The paradox of groundwater scarcity amidst plenty and its implications for food security and poverty alleviation in West Bengal, India: What can be done to ameliorate the crisis?

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Abstract

West Bengal is a state of plentiful rainfall, high groundwater potential most of which is available at very shallow depths. It is also one of the poorer states in India. In view of this, many agencies such as Reserve Bank of India and the World Bank have recommended groundwater irrigation as an important tool for rural poverty alleviation. West Bengal had recorded high agricultural growth rates in the early 1990s and groundwater irrigation played an important role in that growth. Unfortunately, this growth could not be sustained. This paper argues that one of the main reasons for recent stagnation in West Bengal's agriculture is the severe 'energy-squeeze' it is experiencing due to overwhelming dependence on diesel pumps, recent escalation in diesel prices and low rates of rural electrification. This paper argues that the current groundwater related policies have a resource conservation bias because they have been inordinately influenced by the dominant discourse on scarcity and depletion – a discourse which does not hold good in the case of West Bengal – a water abundant state steeped in poverty. In view of this paradox of scarcity amidst plenty, this paper based on primary data from 40 villages and 580 respondents makes a case for deploying groundwater irrigation for poverty alleviation through electrification of irrigation tubewells and continuation of high flat rate tariff. Quite contrary to the received wisdom that electricity subsidies benefit only the rural rich and that metering of irrigation tubewell is the only answer, this paper argues that neither is necessarily true in the case of water abundant eastern India where efficient and largely equitable groundwater markets operate.

1.0 Introduction

Within the larger theme of 'Natural resources: Risks and implications for sustaining development', this paper specifically seeks to answer the question: 'what are the political and economic ramifications of water insecurity and what are its implications for sustaining food security and development?' Water insecurity defined as an individuals' or households' inability to access water (for domestic or other uses) may arise either due to physical or economic scarcity of water (Kijne et al. 2003). Economic scarcity is defined as limited access to water because of the high costs involved and may occur with or without physical water scarcity.

This paper deals with the case of a water abundant state in India, viz. West Bengal, where even though there is no physical scarcity of groundwater, farmers face considerable economic scarcity of the resource due to certain government policies viz. low rates of rural electrification and escalating diesel prices. Groundwater irrigation is crucial to the agricultural economy of the state, as it is elsewhere in India (Deb Roy and Shah 2003, Shah, Singh and Mukherji 2006). Given the ample rainfall (1000 mm to 2500 mm a year) and the alluvial aquifers, West Bengal has high surface water as well as groundwater potential. However, its relatively flat topography restricts

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the possibility of gravity flow surface irrigation, making groundwater the most easily accessible resource for irrigation. Groundwater irrigation started here in a massive way in the late 1970s and early 1980s consequent upon the advent of Green Revolution technologies. The decade of 1980s saw spectacular growth in agricultural sector, much of which could be attributed to groundwater irrigation (Harriss 1993, Palmer-Jones 1999). Given that there is strong evidence to suggest positive correlation between agricultural growth and poverty reduction (Palmer-Jones and Sen 2003, Dutt and Ravallion 1998), the decade of 1980s and early 1990s also saw considerable reduction in rural poverty in the state. Indeed, the potential of groundwater in unleashing agricultural growth and consequent poverty reduction was envisaged by both the Reserve Bank of India (1984) and the World Bank (Kahnert and Levine 1989). However, agricultural growth slowed down in the late 1990s and this had negative impacts of farmers' income and livelihoods.

