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Tradable Water Rights and Pareto Optimal Water Allocation in Agriculture: Results from a Field Experiment in Bhavani Basin, Tamil Nadu

L. Venkatachalam
Associate Professor
Madras Institute of Development Studies

mids Madras Institute of Development Studies

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Madras Institute of Development Studies
79, Second Main Road, Gandhi Nagar
Adyar, Chennai 600 020
Tel.: 2441 1574/2589/2295/9771
Fax : 91-44-24910872
pub@mids.ac.in
http://www.mids.ac.in

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Abstract

The present study aims at exploring the feasibility of introducing a market-based economic instrument namely, the tradable water rights, for efficient surface water allocation within the agriculture sector in the Indian context. Focusing on a 'water scarce' river basin namely, the Bhavani River Basin in Tamil Nadu state, the study tries to estimate willingness to pay (WTP) and willingness to accept (WTA) values of the respective buyers and sellers of 'excess' water available in the basin, in order to assess the potential gains from water trade under the proposed tradable water rights regime. Based on the WTP and WTA values derived from a field experiment conducted within a repeated interaction framework, the study found that the average WTP values of the buyers exceeds the average WTA values of the sellers thereby paving way for market exchange on excess water at least among sixty percent of the farmers across different canal systems in the basin. The study concludes that introducing the tradable water rights as an alternative institutional mechanism will lead to Pareto efficient allocation of water, generating substantial efficiency gains in the agriculture sector. The policy and other institutional arrangements required for implementing the tradable water rights system are underlined in the final section.

Introduction

The problem of ever increasing relative scarcity of water puts a substantial amount of economic and environmental constraints on achieving the development objective of efficient, equitable and sustainable agriculture (Bjornlund, 2004). One of the major policy challenges, in developing countries like India, is how to efficiently reallocate the scarce water within agriculture since the scarcity induced social costs impose extra marginal welfare loss in the already 'distressed agriculture' sector. Of late, the positive relationship between over-extraction of water and unsustainable agricultural development has been recognized as to arise from an 'institutional failure' in the relevant sectors (Young, 1986). Such a failure arises from the fact that: a) the already existing formal institutions (such as, law, constitution, etc) and informal institutions (such as, attitude, perception, etc) governing water management are weak in nature and in certain cases they constantly interact with each other to produce welfare loss (see Dixit, 2004); b) those transaction cost minimizing, institutions (Brewer *et al*. 2007) that are supposed to bring in efficient reallocation of water do not usually emerge in the scenario because of various reasons that include existence of imperfect information, imperfect competition and pervasive negative externality (Dixit, 2004) in the water sector. In recent years, researchers have identified 'bounded rationality behavior' of economic agents (Camerer *et al*. 2005), which may also lead to inefficient use of water in case there is a substantial number of boundedly rational water users; the underlying institutions are identified to be instrumental in explaining such a behavior. Hence, water sector reforms with more emphasise on institutional arrangements have been initiated in many of the developing countries in recent past (Saleth and Dinar, 2004) and the results of these reforms are mixed in nature. Though the phrase 'institution matters' (North, 1994) has been successfully incorporated as part of developmental policies, carving out an 'appropriate institution' for addressing a particular development issue has not yet been so successful; the complexity and heterogeneity of institutions in the water sector provide an ample opportunity for the researchers to explore 'appropriate institutions' for water allocation. This paper is an attempt towards that end.

Institutional Reforms -Background

The early reforms in the water sector were based on the slogan of 'getting the price right'. Real world experiences suggest that 'pricing' of irrigation water runs into many different problems embedded in economic and political arena. On the economic front, the pricing decision is not based on the scarcity value of water so that water can be transferred to its highest value use. Rather, such a decision is based on arbitrary methods and does not reflect the actual preferences of the farmers and therefore, the farmers are less willing to pay such a price. On the political front, any effort to put a price on water is constantly opposed by the farmers' organisations and political lobbies and hence, the indented objectives of pricing (such as, revenue generation and optimal water use) may not adequately be realized if the policymakers are more inclined towards these political concerns. Moreover, mere pricing without improving service delivery and without facilitating the willing farmers to transfer water to other users will not yield any fruitful result. Another approach that was adopted in the irrigation reforms was, 'getting the property rights right'. Measures such as, Participatory Irrigation Management (PIM), are considered to fall within this broader approach. However, the empirical studies that looked at the performance of PIM schemes in some of the canal systems in India suggest that this approach has also not been effective in brining desirable outcomes in the irrigation sector (see Durba and Venkatachalam, 2010).

Since many experiments attempted with narrow approaches have failed in the past, an institutional approach with a slogan of 'getting the institutions right' is being attempted in recent years. A substantial part of this approach deals with how to exploit the market-based instruments (MBIs) to allocate surface water across different uses, provided a 'facilitating' role is being played by other institutions such as, government and water user associations. Empirical evidences from different parts of the world suggest that out of all MBIs, the 'tradable water rights' are found to be more efficient in allocating water among competing uses (Griffin, 1998; Thobani, 1998; Thobani, 1997). They are more incentive-based and do reflect the preference of the farmers that varies according to changes in the underlying factors, including level of water scarcity. It should be noted that this approach, if appropriately regulated, provides: a) sufficient incentives for the farmers to make use of the water more efficiently, b) to develop efficient infrastructure on their own, and c) to explore innovative technologies to sustain water use efficiency on a long-term basis (see Bruns *et al*, 2005; Bjornlund, 2004; Thobani, 1998; Rosegrant and Binswanger, 1994; Rosegrant and Gazmuri, 1994). However, there are researchers who are skeptical about the role of MBIs in addressing the water scarcity in the Indian context where existence of large number of small farmers and huge cost of monitoring informal water extraction are cited to be the factors suppressing the market forces (Shah and Koppen, 2005). Nevertheless, India's Water Policy 2002 and the National Environment Policy 2006 prescribe introducing MBIs in the water sector for effectively addressing the scarcity problem in the coming years. The problem with these policies is that they do not clearly spell out what kind of MBIs will be opted for in a given institutional environment. In order to make things more clear, we demonstrate that there is a substantial potential for introducing tradable water rights system for surface water in the Indian context, which is reflected in terms farmers' willingness to pay (WTP) and willingness to accept (WTA) compensation for transferring extra water from less productive use to more productive use within the agriculture sector in the context of Bhavani River basin, Tamil Nadu, India.

Description of the Bhavani River[1]

River Bhavani, though perennial, experiences the problem of relative scarcity of water due to both intra-sectoral and inter-sectoral demand for limited amount of water. The river originates from the Silent Valley forests of

Kerala, flows towards south-eastern direction up to Mukkaliyar and then towards north eastern direction up to Bhavani town, where it joins Cauvery river. Its major tributaries are the Siruvani on its right side, and Pykara, Kundah, Kallar and Moyar joins on its left-side. After running east-ward of 217 kms, it confluences with river Cauvery at a town called, Bhavani. The river gets flood water during the south-west monsoon period since it originates in the Western Ghats. The Bhavanisagar dam is the largest dam constructed in the Bhavani River. It provides irrigation for about 2,47,243 acres in its command area through four canal systems namely, Arakkankottai, Thadappalli, and Kalingarayan which come under the 'Old Canal System' (hereafter, Old System) and the Lower Bhavani Project (LBP) canal coming under the 'New Canal System' (hereafter, New System).

