VOLUMETRIC PRICING OF IRRIGATION WATER IN INDIA: EXPERIENCES AND LESSONS LEARNED

S. A. Kulkarni[1]

ABSTRACT

Volumetric method of pricing irrigation water has always been advocated as the better approach to induce water savings by farmers. However, owing to seemingly technical and administrative complexities in adoption of the volumetric method - especially in large public canal irrigation systems, the area based pricing method is widespread in most countries. In India, during the last decade, there has been significant development in adoption of the volumetric supply and pricing through participatory irrigation management. Present paper provides a brief overview of international practices and the present status of irrigation water pricing and participatory irrigation management in India. A case study of volumetric allocation, supply and pricing adopted by a Water User Association (WUA) in the State of Maharashtra has been presented. The experiences and lessons learned from the case study and similar other WUAs have clearly demonstrated that a combination of volumetric supply and pricing at the entry point of a WUA command area and subsequent distribution and recovery on crop-area-season basis by the WUA can become successful. Although, the much perceived objective of achieving water savings due to the volumetric pricing was not directly realized, there prevails a win-win situation both to the government department staff and WUAs /farmers. For irrigation staff, this approach has minimized the efforts in area measurement and vigilance on the area irrigated by farmers, and billing of irrigation charges has become simpler. From farmers' side, as there is a full freedom of cropping pattern and the volumetric water charging system being transparent, they are willing to pay higher rates and use the available water efficiently by irrigating more area with same amount of water. Nevertheless, there is a vast scope to refine /upgrade the present system, especially in respect of increasing the accuracy and reliability of flow measurement. The concept of volumetric supply can gradually be introduced at individual farmer's level by roping in available technology and farmers' involvement. There is a particular need to strengthen the role of WUAs to equip them for the enhanced responsibilities which calls for a major capacity building exercise.

1- Director I, Central Office, International Commission on Irrigation and Drainage (ICID), New Delhi <icid@icid.org>

INTRODUCTION

There are many methods of assessing irrigation water prices in different countries across the world; most common being - area based, crop and area based, volumetric, and market based methods. Charging of water on volumetric basis has been considered as superior approach to overcome deficiencies of charging by area based method. The volumetric pricing approach is considered to be conducive to create an incentive for efficient allocation and use of irrigation water and has been advocated by the World Bank and other international donors. The countries employing volumetric pricing approach include Australia, England, France, Israel, Jordan, Mexico, Morocco, Spain, and USA. In California, about 80 % of the more than 100 irrigation districts have shifted to volumetric charging system since the past 20 years (Burt, 2006). In these irrigation districts, the land holdings are large and water is distributed mostly through pipe network up to farm head. In Philippines volumetric charging is practiced as a means of achieving simplicity of billing (Cornish et al., 2004).

There is a vast array of literature available on irrigation water pricing. Water pricing experiences across 22 countries for irrigation purposes have been presented by Dinar and Subramanian (1997). A literature survey on pricing of irrigation water was brought out by the World Bank (Johansson, 2000). The overview of worldwide experiences of water charging in irrigated agriculture is provided by Bosworth et al., (2002), Cornish and Perry (2003), and by Cornish et al., (2004).

In Morocco, the water charges range from US$ 0.02 to 0.06 / m^3 which correspond to about US$ 100 or more per hectare for typical field crops (Cornish and Perry, 2003). Perry (2001) reported volumetric water charges in Iran as US$ 0.004 /m^3, which amounted to US$ 30-40/ha for wheat, barley and maize and US$ 90/ha for rice. He found that if volumetric prices are to be used to induce farmers to invest in improved on-farm technology (e.g. sprinkler, micro irrigation) to save water, these water charges would have to exceed US$ 0.08/m^3 – a 20 fold increase – for the investment in on-farm water management to be profitable. It was thus observed that volumetric pricing in any form, in the absence of much higher water charges, will have very little impact on farmers' choice of crop or choice of irrigation technology. As per the recent report of the Working Group on Financing Water for Agriculture (WWC, 2006), irrigation charges at a level necessary to cover O & M costs tend to be too low to affect farmer's behavior and are useless as tool of water conservation. On the other hand, if the charges were raised to a level that would influence farmer's behavior, it would be politically unacceptable. Paradoxically, raising the price of canal irrigation water could induce farmers to extract more water from groundwater sources, which is highly subsidized (notably in India) through free electricity for pumps leading to overexploitation of aquifers.