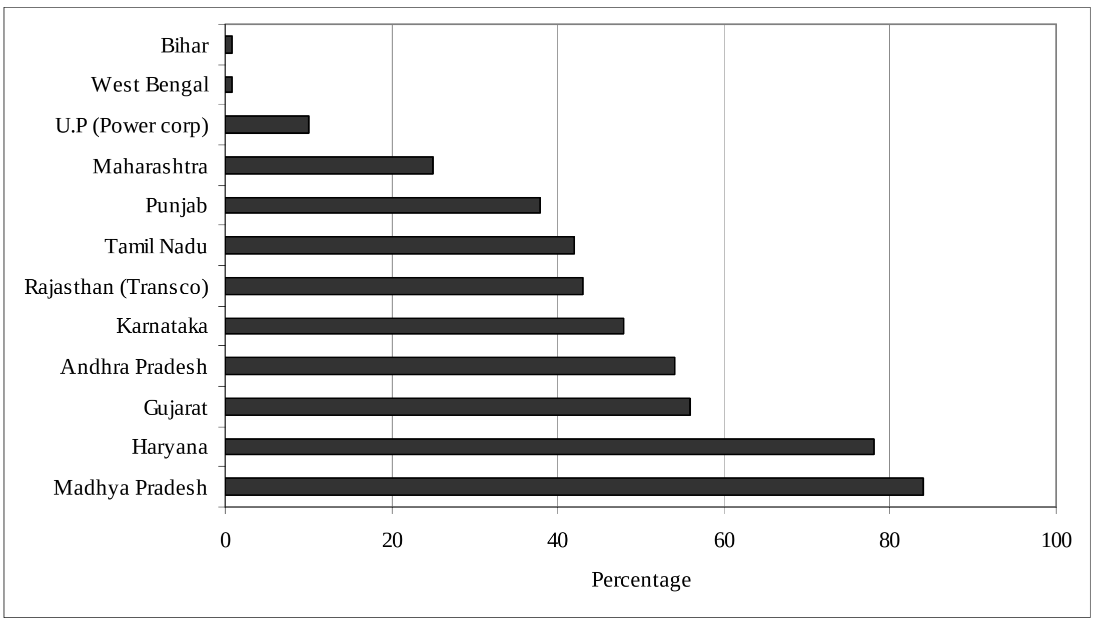
This paper puts forward the argument that recent slowdown agriculture in the state is a result of the severe economic scarcity of groundwater in the state brought about by low rates of rural electrification and high diesel costs. While increase in diesel prices is in response to the rising price of crude oil worldwide, lack of rural electrification that would facilitate cheaper extraction of groundwater is a state policy aimed primarily at restricting access to groundwater. This restrictive policy, as this paper will show, has resulted in economic scarcity of the resource in a land where there is no physical scarcity and the hardest hit are the poor and marginal farmers who depend on groundwater irrigated agriculture for their livelihoods. This paper also argues that the current groundwater related policies have a resource conservation bias because they have been inordinately influenced by the dominant discourse on scarcity and depletion from elsewhere in India – a discourse which does not hold good in the case of West Bengal – a water abundant state steeped in poverty. In view of this, this paper makes a case for rapid rural electrification in West Bengal and continuation of high flat rate tariff as it exists in the state. It argues that flat rate tariff encourages active, efficient and equitable groundwater markets through which small and marginal farmers who can not afford their own means of irrigation, can still profitably practise irrigated agriculture and earn their livelihoods.

2.0 Setting up the argument

State electricity boards (SEBs) in almost all states of India provide subsidised electricity to the agricultural and domestic sectors and in the process incur huge financial loses. For instance, in 1998-99, SEBs spent Rs. 262 billion in subsidising domestic and agricultural consumers (Ahluwalia 2000:3415). It is often alleged that much of the agricultural electricity subsidy goes to the rural rich because they own a major proportion of the water extraction mechanisms (WEMs) fitted with electric pumps. Howes and Murgai (2003) in their analysis based on two rounds of NSS data showed that large farmers in Karnataka on an average received electricity subsidy to the amount of Rs. 29,710 per year. This was almost 10 times the subsidy received by an electric well owning marginal farmer[i]. To compound this inequity, they showed that almost 57% of all electric WEMs in Karnataka were owned by medium and large farmers. While the fact that electricity supply to agriculture is subsidised is well recognised, but there is a lack of clarity on the actual amount of subsidy involved. There is now increasing evidence to show that the quantum of these subsidies are overstated (Sant and Dixit 1996, Bhatia 2005) because of the tendency of SEBs to lump all unaccounted loss under agricultural consumption which is not metered. Low flat electricity tariff for agriculture irrespective of actual hours of usage is also held responsible for groundwater over-exploitation. In view of all the facts stated above, viz. financial un-viability of SEBs due to electricity subsidy, uncertainty over the exact quantum of the subsidy due to flat rate tariff system, certainty that the direct beneficiaries of this subsidy are the richer peasants and that