Old Canal System

Four hundred years back, a Rayar King of the then Mysore State built up the Kodiveri anicut on the downstream of the now Bhavanisagar dam to divert water to Thadappalli canal (on the right-side of the anicut) and Arakkankottai canal (on the left-side). The Thadappalli canal was constructed in the year 1855; it was renovated and sluice gates were installed

Table-1: *District-wise Catchment Areas of the Bhavani Sub-basin in Three States.*

State/Districts	Catchment Area (in Sq. Km.)	Percentage to the Total Area
Tamilnadu State		
1. The Nilgiris District	1,881	31
2. Coimbatore District	1,002	16
3. Erode District	2,469	40
Total	5,332	87
Kerala State Palaghat District	562	9
Karnataka State Mysore District	240	4
Total	**6,154**	**100**

Source : National Water Development Authority, Water Balance Study of Bhavani Sub-Basin, New Delhi in 1993 in the year 1919. The length of the Tadapalli canal including the branches is 90 miles and it has an ayacut area of 17,500 acres. It has two branch canals namely Singiyam canal and Kugalur canal. Arakkankottai canal was constructed during 1870-1877 and it is 34 miles long and irrigates about 7000 acres. It has also got two branch canals namely, Vaniputhur canal and Perumugai Atthani canal. Water in the main canals is opened for irrigation from April 15 to February 15 (a period of 10 months) to facilitate three crops during a crop year. Kalingarayan canal was constructed by a local philanthropist called, Kalingaraya Gounder, 600 years back at the confluence point where the Bhavani River joins with Cauveri. The total length of the canal is 56.2 miles and was designed to irrigate 8000 acres. Later on, it was extended to irrigate a total area of 15743 acres. Water in this canal is opened for irrigation from the month of June 16 to April 30 (a period of ten and half months) irrigating three crops per crop year. Altogether, the old canal system consists of an irrigated area of 32500 acres.

New Canal System

The LB is the first major irrigation project completed during the First Five Year plan period and the first irrigation project completed after Independence. The purpose of establishing the LBP was to divert the excess water available within the catchment area during the flooding season, to the dry areas of the downstream region. The project work started in the year 1947 and completed in the year 1955. Total ayacut area of the LBP irrigation system is 2,07,000 acres. In the LBP, a 'turn system' is being followed to regulate the scarce water available for cultivation. Under the turn system, the fields coming under the 'odd numbered sluices' will be irrigated during the first turn; during the 'second turn', the fields under the 'even numbered sluices' will be irrigated. In the next year, the 'turns' will change: the 'even numbered sluices' will get 'first turn' while the 'odd numbered sluices' will get the second turn. A total quantity of 24 TMC (thousand million cubic feet) of water is being released for the 'wet crops' such as paddy and sugarcane during the first turn and the irrigation period starts usually in August 15th and ends in December15th. During the first turn, half of the total ayacut area (i.e. 1,035,000 acres) of the canal is being irrigated. During second turn irrigation, which starts from December 16$^{th\ and}$ ends in March 15th, a total quantity of 12 TMC water is being released for cultivating 'dry crops' such as, turmeric, cereals and oil seeds, etc in the remaining half of the ayacut area. In a crop year, a maximum of 1,035,00 acres of land can be cultivated if adequate water is available.

Water in the Bhavani basin has become a scarce commodity because of constantly increasing opportunity cost of water use in different sectors such as, agriculture, domestic and industry sectors. Within the agriculture sector, unresolved conflicts over water, especially between the farmers in the Old System and the New System, have come to occupy the centre stage of the water management issues in the Basin. Similarly, upstream-downstream conflicts and head-reach and tail-reach conflicts are well known phenomena within each canal system (see Lennerstad and Molden, 2009). This means that small changes in water use efficiency in an area where it is low would mitigate scarcity in other areas substantially. Apart from conflicts within the agricultural sector, demand for water in the ever expanding domestic and industrial sector in the basin leads to intensify the competition for water. The net result is that the social costs imposed by increasing water scarcity in the form of reduced agricultural output, increased transaction costs, etc are increasing in the basin over a period of time. All these things are happening under the current command-and-control method of water allocation and therefore, our study is carried out with a view to address these issues under the proposed new institutional regime.

Methodology

In order to estimate the potential gains from water transfer, the 'contingent valuation' (CV) survey (Venkatachalam, 2004) was used to elicit the farmers' WTP and WTA values. Voluntary exchange in water will take place only when: (a) there are potential buyers and sellers in the basin, who would prefer to transfer some portion of their irrigation water entitlement through 'voluntary' market exchange; and (b) the marginal WTP value of a potential buyer is greater than the marginal WTA value of a potential seller. Through primary survey, we could identify potential sellers and buyers of 'excess' or 'tradable' water, across different canal systems in the river basin. The potential sellers of the water are those farmers who are: a) not willing to use their entitled water for cultivation, temporarily; b) willing to use lesser amount of their entitled water for a given crop which will leave them with some amount of water; c) willing to switch over from a high water intensive crop to a less water-intensive one in order to generate surplus water; and d) willing to adopt water conserving technology generating 'excess water'. The buyers are all those who are willing to pay for additional water for irrigation. The selling and buying decisions of the farmers are *ex-ante* decisions and taken at present for the immediate, next season of cultivation (i.e. January 2008 to April, 2008 season).

In order to estimate the WTP and WTA values, we have used an experiment within a 'repeated game theoretic framework[2], (Plott and Zeiler, 2005; Shogren *et al.* 1994; Taylor, 2006). From the potential buyers and potential sellers identified, we elicited, in the first round, their initial WTP and WTA values for specific amount of additional water to be purchased and sold, respectively. This initial round was conducted as a 'one-shot game' where the respondents were asked to state their maximum WTP value/ minimum WTA value, based on the CV scenario[3] communicated to them; in this round, the respondents had no idea about the bid values stated by other respondents and the value that they provided was based on their own individual preference. We recorded all these initial values in order to use them in the next round.