Most water pricing literature has indicated that the extra cost of constructing flow measuring devices and related administration of measuring discharges, compilation and preparation of bills is often prohibitive, especially in large and spatially spread public irrigation system serving thousands of smallholders and thus the volumetric based

charging system is not-worth-the-cost of its implementation. As a result, area based fixed rates are dominant in most irrigation systems.

PRICING OF IRRIGATION WATER IN INDIA

In India, pricing of irrigation water has been debated since long. Various committees and commissions have examined the issue from time to time and have given their recommendations. Irrigation commission (1972) recommended that the water rates should be 5% - 12% of the total value of farms produce, the lower percentage being applicable to food crops and higher for cash crops.

Vaidyanathan Committee (1992) recommended a two-part tariff comprising a fixed charge applicable to entire command area as a membership charge, a variable charge based on area irrigated to recover annual operation and maintenance (O & M) cost, and 1% interest on the capital cost. Full cost recovery was recommended to be the ultimate goal. To accomplish this goal the needed changes were to be brought out in phases, eventually leading to pricing on volumetric basis supported by improvement of existing systems, creations of autonomous, financially self-reliant entities at the system level with participatory management by users. Eventually, some of the recommendations have been implemented by a few State Governments. The volumetric pricing of irrigation water is one among others.

In India, all public irrigation systems are Government administered and there is no direct link between water charges and O & M cost. The water rates vary widely from State to State and are decided more as political decision. The water rates presently being charged are highly subsidized and are much less than even the recurring O & M expenses (CWC, 2004). In India, owing to its simplicity, charging of irrigation water on area basis is the most widespread practice. Considerations forming the basis for water charges on area basis include - source (surface water, groundwater), supply type (gravity, lift), season (rainy, winter and summer), type of crop (food grain, cash crops), duration of crop growing season (seasonal, two seasonal, and perennials), method of irrigation (drip, sprinkler), land classification (like wet and dry lands), and scale of the project (major, medium, and minor). In some States water charges are combined with land revenue while in some other electricity to pump groundwater for irrigation is provided free of cost. In some States there is no charging of water for irrigation purposes. In general, in India allocation for O & M are typically half or less of real O & M expenditure needs (CWC, 2004). The prevailing water charges range from about less than US$ 1 to $ 140 per hectare. Table 1 shows the water rates for paddy, wheat and sugarcane in canal command (flow irrigation) areas in major irrigating States of India.

Table 1. Water charges range (lowest and highest) for some crops in India

Sl. No.	State	Irrigation water rates (Rs /ha)		
		Paddy	Wheat	Sugarcane
1	Andhra Pradesh	247 – 494	----	247 – 494
2	Assam	281 – 751	----	222
3	Bihar	108 – 247	138 – 185	185 – 370
4	Gujarat	**701 – 825**	200 – 240	280 – 2750
5	Haryana	148	111 – 123	172 – 197
6	Jharkhand	108 – 217	138 – 185	370
7	Karnataka	247	148	988
8	Madhya Pradesh	200 – 494	200	741
9	Maharashtra	238	**476**	**6297**
10	Rajasthan	49 – 197	64 – 148	103 – 286
11	Tamil Nadu	37 – 49	----	49
12	Uttar Pradesh	40 – 287	128 – 287	99 – 474

PARTICIPATORY IRRIGATION MANAGEMENT (PIM) IN INDIA

The National Water Policy of India (MOWR, 2002) emphasizes that allocation of irrigation water should be done with due regard to equity, social justice and that the supply of water should be made on volumetric basis. Now many States have adopted Participatory Irrigation Management (PIM) approach, where irrigation water is supplied to the Water User Associations (WUAs). As per the Ministry of Water Resources (MOWR), the Govt. of India, more than 60,000 WUAs covering about 12 million hectares have been formed in the country (personal communication). States where PIM has been adopted on a significant scale are Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu. However, excepting the States of Maharashtra and Gujarat, the volumetric allocation and supply is yet to be adopted in other States.