it encourages over-exploitation of groundwater resources has led most researches (and agencies such as World Bank and Asian Development Bank) to recommend phasing out of electricity subsidy and metering farm electricity. This is what I call the conventional wisdom.
However, my argument is that the conventional wisdom is not always wise in making the generic statement that electricity subsidies benefit *only* the rich peasants. Second, metering of farm electricity may be wise from a technical and financial accounting point of view but it is not wise from an equity perspective as it discourages water markets which in the context of water abundant eastern India have more or less equitable and efficient outcomes. Third, while the conventional wisdom may provide solution to the groundwater over-exploitation problems in arid and semi-arid parts of the country with low- yielding hard rock aquifers, it will have entirely negative impact on the rural poor in humid and sub-humid areas with well endowed and adequately recharged alluvial aquifers. Most of the eastern Indo-Gangetic basin (IGB) including eastern Uttar Pradesh, Bihar, West Bengal and Assam has rich alluvial aquifers and concentrated rural poverty. It is precisely in these regions that complete withdrawal of electricity subsidy (which anyway is negligible when compared to states like Gujarat, Andhra Pradesh, Karnataka, Maharashtra, Punjab and Haryana, see figure 1) and metering of agricultural electricity will have deleterious effect. Let me explain why.

Figure 1. Electricity subsidy to agriculture as percentage of gross fiscal deficit 2000-01



Source: Briscoe 2005:24

The argument that major share of the electricity subsidy goes to only those who own electric pumps tells only a part of the story as it disregards that majority of the electric WEM owners sell water to those who do not own WEMs. As such some benefits of subsidized electricity are passed on to the water buyers who would have otherwise remained outside the ambit of irrigated agriculture. Most of these water buyers also happen to be small and marginal farmers. Besides in states like West Bengal, 70- 80% of the WEMs are also owned by small and marginal farmers and they therefore benefit directly from subsidised electricity (GOI 2001). Data from the 54th round of NSSO survey shows that irrigation services markets are an all pervasive feature in rural India (NSSO 1999). Of India's 82 million or so farming households, almost 25 million households reported hiring in irrigation services. Of these, 75% of the households owned and operated less than 1 hectare of land (Table 1).

Table 1. Number and percentage of households hiring irrigation services in India

Size-class category (ha)	Number of households hiring irrigation services (millions)
Below 0.50	12.4 (49.5)
00.51 - 01.00	6.0 (24.1)
01.01 - 02.00	4.1 (16.6)
02.01 - 04.00	1.8 (7.2)
04.01 - 10.00	0.6 (2.4)
10.01 & above	0.1 (0.2)
All	24.9 (100.0)

Source: Author's calculation based on NSSO 54th round data, NSSO 1999. Figures in parentheses are percentage to total