In the next round, we conveyed[4] to 'all' the buyers the minimum WTA value of that respondent whose value was the highest among all the sellers. All the buyers then were asked whether they would be willing to revise (both upwards and downwards) their WTP bid based on the WTA bid made known to them. The answer was recorded properly. Similarly, for the sellers the WTP value of that respondent whose bid was the lowest among the buyers was communicated and the sellers were asked to revise their WTA values accordingly. In the third round, we repeated the same procedure with the 'new' highest WTA and lowest WTP values. We stopped with three rounds since none of the farmers were willing to revise their bids after the third round. The values in all the rounds have been derived by using a 'scientifically' conducted CV survey[5]. The CV scenario consisted of the good under valuation (i.e. five rounds of irrigation on per acre basis), payment vehicle (i.e. in terms of tradable permits equivalent to five irrigation per acre), institutional mechanism through which water trade will take place (i.e. a centralized authority who coordinates buying and selling of permits), frequency of trade (i.e. once prior to start of cultivation season) and debriefing questions and 'cheap talk' information to ensure that the respondents are giving valid answers. In this way, we ensured the validity of the CV results.

Sampling

For the present study, we have selected a sample of 310 farmers across all the canal systems in the Bhavani basin. Using 'purposive sampling', around 52 percent of the farmers (162) were selected from the Old System that consists of Arakkankottai Canal, Kalingarayan Canal and Thadappalli Canal and the remaining 48 percent of the farmers were selected from the New System consisting of the LBP Canal. Out of 162 sample farmers selected from the Old System, around 46 percent of the farmers belongs to the Arakkankottai Canal, around 13 percent belongs to Kalingarayan Canal and the remaining 41 percent belongs to Thadappalli Canal. Out of the total sample farmers selected, the largest number of sample farmers (148 or 47.7 percent) have been selected from the LBP canal, while the smallest number of them (21 or 6.8 percent) have been drawn from the Kalingarayan Canal. The number of sample farmers representing the remaining two canal systems is more or less equal, with the sample farmers representing the Arakkankottai

Table -2 : *Canal-Wise Distribution of Sample Farmers*

Canal System		Number of Sample Farmers	Percentage
Old System	Arakkankottai	74	23.90
	Kalingarayan	21	06.80
	Thadappalli	67	21.60
New System	LBP	148	47.70
Total		**310**	**100.00**

Source : Computed from Primary Data

Table -3 : *Landholding Size of the Sample Farmers across Different Canal Systems –Reach-wise.*

Canal	Reach	Mean	Median	Std. Deviation	Minimum	Maximum
Arakkankottai	Middle	8.11	5.00	7.46	1.00	37.00
	Tail	10.38	10.00	5.73	4.00	22.00
	Overall	**8.45**	**6.00**	**7.24**	**1.00**	**37.00**
Kalingarayan	Head	3.57	2.00	2.63	1.00	7.00
	Middle	2.04	2.00	1.07	1.00	5.00
	Tail	3.50	3.50	2.12	2.00	5.00
	Overall	**2.69**	**2.00**	**1.88**	**1.00**	**7.00**
LBP	Head	7.09	6.00	5.19	0.50	25.00
	Middle	2.50	2.50	00.00	2.50	2.50
	Tail	6.79	5.00	7.08	1.00	40.00
	Overall	**6.96**	**5.00**	**5.82**	**0.50**	**40.00**
Thadappalli	Middle	3.94	2.25	3.29	1.00	10.00
	Tail	5.81	3.00	8.79	0.75	45.00
	Overall	**5.07**	**2.75**	**7.16**	**0.75**	**45.00**
All	Head	6.86	6.00	5.13	0.50	25.00
	Middle	6.26	4.50	6.52	1.00	37.00
	Tail	6.72	4.50	7.69	0.75	45.00
	Overall	**6.62**	**5.00**	**6.48**	**0.50**	**45.00**

Source : Computed from Primary Data

Canal being slightly greater (2.30 percent) than that of the Thadappalli Canal. Though the distribution of sample farmers across different canal systems is unequal, for fulfilling the major objective of the study –namely, to analyse the possible 'voluntary exchange' of water between potential sellers and buyers -we have ensured equal distribution of sample farmers across the Old System and New System (see Table-2).

Discussion of the Results

Before going into the details of the WTP and WTA results, let us discuss the general information about the agriculture and water related aspects of the sample farmers.

The average land holding size of the sample farmers in the basin is estimated to be at 6.62 acres (see Table-3). It should be noted that the average land holding size of the Arakkankottai farmers stands first with 8.45 acres, followed by the LBP farmers' with 6.96 acres –both exceeding the average land holding size (6.62 acres) at the aggregate level. Farmers in the Kalingarayan canal own smaller size of land on an average, compared to the farmers in the other canals. It should be noted that the average land holding size does not differ much across different reaches of the canal system. Altogether, the information about the land holding size of the sample farmers suggests that many of the farmers in the Bhavani basin belong to the 'medium' farmers' category. For example, the frequency distribution of the land holding size of the sample farmers reveals that around 54 percent of them owns land whose size exceeds 5 acres (but less than 10 acres) while another 20 percent farmers owns land between 2.5 acres and 5 acres. Remaining 24 percent of the sample farmers belongs to 'marginal farmers' category, owning less than 2.5 acres of land. Out of all the sample farmers, only 2.6 percent of the farmers own land exceeding 25 acres.

Table-4 explains the details about the primary crops being cultivated by the sample farmers in different canal systems during the cropping season– i.e. April –August, 2008. Out of 310 sample farmers, 308 farmers are found to be cultivating at least one primary crop during the reference period. The cropping pattern in the Bhavani basin at present suggests that paddy and sugarcane –the highly water intensive crops -are those two crops being cultivated by majority of the farmers (76 percent). Banana is being cultivated by around 6 percent of the farmers, constituting third single largest crop being cultivated by the sample farmers. Around 18 percent of our sample farmers cultivate crops called, 'other crops' such as, turmeric, oil seeds, etc, as the primary crop.

As far as paddy growers are concerned, a larger percentage of paddy growers are in the Arakkankottai canal (38.33), followed by LBP (33.33

Table-4 : *Major Crops Being Cultivated by the Farmers at Present –Canal-wise*

		Canal System				
		Arakkankottai	**Kalingarayan**	**LBP**	**Thadappalli**	**Total**
Crops Cultivated	Paddy	**46** (38.33) (62.16)	**3** (2.5) (14.28)	**40** (33.33) (27.02)	**31** (25.83) (47.69)	**120** (100.00) (38.96)
	Sugarcane	**9** (07.89) (12.16)	**2** (01.75) (9.52)	**70** (61.40) (47.29)	**33** (28.94) (50.76)	**114** (100.00) (37.02)
	Banana	**8** (44.44) (10.81)	**2** (11.11) (9.52)	**8** (44.44) (5.40)	**0** (00.00) (00.00)	**18** (100.00) (05.84)
	Other crops	**11** (19.64) (14.86)	**14** (25.00) (66.66)	**30** (53.57) (20.27)	**1** (01.78) (01.53)	**56** (100.00) (18.18)
Total		**74 (100.00)**	**21 (100.00)**	**148 (100.00)**	**65 (100.00)**	**308 (100.00)**

Source : Computed from Primary Data

percent) and Thadappalli (25.83 percent) canals. Out of 120 sample farmers cultivating paddy as a primary crop, only 2 of them (i.e. 2.5 percent) are in the Kalingarayan canal. In the case of sugarcane farmers, a larger percentage of them (i.e. 61.40 percent) are located in the LBP, than in other canal systems. Around 29 percent of the sugarcane farmers belong to the Thadappalli canal system, followed by Arakkankottai (07.89 percent) and Kalingarayan (01.75 percent). In the case of farmers cultivating banana, around 44.00 percent of them belong to Arakkankottai canal and an equal percentage of them belong to LBP canal. Only 11.11 percent of the banana growers are located in the Kalingarayan canal, while no farmer in the Thadappalli canal cultivates banana. When we look at the farmers cultivating 'other crops', we find that a larger percentage of farmers in this category belonging to the LBP canal (53.57), followed by Kalingarayan canal (25.0 percent), Arakkankottai (19.64 percent) and Thadappalli canal (1.78 percent).