VOLUMETRIC PRICING IN MAHARASHTRA

Maharashtra State, situated in the south-west of India has semi-arid climate and irrigation is essential to obtain assured and reasonable crop yields. Of the total cultivable area of 22.4 million hectares, some 1.26 million ha are irrigated by canal (surface) water (inclusive of 0.44 million ha by wells in the command area) (WRD, GOM, 2006a). As a part of water sector reforms, special campaigns were taken up to promote PIM by formation of WUAs in the public canal irrigation schemes.

The first successful attempt of establishing a WUA in Mula project was made in Maharashtra in 1989. Since then the PIM movement has been spreading slowly but steadily in the State. At present, more than 1100 WUAs covering about 0.35 million hectares are fully functional (Damani et al., 2006). Beside this, more than 1500 WUAs covering 0.6 million ha were in pipeline. Figure 1 shows the growth of WUAs in Maharashtra.

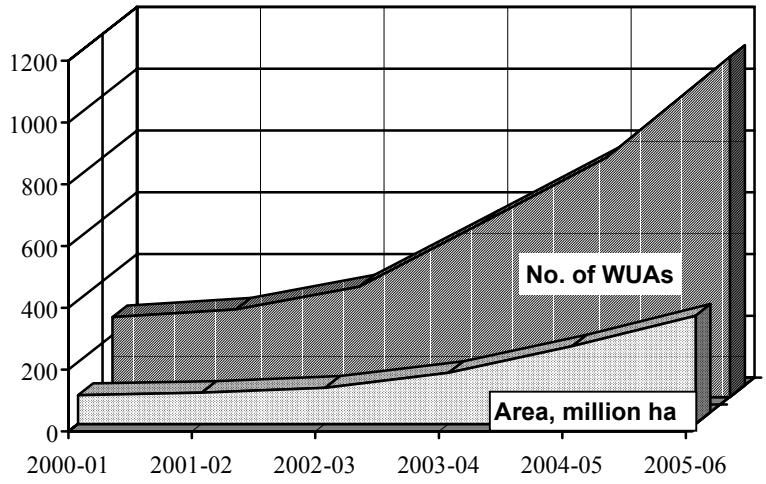

Figure 1. The growth of Water User Associations in Maharashtra State

Maharashtra is one of the pioneering States in initiating supply and pricing of irrigation water on volumetric basis. As per the Maharastra State Water Policy, 2003, Maharashtra Management of Irrigation Systems by Farmers (MMISF) Act 2005, and Maharashtra Water Resources Regulatory Authority (MWRRA) Act, 2005, it is mandatory to allocate water to WUAs on volumetric basis. In the public canal irrigation schemes, water is supplied to the WUA at the minor (tertiary canal) head (an entry point of the WUA's command area) and charged on volumetric basis. The WUA has the freedom to deliver water to its members either on crop-area or delivery time basis and also to determine rates to be paid by the members to the WUA. The farmers have freedom to grow crops of their choice and reuse the return groundwater (through percolation and seepage) through wells without any extra charge. Farmers generally make conjunctive use of canal and groundwater for irrigating their crops. Crops like vegetables and orchards which require irrigation at short intervals are often irrigated by groundwater, besides surface water made available during rotations. There is a provision that if water is not availed in a particular rotation or season, it can be saved / reserved and demanded in the next rotation or season.

In order to promote the concept of volumetric supply and pricing, capacity building and training of field level functionaries, and farmers is taken up on regular basis. Seminars and workshops with the active involvement of NGOs and experts are held to orient and explain the technical and socio-economic aspects of volumetric pricing to engineers as well as farmers.