There is also enough primary evidence to show that electric WEM owners under a flat rate tariff are not only more likely to sell water than diesel WEM owners, but also they sell a larger share of their total pumped water and that too at lower prices[ii]. This is because under a flat rate electricity tariff, marginal cost of water extraction is almost zero. This provides an incentive to electric WEM owners to sell water because by doing so, they can at least recover their electricity bills, if not make a profit. This incentive for water selling transforms to a pressure for selling water if the flat rate tariff is set at sufficiently high levels because then self-use no longer justifies the electricity bill. In the process, water sellers provide better service to the water buyers and that too at competitive rates. That the water buyers stand to benefit under such competitive water markets is fairly obvious. This is especially true in regions with well endowed and adequately recharged alluvial aquifers where the threat of groundwater over-exploitation is minimal.
However, metering of electricity supply will in one stroke take away the incentive for water selling[iii] with the possibility that monopoly power of the water seller would increase and bargaining power of the water buyers would decline. Already much of diesel pump dependant eastern India is experiencing a severe 'energy squeeze' triggered by escalating diesel prices and low rates of rural electrification. If in addition, electricity subsidies are drastically reduced and supply metered, the region will face very uncertain agrarian future. *Therefore, my central argument in this paper is that while electricity subsidy and flat rate tariff might benefit the largest and the richest peasants the most, its absence will hurt the marginal and the poorest peasants the hardest. This is especially so in water abundant eastern India which is reeling under a severe energy squeeze due its overwhelming dependence on diesel pumps, recent escalation in diesel prices and dismal state of rural electrification.* Two lines of clarification are in place here. It is not my intention to justify continuation of unsustainably high electricity subsidy, but simply to point out that not all of it is regressive as many scholars claim. Second, flat rate tariff need not necessarily be low and highly subsidised, indeed low flat rate tariff or free electricity offer little or no benefits to the water buyers.

While the arguments made above are valid for the whole of eastern India with rich and amply recharged alluvial aquifers and dismal rates of rural electrification, in this paper, I will validate these propositions with the help of primary data collected from 40 villages in West Bengal during the year 2004-05. Summing up this section, I make four main propositions. These are presented in table 2.

Table 2. Main and secondary propositions

Sr. No.	Primary propositions	Secondary propositions
1.1	A sufficiently high flat rate electricity tariff would generate an efficient and pro-active groundwater market where water buyers (who happen to be mostly small and marginal farmers) would benefit substantially through better service and lower water prices.	Electric WEM owners facing high flat rate tariff are more likely to sell water, sell larger volume of their pumped water and at cheaper prices than diesel WEM owners.
1.2		Water buyers from electric WEMs would have lower cost of cultivation for major crops and more favourable cropping pattern than water buyers from diesel WEMs.
1.3		Electric WEM dominated groundwater markets are more developed in terms of breadth and depth of transactions than diesel WEM dominated water markets.
1.4		All above three propositions would be true only when flat rate electricity tariff is sufficiently high. Under a low flat rate tariff, electric WEM owners would have very low incentive to sell water and terms of transactions may be exploitative.
2.1	Rapid rural electrification and continuation of progressively higher flat rate tariff (that keeps the subsidy component to a minimum) would benefit millions of small and marginal water buying farmers. This will be especially so given the escalating diesel prices which resulted in an acute energy squeeze in West Bengal's agriculture.	With electrification of existing diesel pumpsets net irrigated area will increase because on an average electric pumpsets irrigates higher amount of land than diesel pumpsets.
2.2		With electrification of pumpsets coupled with continuation of high flat rate tariff, there would be a reduction in cost of cultivation when compared to existing costs under diesel WEMs.
2.3		Flat rate electricity tariff does not necessarily mean higher subsidy, it can be fixed at a level of proposed metered rates so as to reduce the subsidy component.
3.1	Imposition of metered electricity tariff will take away the incentive for water selling to a large extent. Therefore groundwater markets would contract and hardest hit would be the water buyers.	Electric WEM owners facing a metered tariff would be less willing to sell water than electric WEM owner facing a high flat rate tariff.
3.2		Even under metered electricity tariff, there would be some amount of buying and selling of water, but the terms of transactions would move against the water buyer as will the price at which water is sold.
4.0	Chances of rapid depletion of groundwater resources due to flat rate tariff system as has happened in many parts of western and southern India is very unlikely in West Bengal given that it receives very high rainfall and is endowed with rich and mostly unconfined alluvial aquifers with good recharge potential. Under use of groundwater resources is the main issue in this state rather than over-exploitation of it. While arsenic is a threat, banning groundwater irrigation to reduce exposure to arsenic contamination is likely to have negative impacts on farmers' income and health. In this context development of groundwater would have high poverty alleviation impacts.	