Let us now see the distribution of sample farmers cultivating different crops 'within' a canal system. In the case Arakkankottai canal, around 62 percent of the sample farmers cultivates paddy crops followed by those farmers cultivating 'other crops' (14.86 percent), sugarcane (12.16 percent) and banana (10.81 percent). In Kalaingarayan canal, a large number of farmers (around 67 percent) primarily cultivate 'other crops', while 14.28 percent farmers cultivating paddy, and 9.52 percent cultivating sugarcane and banana each. In LBP, a majority of sample farmers cultivate sugarcane as the primary crop (i.e. 47.29 percent), followed by paddy growers (27.02 percent), cultivators of 'other crops' (20.27 percent) and banana cultivators (05.40 percent). In Thdapalli canal, the farming group is dominated by the sugarcane growers with 50.76 percent, followed by paddy cultivators (47.69 percent). There is only one sample farmer who cultivates 'other crop' as a primary crop, in this canal.

What lesson one can learn from the above analysis? On an average, majority of the farmers in the Bhavani basin cultivates those two major crops namely, paddy and sugarcane that are 'relatively high water intensive' in nature. In the LBP canal where there was a restriction for cultivating water intensive crops like paddy and sugarcane, around three fourth of the farmers cultivate these two crops as primary crops. This has larger implications on the use of already scarce water in the LBP canal system. This means that since these farmers will not easily switch over to less water intensive crops due lack of incentives provided by the present system, their demand for water in the future is expected to be at least at the current level. Moreover, sugarcane cultivation requires water continuously for at least 10 months and the 'regulated water supply' ('turn system') in the LBP system should have discouraged the farmers to cultivate sugarcane (Lennerstad and Molden, 2009). However, nearly 47 percent of the farmers cultivates sugarcane and this suggests that despite the regulation in water supply being followed (turn system) in the LBP at present, the farmers in this canal are somehow able to get constant supply of irrigation water to grow sugarcane. The LBP farmers incur substantial amount of transaction costs to get this continuous water supply especially, for long term crops. If the tradable water rights are introduced, the LBP farmers will have incentive to buy additional water required for growing long-duration, water-intensive crops from those farmers with excess water at a relative lower level of transaction cost. Another important aspect to be noted is that even during the 'wet crop' season, a significant number of farmers cultivate 'other crops' which are mainly dry irrigated crops in nature. This means that these farmers 'voluntarily' forego certain portion of their entitled water during this season. So, proper incentives would make them to save this excess water properly and transfer it to the needy ones. Again, the 'turn system' followed in the LBP canal is not an incentive compatible one –though it is claimed to be a desirable adaptation strategy devised by the farmers (Lennerstad and Molden, 2009). Because, during a particular season where the 'odd sluice farmers' are supplied water, the farmers in the 'even slices' are not able to cultivate their land even if they are willing to pay a very high amount for water. So, the present system of water allocation may not be highly efficient since the water is not allocated to its 'most efficient use'. Therefore, the tradable water rights regime is expected to provide appropriate incentives and disincentives for the farmers so that the water is allocated to its highest valued use.

The details of annual net farm income obtained by the sample farmers are available in Table-5. The correlation between landholding size and the net farm income is highly significant. This means that larger size of land holding is associated with larger farm income. The average net farm income for all the sample farmers is estimated to be at Rs. 93170 per annum. As in the case of average land holding size, the average net farm income of the farmers

Table-5 : *Annual Net Farm Income Received by the Sample Farmers across Different Canal Systems –Reach-wise*

Canal	Reach	Number of Farmers	Mean	Median	Std. Deviation	Minimum	Maximum
Arakkankottai	Middle	63	118333.33	75000.00	149205.85	10000.00	768000.00
	Tail	11	125454.54	50000.00	186204.92	10000.00	500000.00
	Overall	**74**	**119391.89**	**65000.00**	**153830.79**	**10000.00**	**768000.00**
Kalingarayan	Head	7	75714.28	40000.00	90895.02	10000.00	260000.00
	Middle	12	83416.66	57000.00	81745.12	10000.00	322000.00
	Tail	2	60000.00	60000.00	14142.13	50000.00	70000.00
	Overall	**21**	**78619.04**	**50000.00**	**78836.84**	**10000.00**	**322000.00**
LBP	Head	101	94742.57	50000.00	110261.38	10000.00	500000.00
	Middle	1	25000.00	25000.00	-	25000.00	25000.00
	Tail	46	70119.56	50000.00	80031.88	10000.00	500000.00
	Overall	**148**	**86618.24**	**50000.00**	**101919.39**	**10000.00**	**500000.00**
Thadappalli	Middle	26	75125.00	47500.00	100366.85	10000.00	500000.00
	Tail	41	88395.12	30000.00	144407.62	10000.00	750000.00
	Overall	**67**	**83245.52**	**40000.00**	**128439.46**	**10000.00**	**750000.00**
All	Head	108	93509.25	50000.00	108846.92	10000.00	500000.00
	Middle	102	102296.56	60000.00	131678.44	10000.00	768000.00
	Tail	100	83497.00	50000.00	123049.60	10000.00	750000.00
	Overall	**310**	**93170.80**	**50000.00**	**121156.83**	**10000.00**	**768000.00**

Source : Computed from Primary Data

in the Arakkankottai canal is also found to be greater than the overall average net farm income. The average net farm income for the farmers in the other three canal systems is found to be lesser than the overall value. However, the median values of the net farm income for Kalingarayan and LBP canals suggest that these values do not differ with overall median value. This means that the net farm income derived by majority of the farmers in the basin is more or less equal to what the farmers in the LBP and Kalingarayan canals are getting. The median value for the Arakkankottai farmers is greater than the overall median value, while that of the Thadappalli farmers is lesser.