FIXING OF VOLUMETRIC PRICING

Allocation of water volume (quota) on seasonal and area basis varies from project to project and decided on the basis of- (i) Live storage capacity of the reservoir (ii) Evaporation losses from the reservoir (iii) Commitments /reservations for irrigation and non-irrigation uses both at upstream and downstream (iv) Cropping pattern in different seasons, and (v) Conveyance losses in canal and distribution network.

In Maharashtra, the volumetric charges for bulk water supply have been so fixed that the assessment on the volumetric rate and the prevailing crop-area-season rate almost matches. The volumetric rates vary as per the season – low in monsoon (kharif) season and high in summer (hot weather) season. The present volumetric rates in the State are Rs. $47.6/10^3$ m^3 for kharif season (1 July to 14 October), Rs. $71.4/10^3$ m^3 for rabi season (15 October to 28 February), and Rs. $144.8/10^3$ m^3 for hot weather season (1 March to 30 June). These volumetric rates are applicable until the next revision of the crop area rates. A comparison of water rates on crop-area-season and volumetric basis is shown in table 2.

FLOW MEASURING DEVICES IN CANALS

In India, the tradition of flow measurement in canals is in vogue since more than a centaury, and the conventional measuring devices like Standing Wave Flume (SWF), Parshall Flumes, Orifices and V notches are generally used. In some States, the measuring devices are not constructed separately, but only the gauges .are installed in the canals. The discharges are then computed by using Manning's or other empirical formula.

In Maharashtra, in most of the irrigation projects, the discharge measurement data of main canals, branch canals /distributaries is routinely maintained. A SWF was installed on Mutha canal in 1928. Since then the SWF is normally provided on all canals and distribution system having discharging capacity more than 0.15 cumecs. Later in 1970s, under the World Bank and USAID assisted programmes, Parshall and Cut-Throat Flumes were introduced for measuring flow below 0.15 cumecs. Manuals and Standards on design and construction of measuring devices have been prepared by the Department. Irrigation engineers are trained in the subject at the State's Water and Land Management Institute (WALMI) on regular basis. A typical installation of a SWF on a minor in the Waghad project is shown in figure 2.

Table 2. Comparison of water rates on crop-area-season and volumetric basis (Adopted from Damani et al., 2006)

Season	Crops	Water rates on crop-area basis		Water rates on volumetric basis	
		(Rs./ha)	(US$ /ha)*	(Rs./10^3 m^3)	(US$ /10^3 m^3)*
Kharif	Millet	238	5.3	47.6	1.06
	Sorghum	238	5.3	47.6	1.06
	Peanut	724	16.0	47.6	1.06
	Rice- paddy	724	16.0	47.6	1.06
Rabi	Wheat	476	10.6	71.4	1.6
	Sorghum	357	8.0	71.4	1.6
	Gram	476	10.6	71.4	1.6
Two-seasonal	Kharif and Rabi crops (e.g. Cotton)	724	16.0	59.5	1.3
Hot weather	Peanut	1438	32.0	144	3.2
Perennial	Sugarcane	6297	140	87.7	1.9

* (1 US$ ≈ Rs. 45)

Figure 2. A view of a Standing Wave Flume in operation (left) and a gauge chamber (right)

VOLUMETRIC PRICING IN JAI JAGDAMBA WATER USER ASSOCIATION – A CASE STUDY

Waghad dam located in the north Maharashtra is one of the four dams that comprise the Upper Godavari Project. The dam was constructed in 1979 with a live storage capacity of its reservoir as 72 million cubic meters. Water is conveyed through two main canals viz., a 45 km long Right Bank Canal and a 15 km long Left Bank Canal. The culturable command area of the Waghad irrigation scheme is 9642 ha and the irrigable command is 6750 hectare. There are 24 WUAs covering the entire command area of the scheme. Recently, the entire project has been transferred to a Project Level Association (PLA) by forming a 'Federation of Water User Associations' under 'Maharashtra Management of Irrigation Systems by Farmers (MMISF) Act 2005'. Water is supplied to the PLA at the main canal head on volumetric basis, which is further distributed among WUAs as per their sanctioned quota. The water quota allocation for kharif and rabi season in the Waghad command has been worked out as 1360 cubic meter/ha and 1648 cubic meter/ha for kharif and rabi seasons, respectively (Belsare, personal communication).

