serious impact on the poor. Even in the absence of privatization the poor are paying more for water. However, the rich depriving the poor, often corner the benefits from the social good. Here the state should ensure and protect the entitlements. In the case of irrigation, privatization could help improve the situation by increasing the financial viability. In these cases water can be treated as an economic good. The third option is the middle path i.e., private public partnership in water resource management. This approach is expected to integrate the good aspects of social and economic goods. However, a cautious approach is required given the strident nature of the resource. Understanding the nature, structure and process of such partnership (adopted mainly in the developed countries) and its adaptability to the developing country context is a precondition for adopting such an approach.

While the SA model (discussed above) and the Chinese model (Vaidyanathan 1999) present a centralized public management of water resources, the Dutch model (van Dijk 2006) illustrates the relevance of different types of public-private partnerships in the water sector and who the participants would be. However, water utilities in the western countries are different, both in form and functions, to those in countries like India. The implications obviously are manifold but vitally influence the methods for raising resources. Besides the differences, there have been attempts by government departments in India toward enlisting private participation as well as in raising money for initial and working capital expenses such as Narmada Bonds issued by Sardar Sarovar Narmada Nigam (Corporation) Limited of Gujarat, India. It is interesting to observe that even in the Netherlands one-third of the Water Board's budget comes by way of loans every year. Even in the other two-thirds component, pollution tax appears to be the principal factor. In a country where pollution laws are in a nascent stage but not integrated to water management institutions there is no immediate logical case on which an argument could be made for an integration. Similarly, 'who benefits pays and also have a say' model have equity dimensions in smallholder-dominated agriculture. The equity aspects need to be resolved in an amicable manner.

Conclusions

Irrigation water pricing is one of the most discussed and little acted upon issues in the policy discourse. While pricing, as a demand management instrument is the prima dona of a policy economist, it has become a political nightmare for the policy implementers. Pricing of irrigation is critical from many angles: a) more than 70 % of the total water resources are used for irrigation and, hence, takes a lion's share in the public investment; b) irrigation generates surpluses to the farmers and, hence, an economic good; c) irrigation also attracts substantial private investments, especially groundwater; d) improvements in irrigation efficiencies could result in substantial resources, physical as well as financial; and e) irrigation investments are becoming increasingly capital intensive and can no longer be considered as social welfare measure, e.g., food security.

Though price is an important demand management variable in a strict economic sense, the criticality of water for irrigation makes it inelastic to price. As a result, the threshold levels of pricing that are required for making irrigation demand sensitive are very high. Even in the case where water is priced volumetrically, the prices fixed are often below the threshold levels. This is true even in the case of water markets. As a result, no evidence could be found on the effectiveness of price as a demand management variable. Institutional reforms have failed to address the pricing issue effectively i.e., moving towards cost-based / marginal-cost pricing. Moreover, the feasibility of pricing on a cost basis has been diminishing over the years in the context of agrarian crisis and globalization. Increasing input costs has been identified as the main reason for agrarian crisis in countries like India. Globalization has brought in the contrasts in the agriculture subsidies across countries, further strengthening the demand for subsidies in the developing world. The recent growth spurt in economies like India has pushed the cost-based pricing issues to the margin i.e., subsidies are no longer a big burden on the exchequer. In fact, allocations for expensive and unviable irrigation projects have gone up in the recent years (Reddy 2006). This appears to be a politically correct strategy, at least in the short run.

Provision of irrigation has become a major political concern rather than an economic issue. Irrigation needs to be provided at any cost to sustain agriculture, and agriculture continues to support 50 % of the population in countries like India. Since water is not a finite good, demand management becomes critical for judicious management and equitable distribution of water resources across regions and communities. Pricing of water is not an effective instrument of demand management as long as prices do not reflect the actual costs of provision. At the same time pure supply management may not be efficient in the long run. As evident from the literature available it is the combination of demand management and supply regulation that is more effective. In the given socioeconomic and political context, (cost-based) pricing though necessary is not a feasible option for demand management. And the present level-pricing is not sufficient to effect demand management on its own. On the other hand, supply regulation has been the main strategy of the irrigation administrators for demand management, especially to address scarcity. But, often supply-side management is used to the neglect of demand-side management pushing the departments into debt.

Pricing in the present context need to be considered to the extent of generating resources in order to meet the O & M costs and reduce the financial burden on the exchequer. Pricing is also needed to emphasize that water is not a free social good. Supply regulation should be fostered and perhaps linked with pricing i.e. prices may vary as per supply. But in any case supplies need to be measured at the level closest to the actual users. In the Indian context supplies should be metered at the water user association (WUA) level. The WUA should take the responsibility of distributing the water equitably among its members and collect the water charges. For this, metering of supplies and strengthening of WUAs is mandatory. As evident in the case of Gujarat, metering of power along with supply regulations alone could not address the equity issues in groundwater distribution. Institutions should make equity issues integral to overall resource management. This is being tried in a project in Andhra Pradesh where groundwater is managed at the community level in 638 villages (APFAMGS 2008).

Pricing becomes affordable if the land and water productivities are enhanced. This coupled with effective institutional arrangements could pave the way for full-cost or marginal-cost based pricing in the long run. Water saving technologies like sprinkler and drip systems need to be promoted through institutional arrangements rather than through subsidies. WUAs need to be encouraged and capacitated to promote these technologies. Of late, labor saving technologies like mechanical threshers and harvest combines are promoted through WUAs in Andhra Pradesh, India (Deshpande et. al. 2008). Either way, institutional strengthening holds the key for effective demand management of irrigation.

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