In the case of annual net farm income per acre, we get a different type of picture (see Table-6). The farmers in the Kalingarayan canal who obtain lowest annual net farm income from all the land area that they currently cultivate are getting highest level of annual net farm income per acre (with

Table-6 : *Per Acre Net Farm Income Received by the Sample Farmers across Different Canal Systems –Reach-wise*

Canal	Reach	Mean	Median	Std. Deviation	Minimum	Maximum	Range
Arakkankottai	Middle	18296.31	10555.55	17653.31	2000.00	80000.00	78000.00
	Tail	12360.44	5000.00	17085.45	2000.00	60606.06	58606.06
	Overall	**17401.86**	**10000.00**	**17582.46**	**2000.00**	**80000.00**	**78000.00**
Kalingarayan	Head	28367.34	10000.00	45001.55	6666.67	130000.00	123333.33
	Middle	42750.00	40000.00	29102.09	5000.00	107333.33	102333.33
	Tail	19500.00	19500.00	7778.17	14000.00	25000.00	11000.00
	Overall	**35741.49**	**25000.00**	**33930.25**	**5000.00**	**130000.00**	**125000.00**
LBP	Head	18180.05	10714.28	24454.04	2000.00	160000.00	158000.00
	Middle	10000.00	10000.00		10000.00	10000.00	.00
	Tail	15992.59	10000.00	16855.53	2500.00	100000.00	97500.00
	Overall	**17444.89**	**10166.66**	**22252.71**	**2000.00**	**160000.00**	**158000.00**
Thadappalli	Middle	30852.41	14125.00	51958.84	4000.00	250000.00	246000.00
	Tail	17365.79	10833.33	14680.36	2222.22	62500.00	60277.78
	Overall	**22678.70**	**12458.33**	**34810.29**	**2222.22**	**250000.00**	**247777.78**
All	Head	18840.34	10523.80	26053.54	2000.00	160000.00	158000.00
	Middle	24351.82	15000.00	32165.10	2000.00	250000.00	248000.00
	Tail	16214.70	10000.00	15782.25	2000.00	100000.00	98000.00
	Overall	**19803.72**	**11013.88**	**25775.53**	**2000.00**	**250000.00**	**248000.00**

Source : Computed from Primary Data

Rs. 35741.49). While the farmers in the Thadappalli canal obtain net income per acre exceeding the overall average value of Rs. 19803.72, the farmers in LBP[6] and Thadapalli get lesser income than the overall average. The median values also support these findings. Another interesting aspect to be noted here is that some of the farmers obtain a net income of Rs. 2000.00 per acre per annum, which is a very small amount. In many cases, it is the 'tail reach' farmers who get the lowest per acre income while the 'middle reach' farmers getting the highest level of income per acre. Around 5 percent of the sample farmers an annual pr acre income of less than R. 2500.00, while 18 percent of the farmers getting more than Rs. 25000.00. Since cultivating water intensive crops generates more amount of farm income, the farmers who are assumed to be rational in their decision would be expected to cultivate largely the water intensive crops pushing the demand for irrigation water in the coming years.

Results of the Field Experiment

If the new institutional arrangement in the form of tradable water rights has to be introduced in the Bhavani basin, then the necessary condition is that there should be potential buyers and sellers of water. More precisely, the marginal WTP for 'additional' water by the potential buyers should exceed the marginal WTA compensation for the same amount of 'excess' water to be transferred by the potential sellers. To identify such buyers and sellers of water, we have used a specific technique during our field survey. Each one of the sample farmers was asked to provide details such as, his crops cultivated in the past season, crops to be cultivated in the coming season, water availability for the crops to be cultivated, current irrigation practices being followed, best irrigation practices that they intend to follow in future, awareness about the minor irrigation systems, etc. Based on all these information, each farmer was asked whether he could generate some amount of 'excess water' (please see footnote 13 below) from the irrigation water they are entitled for or he would prefer to have more water in addition to what he is entitled for, during the next season (i.e. January–April, 2008). Those who said they could generate excess water during the next season have been identified as 'potential sellers' and those who wanted to have additional water have been identified as potential buyers. During the main survey, the potential sellers identified were told that they are free to use the irrigation water -they are currently entitled for -in whatever way they want to use during the reference season. They were also told that in case they could 'save' some amount of water through 'improved irrigation practices' then they are free to sell that 'excess' water to the potential buyers both within as well as in other canal systems. All these potential sellers were specifically asked through a CV scenario that in case they could save 'ten irrigations'[7] during the next cropping season and sell it to potential buyers within the basin, what is their 'minimum WTA compensation' for the water they are willing to trade. Similarly, the identified potential buyers were told to state their 'maximum WTP' for obtaining 'ten irrigation' during the next cropping season, with which they could even cultivate a 'wet' crop rather than cultivating the 'irrigated dry' crop that they normally grow during the reference season.

The results from the main survey reveal that almost all the 'potential buyers' of water are located in the LBP canal (except one buyer from Arakkankottai canal) and the entire potential sellers are located in the other Old System[8]. Altogether, we have identified 125 farmers as potential buyers and 129 as potential sellers. The remaining 54 farmers in our sample were not willing to participate in water trading. In the CV survey, we have elicited WTP values from the potential buyers and WTA values from the potential sellers for trading water equivalent to 'ten irrigations' that could be saved by the latter and used by the farmer in the coming cropping season. To elicit the WTP/WTA values, we have used 'repeated experimental method of value elicitation' in the field. This method involves asking the WTP/WTA questions to the same farmer in every subsequent rounds, wherein the information about the WTP/WTA values elicited during the previous round is disclosed to the farmer in each subsequent rounds. For example, as explained in the Methodology section earlier, the maximum WTP value of the potential buyers and minimum WTA values of the potential sellers are elicited separately during the first round. Subsequently, the maximum WTP value of a water buyer (who stated a lowest WTP value among all buyers) elicited during the first round was disclosed to a seller (who stated the 'highest' WTA value among all sellers in the first round) and then this seller was asked if he was willing to revise his WTA value accordingly. Similarly, a buyer (who stated the lowest WTP value among all buyers) was provided with the WTA value of the seller (who stated the highest WTA value among all sellers) and asked if he was willing to revise his WTP value (stated in the previous round) accordingly. This kind of repeated experiment is expected to eliminate any information asymmetry among the buyers and sellers that may potentially affect the water trade in the absence of such information flow. The major objective of this experiment is to create a 'real market' situation for the water buyers and sellers so that the trade in water could reach an 'equilibrium' point.