This paper is organised thus. After the second section where the central argument has been set, the third section briefly discusses the study area, data and sample size. In the sections that follow, each of the four propositions are discussed (in sections 4, 5, 6 and 7) while in the last and the final section, the conclusions and policy implications of the findings are spelled out.

3.0 Study area, data and sample size

This paper is based on primary data collected from 40 villages located in 17 districts of West Bengal (Figure 2). West Bengal, an eastern state of India located within the Ganga-Meghna-Brahmaputra basin is a land of plentiful rainfall (1500 to 2500 mm annual rainfall), rich alluvial aquifers with a gross potential of 31 billion cubic meters (BCM) (WIDD 2004). In 95% of the villages, water table is within 5 to 10 meters below ground level (GOI 2001). The overall level of groundwater development in the state is 42 percent (table 3). As per groundwater estimation carried out jointly by the State Water Investigation Directorate (SWID) and the Central Groundwater Board (CGWB), of the 269 blocks in the state, as many as 231 blocks (or 86 percent) of the blocks were declared 'safe', while 37 blocks were declared 'semi-critical' and only one block was put in the 'critical' groundwater category (Ray Chowdhury 2006). This is in sharp contrast with groundwater situation in many parts of India, notably Punjab, Gujarat, Tamil Nadu and Andhra Pradesh. Yet partly due to the global notoriety generated by arsenic contamination of groundwater and partly due to other political reasons (discussed in detail in Mukherji 2006a), there is a widespread threat perception regarding groundwater use among the policy makers in West Bengal[iv].

There are several policy effects of this threat perception. First, farmers in West Bengal pay one of the highest flat electricity tariffs anywhere in India. Yearly fixed electricity bill for a five horsepower (HP) centrifugal and submersible pump is Rs. 5460 and Rs. 6810 respectively. This works out to be Rs. 1092 to Rs. 1362/HP/year. Farmers in Gujarat pay only Rs. 850/HP/year while farmers in Punjab, Tamil Nadu and Andhra Pradesh get electricity free of cost. When translated into rupees per unit, electricity tariff in West Bengal amounts to Re 0.92/unit, while it is only Re. 0.42/unit in Haryana and Re. 0.62/unit in Gujarat (Narendranath 2005). Second, the state also has the lowest number of electrified WEMs anywhere in the country. Only 10.1 percent of all WEMs in West Bengal are electrified (NSSO 1999) as against a national average of 51 percent. While high flat rate tariff encourages water markets, low rates of rural electrification impede the same. All these puts West Bengal in sharp contrast with other Indian states such as Punjab, Haryana, Gujarat and Tamil Nadu where in spite of precarious groundwater conditions; farmers get huge electricity subsidies from the state.

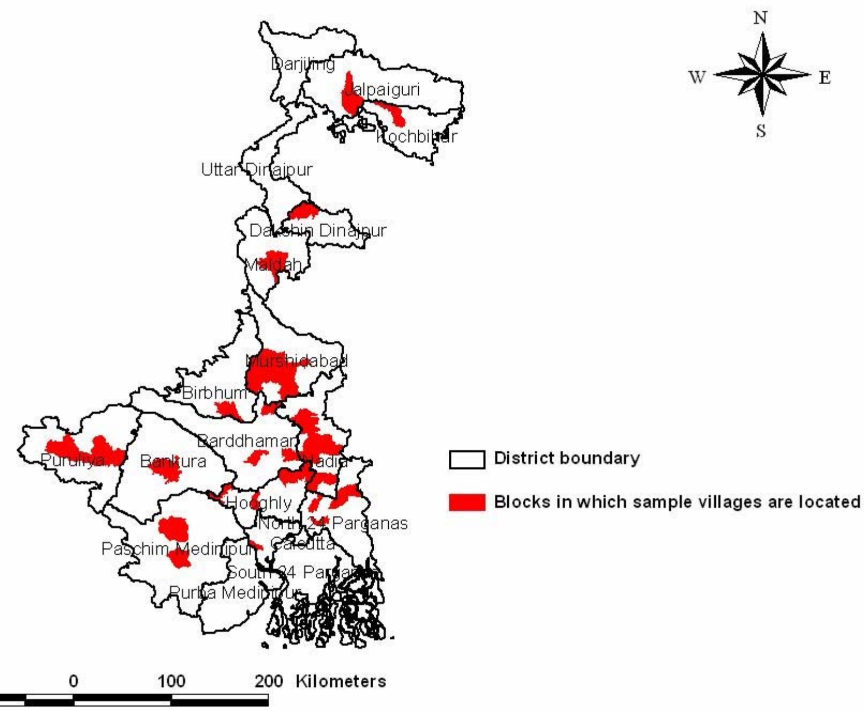
Table 3. Groundwater availability in major states of India, 2004-05