Jai Jagdamba Water User Association is one of the 24 WUAs of the Waghad Irrigation scheme and was formed in 1997. The command area of the WUA is 338 ha and receives water from two minors (minor No. 16 and 17) and three direct outlets (19A, 20 and 21) of a distributary. There are 162 beneficiary farmers belonging to three near by villages. Originally, the Waghad system was planned and designed for supplying water only for two seasons (kharif, and rabi) and mostly for providing supplemental irrigation to cereal crops. The agreed upper limit of water volume (quota) allocated to the Jai Jagadamba WUA following the agreed norms is 166 x 10^3 m^3 for kharif season, and 356 x 10^3 m^3 for rabi season. However, the WUA has freedom to use any amount of water within the total allocated quota (522 x 10^3 m^3) during any season and also to grow crops as per farmers' preference. Subsequently, all farmers shifted to cash crops (sugarcane, grapevines, vegetables, and flowers) with food grain crops grown on small area. As per the provision, if the WUA saves from the allocated water quota of either kharif and/or rabi season, it is entitled to get the balance volume of water (after consideration of evaporation and other losses) for irrigating crops in the hot weather season. Generally, there is no demand for water in kharif season as rain water and groundwater are sufficient to satisfy crop water requirement. There are 176 open wells and 64 bore wells in the command area of the WUA. Conjunctive use of water is extensively practiced, meaning crops are irrigated both from canal water and groundwater. The WUA receives bulk water on volumetric basis as per the overall water quota allocation policy of the Waghad Project and subject to the actual storages in the reservoir. Individual members receive water as per their sanctioned area and schedule - prepared prior to each irrigation rotation by the WUA. Internal distribution of water, assessment and recovery of charges rests with the WUA. Members are charged on crop-area basis while the WUA pays to the Department on volumetric basis. Table 3 shows an abstract of area irrigated and water supplied to the WUA in each of the three rotations in the hot weather season- 2005-06.

Table 3. Crop wise area irrigated and water supplied in hot weather season (2005-06)

Crop	Area irrigated in rotation (Hectare)		
	1st (3 to 9 April 2006)	2nd (11 to 16 May 2006)	3rd (28 and 29 May 2006)
Grape Vines	32.7	39	11.6
Vegetables	11.8	11.20	1.3
Others	5.92	6.8	0.8
Sub total	50.42	57.0	13.7
Water supplied to the WUA (10^3 m^3)	102.6	113.4	27.1

A sample discharge measurement record of the minor 16 for the rotation 2 as maintained by the Water Resource Department and the WUA is shown in table 4.

Table 4. Record of gauge reading (H) and corresponding flow (Q) of the SWF at the minor 16 for the rotation 2

Date		Gauge reading at the hour									Average Volume	
		6	9	12	15	18	21	24	3	6	(Day-Cusecs)	(10^3 m^3)
11/5/2006	(H)	-	0.55	0.55	0.52	0.48	0.48	0.48	0.48	0.47		
	(Q)	-	7.15	7.15	6.45	5.81	5.81	5.81	5.81	5.62	4.91	12.2
12/5/206	(H)	0.47	0.47	0.46	0.46	0.52	0.58	0.58	0.58	0.58		
	(Q)	5.62	5.62	5.45	5.45	6.45	7.75	7.75	7.75	7.75	6.62	16.2
13/5/2006	(H)	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.52		
	(Q)	7.15	7.15	7.15	7.15	7.15	7.15	7.15	7.15	6.45	7	17.1
14/5/2006	(H)	0.58	0.55	0.46	0.42	0.38	0.55	0.6	0.58	0.58		
	(Q)	7.75	7.15	5.45	4.75	4.1	7.15	8.15	7.75	7.75	6.67	16.3
15/5/2006	(H)	0.58	0.62	0.48	0.42	0.44	0.55	0.48	0.42	0.42		
	(Q)	7.75	8.15	5.91	4.75	5.09	7.15	5.91	4.75	4.75	6.02	14.7
16/5/2006	(H)	0.42	0.4	0.34	0.32	0.45	0.2	-	-	-		
	(Q)	4.75	4.45	3.49	3.18	5.27	1.57	-	-	-	2.26	5.52
Total											33.48	82