In our experiment, we found that out of all the 148 sample farmers in LBP canal, 124 farmers (i.e. 83.78 percent) were willing to pay for additional water equivalent to 'ten irrigations'. Out of 74 sample farmers in the Arakkankottai canal, one farmer (i.e. 1.35 percent) happened to be a potential buyer and was willing to pay for the additional water. Similarly, out of the 185 sample farmers in the Old System we have identified 129 'willing sellers' (around 70 percent) spread across all the three canals in this System. The mean WTP value stated by the potential buyers for obtaining '10 additional irrigations' during the first round of our experiment stands at Rs.274.44. However, the mean WTA compensation, elicited in the first round, for selling excess water equivalent to same number of irrigations is estimated to be Rs. 318.44. The results on WTP and WTA values derived from the first round indicate that even though there are water buyers and sellers who are willing to exchange excess water, the exchange will *not* take place smoothly because of the fact that the mean value of 'selling price' (i.e. WTA) is greater than that of 'buying price' (i.e. WTP). The reason for this WTP/WTA disparity affecting the market exchange is that since the buyers (sellers) had no idea about the selling (buying) price of the water sellers (buyers) during the initial round they had to value the water based only their 'own' preference. However, one's value of water in a market environment not only depends on one's own individual preference but also on how much value that others place on the same amount of water. This means that a buyer's WTP for water is not dependent entirely on his own valuation but also on the WTA value of the seller. Recognising this 'interdependent' nature of the valuation process, we conducted the second round of value elicitation with a view to see how disclosing the value of water elicited in the first round affects the value of the respondent in the second round. In the second round, we have disclosed the maximum WTP value of that farmer whose stated WTP value was lowest among all buyers (i.e. Rs. 75.00) to all the sellers. Similarly, we have informed the buyers about the minimum WTA value of that farmer whose stated WTA value was highest among all sellers (i.e. Rs. 960.00). All these farmers were asked if they were willing to revise their initial value given by them in the first round, and were subsequently asked to revise the values in case they were willing to do so. In the case of buyers, 110 farmers out of 125 – or, 88.00 percent farmers –were willing to revise their WTP values and did so accordingly. In the case of sellers, 42 farmers out of 129 – or, 32.60 percent farmers- were willing to revise their stated WTA values and revised subsequently. After the second round, we found that the mean WTP value increased to Rs. 318.44 and that of the WTA value declined to Rs. 302.00 approximately.

In the third round, we have repeated the same procedure followed in the second round, and recorded the WTP and WTA values. In the third and final round, only 24 buyers (i.e. 19.20 percent) did revise their WTP value again; in the case of sellers, only 10 sellers (i.e. 7. 8 percent) revised their WTA values. In all the rounds, the buyers revised their values 'upwards' while the sellers revising their values 'downwards'. Another round of

Table-7 : *Change in the WTP values Across Three Rounds*

Elicitation Round	Number of Farmers	Mean Value	Median Value	Minimum Value	Maximum Value	Std. Deviation
WTP1	125	272.44	250.00	75.00	560.00	156.80
WTAC1	129	318.44	260.00	100.00	960.00	195.31
WTP2	125	308.12	250.00	100.00	600.00	169.53
WTAC2	129	301.97	250.00	75.00	960.00	190.51
WTP3	125	312.64	250.00	100.00	600.00	170.14
WTAC3	129	300.03	250.00	75.00	960.00	190.25

Source : Computed from the primary data

elicitation was not possible because almost all farmers in both the categories refused to revise their values any more. So, we stopped the elicitation process only with three rounds. In the final round, the mean WTP value slightly increased to Rs. 312.64 and the mean WTA value declined to Rs. 300.03. The repeated rounds of value elicitation suggest that in a 'market set-up' where full information about the buying and selling prices made available to the farmers, the WTP and WTA accept values converge to an equilibrium point, making the trade in the water to be optimal. Out of all the buyers, 64 percent of them are willing to pay the equilibrium price of Rs. 300 and 63 percent of sellers are willing to accept this amount as compensation. This means that water trade will take place at least among 63 percent of the sample farmers whose selling price and buying price are found to be in equilibrium. The results suggest that water transfer from the sellers to the buyers will benefit the buyers at least equivalent to Rs. 312.64 (on an average) per cropping season. However, in terms of 'efficiency gains' which should be measured in terms of market value of increased output, the benefits would be much greater than the WTP value. Similarly, the sellers are benefited additionally with Rs. 300.00 per season without any reduction in their farm income.

The distribution of WTP values of farmers across different reaches within the canal system provides us some useful information on who will benefit more from a possible market exchange of water. In the case of only one buyer in Arakkankottai canal, the 'net surplus' that could be achieved through water exchange per season is estimated to be Rs. 200.00. Because, this farmer will be better of with Rs. 200.00 worth of surplus even after paying the maximum value compensation of Rs. 300[9]. Within LBP, transfer

Table-8 : *The Distribution of WTP Values among the Potential Buyers*

Canal	Reach	Number of Farmers	Mean	Median	Std. Deviation	Minimum	Maximum
Arakkan kottai	Middle	1	500.00	500.00	00.00	500.00	500.00
	Overall	1	500.00	500.00	00.00	500.00	500.00
LBP	Head	81	276.29	200.00	167.41	100.00	600.00
	Tail	43	376.74	350.00	156.50	170.00	600.00
	Overall	124	311.12	250.00	169.98	100.00	600.00
All	Head	81	276.29	200.00	167.41	100.00	600.00
	Middle	1	500.00	500.00	00.00	500.00	500.00
	Tail	43	376.74	350.00	156.50	170.00	600.00
	Overall	**125**	**312.64**	**250.00**	**170.14**	**100.00**	**600.00**

Source : Computed from the primary data

Table-9 : *Distribution of the WTA Values among the Potential Sellers*

Canal	Reach	Number of Farmers	Mean	Median	Std. Deviation	Minimum	Maximum	Range
Arakka nkottai	Middle	46	351.73	260.00	192.47	100.00	750.00	650.00
	Tail	6	296.66	210.00	182.06	150.00	550.00	400.00
	Overall	**52**	**345.38**	**260.00**	**190.40**	**100.00**	**750.00**	**650.00**
Kalinga rayan	Head	4	170.00	165.00	61.64	100.00	250.00	150.00
	Middle	11	264.09	160.00	223.07	100.00	800.00	700.00
	Tail	2	492.50	492.50	95.45	425.00	560.00	135.00
	Overall	**17**	**268.82**	**160.00**	**202.72**	**100.00**	**800.00**	**700.00**
Thadap palli	Middle	23	218.69	190.00	111.77	100.00	500.00	400.00
	Tail	37	301.21	220.00	209.23	75.00	960.00	885.00
	Overall	**60**	**269.58**	**215.00**	**181.68**	**75.00**	**960.00**	**885.00**
All	Head	4	170.00	165.00	61.64	100.00	250.00	150.00
	Middle	80	301.43	260.00	185.85	100.00	800.00	700.00
	Tail	45	309.11	240.00	203.45	75.00	960.00	885.00
	Overall	**129**	**300.03**	**250.00**	**190.25**	**75.00**	**960.00**	**885.00**

Source : Computed from the primary data of water to the 'head reach' area is not economically viable because the mean WTP value is found to be lesser than that of the overall WTA value. However, a substantial amount of benefit would be garnered if excess water is transferred to the 'tail reach' farmers whose mean WTP value stands at Rs. 377.00, approximately. So, the conclusion is that even among the buyers it is the 'tail-enders' who will be benefited more in case the water is transferred from the excess region to the LBP area.