The rotation and season wise volume of water supplied to the Jai Jagadamba WUA and corresponding area irrigated during the last five years (2001 to 2006) is shown in table 5.

Table 5. Season and rotation wise water supplied to the WUA and area irrigated

Year	Season	Irrigation rotation No.	Volume supplied to the WUA (10^3 m^3)	Area Irrigated (ha)	Av. water withdrawal at the minor head (m^3/ha)
2005-06	Rabi	1	65.1	31.8	2047
		2	84	38	2211
		3	117.8	55.5	2123
		4	83.5	40.1	2082
	Hot Weather	1	102.6	50.42	2035
		2	113.4	57	1989
		3	27.1	13.7	1978
2004-05	Rabi	1	42.29	18.9	2238
		2	86.1	38.6	2231
		3	110.8	52.6	2106
	Hot Weather	1	115.3	56.1	2055
		2	96.5	47.3	2040
		3	26.7	11.34	2354
2003-04	Rabi	1	92.3	43.1	2142
		2	112.2	53.7	2089
	Hot Weather	1	97.6	46.9	2081
		2	68.8	33.2	2072
2002-03	Rabi	1	136.5	59.1	2310
		2	142.3	74.2	1918
		3	87	45.3	1921
	Hot Weather	1	120	57.1	2102
2001-02	Rabi	1	78.3	35.9	2181
		2	124	66.5	1865
	Hot Weather	1	120.4	59	2041

As can be seen from the table 5 that the area irrigated in each rotation varied from 11 ha to 74 ha during the last five years. On an average about 2000 cubic meter was used to irrigate a hectare (at minor head). As mentioned elsewhere, conjunctive use of surface and groundwater is extensively practiced in the command of the Jai Jagadamba WUA and in the hot weather season about 166 hectares were irrigated by wells, indicating significant reuse of recharged water. Some farmers have constructed farm ponds to store

rain water and in some cases irrigation water. Grapevines are grown on about 130 hectares and almost all the area is irrigated by drip system. The computation of water charges for the hot weather season (2005-06) to be paid by the WUA to the Water Resources Department is shown in table 6.

Table 6. Assessment of water charges by the Water Resources Department to the WUA for the hot weather season 2005-06

Total water delivered to the WUA (10^3 m^3)	Water rate (Rs./10^3 m^3)	Amount (Rs.)	Local cess (20% of the amount in column 3, Rs.)	Total water charges to be paid by the WUA (Rs.)
(1)	(2)	(3)	(4)	(5)
243.1	144.8	35,200.90	7040.2	42,241.00 (US$ 939)

The Water Resources Department gives a rebate of 20% on the total charges to WUAs as a grant and a further rebate of 5% is given if the WUA pays the water charges by 15 October of that year. The Jai Jagadamba WUA charges Rs. 750 /ha for all crops in the rabi season and Rs. 1075 /ha /rotation for all crops in hot weather season to its members. The amount charged for the hot weather season (2005-06) was Rs 130,203 thus leaving profit of Rs .87,962 (inclusive of the rebates as above) to the WUA.