In the case of distribution of WTA values (Table-9), transferring water from the Kalingarayan canal and Thadappalli canal to other canals will result in more benefits since the mean WTA value is lower than that of the WTP value. This means that the buyers will get more surplus by buying water from the sellers located in these two canals. Since the mean WTA value in the Arakkankottai canal is greater than that of the WTP value, the trade in water here is constrained. However, trade between the 'tail-end' farmers in this canal and the potential buyers in other areas is possible because the mean WTA value of the 'tail-enders' is found to be lesser than the overall mean WTP value. In the Kalingarayan canal, transferring water from the 'head reach' and 'middle reach' to the scarce areas will result in more benefits while water transfer from the 'tail reach' will result in economic loss. In the Thadappllli canal, moving excess water from the 'middle' and 'tail' reaches to the scarce areas would generate substantial amount of net benefits. On an average, water transfer from the 'head' and 'middle' reaches of the Old System to scarce areas would generate net benefits while such a transfer from the 'tail reach' would generate net loss.

The analysis of WTP and WTA values for a possible water trade suggests that an alternative institutional arrangement with more 'incentive-based' mechanism inbuilt in it would generate more benefits to the farmers in the Bhavani basin, through more efficient allocation of water. Since the tradable water rights provide such kind of incentives, making effort to introduce it in the Bahavani basin would generate substantial benefits to the farmers.

Discussions and Conclusions

In the present study, to estimate the 'benefits' that could be obtained from the water allocation under the tradable regime, we have elicited WTP values from the potential buyers and WTA values from the potential sellers for exchanging excess water through market process. Through the repeated experiments, we have arrived at equilibrium level of WTP and WTA values under which trade in excess water could take place. The elicited WTP and WTA values suggest that there is a greater potential for allocating water through tradable permits mechanism, which would result in increased net benefits to the farmers. Under the existing institutional arrangement, the water allocation pattern is found to result in excess water use; therefore, diverting water from the 'excess use' area (i.e. the Old System) to the 'water scarce area' (i.e. the LBP system) would generate larger net benefits in the Bhavani basin as a whole. Therefore, our study results suggest that the tradable water rights mechanism, if introduced in the Bhavani river basin, can act as an efficient, alternative institution by way of increasing the 'value' per drop of water.

Though we have found the above new institutional arrangement would generate additional benefits, the primary institutions required for introducing and implementing the tradable water rights are to be established for this purpose, in the Bhavani basin. It is noted that the present organizations such as, public works department (PWD), responsible for allocating water may not be adequate to implement the new institutional arrangement with tradable water rights. Rather, a new institutional 'structure' at the river basin level is required for making the tradable rights to work well. It should be noted that in different parts of the world where the tradable permits are already used a mechanism to allocate water efficiently at the river basin level, a regulatory authority such as, River Basin Board or River Basin Authority, is created for the overall coordination of the activities under the tradable regime. However, one may argue that the Basin Boards or Authorities will not work properly in the Indian context. There are evidences to support this argument, even within India. For example, River Basin Authorities were created for two river basins namely, Palar and Thambirabharani, during the early 2000 in Tamil Nadu state. These authorities were created to formulate 'stakeholder' oriented water policies with an objective of reducing the conflicts among the water users and to increase the water-productivity in the basins. Though these Authorities are still functioning, they are not very effective in resolving the scarcity problems in the concerned basins. One of the reasons for this is that though these basin authorities have been established with good intention, the rules and functions that these authorities have to carry out are not properly spelt out; the information required for taking decisions on efficient water use is also not coming forth. This means that the effective functioning of the Basin Authority depends mainly on the rules of the game earmarked for the authority to play with. The dysfunctional nature of the existing Basin Authorities for the two river basins in Tamil Nadu can be attributed to the problem of 'ill-defined rules'. The lessons learnt from these two Boards can be used to strengthen similar effort in the state in future. In the case of Bhavani basin, the proposed Basin Authority can be expected to work efficiently because of the fact that the Authority will have a clear mandate of 'implementing the tradable water rights' in the basin. The Basin Board created should have individual decision makers representing all the stakeholders in the Basin, such as, the government organizations, farmers' organizations, industrial organizations, fishermen's cooperative societies, etc so that trade in water could be effected across different sectors when the relative scarcity of water changes in each sector in future. This would minimize the water conflicts across different stakeholders in the Basin when the overall scarcity regime changes within the Basin.

Within the agriculture sector, the tradable water rights can be initially traded among the WUAs (Rosegrant and Binswanger, 19940, rather than across individual farmers. It should be noted that there are 44 WUAs in the LBP canal and these associations were created deliberately for managing the water scarcity problem within the canal system. Each WUA controls 4 or 5 sectors and each sector covers 1000 acres. We found that these WUAs are functioning effectively for the several years in the past. The functioning of these WUAs is being coordinated by an umbrella organization created by the members of all the 44 WUAs. This organization is governed by a President and a Secretary, who are selected democratically by the members of the WUAs. The cost of running these WUAs and the umbrella organization is met with from the financial contribution both from the government as well as from the members of the WUAs. For example, the one time functional grant of Rs.450.00 per hectare (Central government's share of Rs.225.00 and the State government's share Rs.225.00) is being released to the WUAs on receipt of farmers' contribution of Rs.50.00 per hectare. The functional grant and farmers' contribution were deposited by the PWD in the National Banks. The interest accruing from the above deposit is being utilized for the day to day functioning of the WUAs as per the resolution passed by the WUAs. In recent years, the PWD also releases grant the WUAs as a maintenance grant at the rate of Rs.100 .00 per hectare per year. This also supplements the fund position certain extent. With these institutional and financial arrangements, the WUAs in the LBP are found to function efficiently. On top of everything, the transaction cost of running these organizations is also very low. Therefore, the WUAs promise a greater potential for making the tradable permits more efficient. However, these kinds of well-established, formal WUAs are not found in the Old System of the Bhavani basin. There are few informal associations functioning in the Old Systems but they are fragmented in terms of their objectives, functioning, etc. Therefore, establishing formal WUAs in the Old System and integrating all these WUAs under the proposed River Basin Authority will make the tradable water rights regime more efficient. Installing these institutions and making them to function involves transactions costs which need to be measured; this can be an area for further research.

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Notes

1 The information used under this heading is extracted from a report entitled, History of the Lower Bhavani Project (Volume II-Canals) prepared by the Government of Madras in 1966.

2 This is explained in the analysis part in the subsequent section.

3 In the CV scenario, the potential buyers of water were asked to state their maximum WTP for water equivalent to 10 irrigations for the next cropping season in case the irrigation water will be supplied to them under the condition of payment. Similarly, the potential sellers were asked to state their minimum WTA compensation for selling water equivalent to 10 irrigations, in case they could save such amount of water without affecting crop growth. Prior to asking the WTP and WTA questions, the farmers were told that a new 'tradable water rights system' will be introduced in the Bhavani River Basin and a River Basin Board, consisting of representatives from all the stakeholders, will be created for coordinating the water trade between buyers and sellers. The farmers were told very clearly that their current entitlement for water will never get affected under the tradable rights system. It was explained to them that their decision on whether to make use of the entitled water for their own purpose or sell the 'excess' water to others (or buy the water from others) is purely their own decision.