EXPERIENCES AND LESSONS LEARNED

The volumetric pricing has been proved as a win-win approach both to Water Resources Department and WUAs /farmers. Generally, there has been a positive attitudinal shift towards volumetric pricing among Department personnel –from the top administration to the lower level field staff. Some experiences and lessons learned in implementation of the volumetric supply and pricing in Maharashtra state are briefed as follows:

WATER RESOURCES DEPARTMENT

Initially, engineers had a feeling that the farmers, being illiterate would not understand the discharge measurement procedure and hence it would be difficult to implement the volumetric supply. Many field engineers used to complain that the farmers tend to tamper /break the measuring devices and hence there is no point in constructing /repairing them. Some field officers had an apprehension that once the volumetric supply system is introduced they will be fully accountable in delivering the committed quota and flexibility in supply to the WUAs.

As accounting of water is in-built in the volumetric supply system, assessing water charges and preparing bills became simple and time /cost saving. As the scheduling of water, maintenance of the system below the minor head and recovery of water charges from individual farmers is taken care by the WUAs, there has been a decline in number of complains from farmers. The tedious task of measurement of irrigated areas of every

farmer in each rotation has been curtailed. Both, the Department and the WUAs jointly keep record of flow measurement at the minor head. The assessment and billing can be done quickly without waiting for measurement /verification of actual irrigated areas. As the measurement of discharges at different points of the canal network become mandatory, it provides factual information on the extent of conveyance losses in the system.

WUAS AND FARMERS

WUAs / farmers have incentive to apply water efficiently and water thus saved can be used to irrigate additional area and /or for the next season. Tail end farmers who were earlier deprived of getting reliable and adequate water supply are now getting assured and equitable supply. The WUAs have developed a confidence as they know about the quantum of water being used by them in a transparent manner. The water charges are payable for an actual volume received at the minor head. The recharge due to seepage /percolation of water in the command area of the project is available for reuse, free of charge.

Some farmers feel that the measuring devices obstruct /reduce the flows due to constriction /hump and hence they tamper or break the measuring device. When explained properly with field demonstration that they are required to pay only for actual quantity of water supplied /received by them, most of the farmers /WUAs were convinced and accepted the volumetric supply. Once the farmers understand the full implications of measurement of discharge, they insist on charging water on volumetric basis, instead of crop-area basis. This has created a sort of competition among WUAs for irrigating more and more area with the same volume of water.

REGULATORY PROVISIONS

To adopt volumetric supply, a regulatory framework for allocating water among farmers, acts, rules and procedures defining rights and responsibilities, priorities in case of shortage or excess supplies, penalties for breach of rules greatly help empower both irrigation officials and WUAs.

CAPACITY BUILDING AND TRAINING

Capacity building and training of the field staff of the Water Resource Department, office bearers, farmers and employees of the WUAs in understanding the volumetric pricing, measurement of discharge, calculation of volumes and preparation of bills, maintenance of flow measuring devices, crop water requirement, efficient on-farm irrigation methods, measuring losses in canals and water courses will go a long way in building confidence and competence among them.

FLOW MEASURING STRUCTURES

Some common deficiencies in construction and maintenance of measuring devices as observed are as follows:

Construction: The throat width of the flumes is altered during or after the construction due to application of a cement plaster layer. The gauge chamber is not properly constructed. The gauge sill levels are not connected to the hump or sills of the measuring device i.e. the zero level of the gauge does not tally with hump level. The distance of the gauge from the throat sill is not kept as per design. The pipe connecting the canal to the gauge chamber is either choked or provided with higher diameter than the design or at times the pipe is not provided at all. The fluming on upstream and down streamside is sometime not done with care and as per the geometrics of the device. In some cases the measuring structure is installed at incorrect location where required approach conditions do not prevail.

Operation and Maintenance: Measuring devices are not properly calibrated. Most of the flumes work under submergence condition. Gauge chambers are filled with debris and are not maintained on regular basis. Gauges are either damaged or not painted regularly. In case of chambers in deep cutting, the stairs /steps to go down for gauge reading are damaged. The sills /humps of measuring structures are generally broken or damaged. The downstream section is rough, filled with debris, which obstructs the formation of a standing wave or jump.