4 The initial interview of all the farmers was conducted through 'personal interview'. But the subsequent rounds were conducted through 'telephonic survey' where we conducted the interview through mobile phones. During the first round, we informed the farmers that we would get back to them over their mobile phones with further questions on the WTP/WTA values that they had stated during the first round. Since all the sample farmers own mobile phones, we could minimize the transaction cost conducting the repeated experiments with the farmers.

5 Scientifically used CV survey is the one which takes all possible measures - as much as possible - to reduce biases and errors that could potentially infect the true values.

6 It should be noted that the LBP farmers get irrigation only for two seasons in a year while the farmers in other canals get irrigation for three seasons. However, the average net farm income of the LBP farmers is comparable with that of the farmers in other canal system. This is because of the fact that the productivity in the LBP canal is grater than that of other canal systems.

7 During the pilot survey, we have asked those farmers who said they could generate excess water by way of reducing the 'number of irrigations' per season to tell us how many irrigations that they could 'reduce' during the January- April season (i.e. four months period) in order to generate excess water without affecting the growth of the crop that they cultivate, and in what way they could reduce. The results suggested that on an average each potential seller could save that amount of water equivalent to 'ten irrigations' during the four months period, irrespective their size of land holding. Different farmers reported different types of methods of saving water during the next season: some farmers said they were planning to cultivate less water intensive crops (such as, oil seeds), instead of paddy or sugarcane; some farmers said they would adopt 'drip' irrigation method which is becoming popular among the farmers in the basin. This method is becoming popular because farmers could save not only water but also labour, which is a scarce input in the basin. Substantial amount of subsidy is also being given to encourage the farmers to adopt this method; some of the farmers said they would substitute irrigation between different crops that they cultivate; and some other farmers said they would reduce the number of irrigations as such, provided their efforts are being rewarded properly.

8 It should be noted that at present there are ongoing conflicts over water between the LBP farmers and the farmers in the Old Canal System and therefore, one may wonder how the farmers in the Old Canal System will be even willing to accept that there is an 'excess' water in their fields, let alone agree for transferring water to the LBP farmers. The point to be noted here is that the ongoing conflict is mainly to retain the 'riparian rights' possessed by the farmers in the Old System and therefore, the potential sellers are willing to 'sell' the excess water to any potential buyer located anywhere in the Basin ***provided that they are adequately compensated for transferring the water***.

9 The farmers with higher WTP value will be better off by buying water from a seller with much lower WTA value. Similarly, we can expect the sellers also to benefit more if they sell their water to those who are willing to pay a value at least equivalent to their minimum WTA value.

References

Brewer, Jedidiah., Robert Glennon, Alan Ker and Gary Libecap (2007). 'Transferring Water in the American West: 1987-2005', *Michigan Journal of Law Reform*, 40(4): 1021–53.

Bruns, Bryan Randolph., Claudia Ringler and Ruth Meinzen-Dick (2005). Water Rights Reform: Lessons for Institutional Design, *International Food Policy Research Institute,* Washinton D.C.

Dixit, Avinash (2004). *Lawlessness and Economics: Alternative Modes of Governance,* Princeton University Press, Princeton.

Durba, Biswas and L. Venkatachalam (2010). 'Institutions and their Interactions: An Economic Analysis of Irrigation Institutions in the Malaprabha Dam Project, Karnataka, India,' *ISEC Working Paper No.250*, Institute for Social and Economic Change, Bangalore.

Griffin, Charles W (1998). 'The Application of Water Market Doctrines in Texas', In: K. William Easter, Mark W. Rosegrant and Ariel Dinar (Eds.) *Markets for Water: Potential and Performance,* Kluwer Academic Publishers, Boston, pp. 51 – 64.

Bjornlund, Henning (2004). 'Formal and Informal Water Markets: Drivers of Sustainable Rural Communities', *Water Resources Research*, 40 (9): W09– S07.

Lennerstad, Mats and David Molden (2009). 'Adaptive Water Resource Management in the South Indian Lower Bhavani Project Command Area', *IWMI Research Report 129,* International Water Management Institute, Colombo.

North, Douglass C. (1994). 'Institutions Matter' In: http://129.3.20.41/eps/eh/papers/9411/9411004.pdf (Accessed 22 march, 2010).

Plott, Charles R and Kathryn Zeiler (2005). 'The Willingness to Pay-Willingness to Accept Gap, the "Endowment Effect," Subject Misconceptions, and Experimental Procedures for Eliciting Valuations', *American Economic Review,* 95 (3): 530 – 545.

Rosegrant, Mark W and Hans P. Binswanger (1994). 'Markets in Tradable Water Rights: Potential for Efficiency Gains in Developing County Water Resource Allocation, *World Development,* 22 (11): 1613 – 1625.

Rosegrant, Mark W and Renato S. Gazmuri (1994). 'Reforming Water Allocation Policy through Markets in Tradable Water Rights: Lessons From Chile, Mexico, and California', *EPTD Discussion Paper No. 6,* International Food Policy Research Institute, Washington, D. C.

Saleth, Maria R and Ariel Dinar (2004). '*The Institutional Economics of Water: A Cross-Country Analysis of Institutions and Performance',* Edward Elgar, Cheltenham, UK.

Shah, Tushaar and Barbara van Koppen (2006). 'Is India Ripe for Integrated Water Resources Management? Fitting Water Policy to National Development Context', *Economic and Political Weekly,* Vol. 41 (31): 3413 – 3421.

Shogren, Jason F, Seung Y. Shin, Dermot J. Hayes, James B. Kliebenstein (1994). 'Resolving Differences in Willingness to Pay and Willingness to Accept' *American Economic Review,* 84 (1): 255 –270.

Taylor, Laura O (2006). 'Experimental Methods for the Testing and Design of Contingent Valuation', In: Anna Alberini and James Khan (Eds.) *Handbook on Contingent Valuation,* Edward Elgar, Cheltenham, pp: 177 –203.

Thobani, Mateen (1998). 'Meeting Water needs in Developing Countries: Resolving Issues in Establishing Tradable Water Rights', In: Easter, William K., Mark W. Rosegrant and Ariel Dinar (Eds.). *Markets for Water: Potential and Performance,* Kluwer Academic Publishers, London, pp: 35 – 50.

Thobani, Mateen (1997). 'Formal Water Markets: Why, When, and How to Introduce Tradable Water Rights', *World Bank Research Observer,* 12(2): 161 – 179.

Venkatachalam, L. (2004). 'The Contingent Valuation Method: A Review', *Environmental Impact Assessment Review*, 24(1): 89 – 124.

Young, Robert A (1986). 'Why are there so few Transactions among Water Users?' *Land Economics*, 65 (8): 1143 – 1151.

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