WAY FORWARD

Volumetric supply and pricing of irrigation water in India is still at experimental stage and has to go a long way before it becomes a widely accepted and an integral component of WUA's operation. The case study has amply demonstrated that farmers are willing to pay higher water charges provided the supplies are reliable, flexible, equitable and there is a transparency in the billing system. In the Waghad project, a few WUAs have gone one step ahead by practicing internal distribution of water on hourly basis instead of crop-area basis (proxy volumetric approach). Nevertheless, the political will, quality of service, and leadership are the *buzzwords* to make it happen. There is a need to make the flow measurements more accurate, reliable and the structures more robust. The flow measuring device may be equipped with an automatic water level recorder /totalizer to account for fluctuating flow rates and convert those into volumes. Deficiencies in the construction and maintenance of the measuring structures need to be removed. Some innovative flow measuring devices may be tried. There is a need to provide water level regulating structures in the canal network to maintain stable flows at the measuring points. Capacity building and training of all concerned – Department personnel and farmers should continue. With the given scenario, one can hope of using volumetric water pricing as a tool to bring about water savings in reality.

ACKNOWLEDGEMENT

The Author is grateful to Mr. M. Gopalakrishnan, Secretary General, ICID for his encouragement in preparation of the paper. Thanks are due to Dr. Sanjay Belsare, Executive Engineer and Er. Avinash Lokhande, Section Officer, Palkhed Irrigation Division, Nashik, Maharashtra for providing information and data related to Jai Jagadamba Water User Association.

REFERENCES

1. Bosworth B., G. Cornish, C. Perry, F. van Steenbergen (2002): Water Charging in Irrigated Agriculture – Lessons from the literature, DFID, HR Wallingford, Report OD 145

2. Cornish G. B., Bosworth, C. Perry, and J. Burke (2004): Water Charging in Irrigated Agriculture – An analysis of international experience, FAO Report 28

3. Central Water Commission (2004): Pricing of Water in Public System in India, Information Systems Organisation, Information Technology Directorate, Water Planning & Projects Wing, Central Water Commission, New Delhi

4. Belsare S. M., Executive Engineer, Palkhed Irrigation Division, Nashik, Maharashtra (personal communication)

5. Damani R .L, Purandare P. V., Purandare V. P., and Ingle A. P. (2006): Volumetric Supply and Pricing of Irrigation water: Scenario in Maharashtra, Paper presented at the Workshop on Volumetric supply and Pricing of Canal Water, December 2006, SOPPECOM, Pune, Maharashtra, India

6. Dinar A., and A. Subramanian (1997): Water Pricing Experiences – An International Perspective, World Bank Technical Paper No. 386

7. Johansson R. C. (2000): Pricing Irrigation Water – A literature Survey, Policy Research Working Paper 2449, The World Bank

8. Ministry of Water Resources (2002): National Water Policy, Ministry of Water Resources, Govt. of India, <http://wrmin.nic.in/nwp2002.pdf>.

9. Perry, C. J. (2001): Charging for Irrigation Water: the Issues and Options with a Case Study from Iran, Research Report 52, IWMI, Colombo

10. Vaidyanathan, A. (1992): Report of the Committee on Pricing of Irrigation Water, Planning Commission, Govt. of India, New Delhi

11. Water and Land Management Institute (2004): National Workshop on Participatory Irrigation Management (PIM) and Volumetric Measurement, 2-3 July 2004, Aurangabad, Maharashtra, India.

12. Water Resources Department (2006a): Report on Water Audit of Irrigation Projects in Maharashtra, Government of Maharashtra, India

13. Water Resources Department (2006b): Report on Benchmarking of Irrigation Projects in Maharashtra, Government of Maharahstra, India

14. World Water Council (2006): Financing Water For Agriculture, Working Group on Financing Water for Agriculture, Progress Report No. 1, <www.worldwatercouncil.org>