State	Gross annual replenishable groundwater resource (BCM/year)	Net annual GW availability (BCM/year)	Annual GW draft (BCM/year)	Level of groundwater development (%)	Gross replenishable GW per unit of NCA (MCM/'000 ha)
Assam	27.23	24.89	5.44	22	9.03
West Bengal	30.36	27.46	11.65	42	5.55
Tamil Nadu	23.07	20.76	17.65	85	4.83
Uttar Pradesh#	78.62	72.28	50.17	69	4.78
Bihar*	34.77	32.67	11.83	34	4.53
Punjab	23.78	21.44	31.16	145	4.43
Kerala	6.84	6.23	2.92	47	3.51

State	Gross annual replenishable groundwater resource (BCM/year)	Net annual GW availability (BCM/year)	Annual GW draft (BCM/year)	Level of groundwater development (%)	Gross replenishable GW per unit of NCA (MCM/'000 ha)
Orissa	23.09	21.01	3.85	18	3.31
Andhra Pradesh	36.50	32.95	14.90	45	3.31
Madhya Pradesh@	52.12	49.01	19.32	39	2.68
Haryana	9.31	8.63	9.45	109	2.38
Maharashtra	32.96	31.21	15.09	48	2.13
Gujarat	15.81	15.02	11.49	76	2.13
Karnataka	15.93	15.30	10.71	70	1.56
Rajasthan	11.56	10.38	12.99	125	0.78

Source: Central Groundwater Board (data downloaded from website www.cgwb.in on 1st March 2007) # includes Uttar Pradesh and Uttaranchal, * includes Bihar and Jharkhand, @ includes Madhya Pradesh and Chattisgarh.

Figure 2. Location of blocks in which 40 study villages are located



As in rest of South Asia, groundwater markets are ubiquitous in West Bengal. As per the 54th round of NSSO survey (NSSO 1999), of the 6.1 million farming households in West Bengal, only 1.1 million reported owning WEMs, while 3.1 million households reported hiring of irrigation services from other farmers. In order to understand various aspects of groundwater markets and how it gets influenced by motive power of pumps, primary data through detailed questionnaire survey was collected from 580 respondents in 40 villages. The respondents were pump owners and ‘pure’ water buyers (WB), i.e. those water buyers who did not own any WEMs. Pump owners were again of various types[v] as were the types of WEMs they owned[vi]. Table 4 gives the sample size and category wise break-up of respondents by their water transaction status and motive power of WEMs.

Table 4. Sample size and category wise break-up of respondents

Sr. No.	Water transaction status	Electric WEM	Diesel WEM	All
1.	WEM owners who neither buy or sell water (PO)	14	49	63
2.	WEM owners who only sell water (WS)	68	53	121
3.	WEM owners who buy as well as sell water (SB)	55	44	99
4.	WEM owners who do not sell water, but buy from others (PB)	2	9	11
5.	Total number of WEM owners	139	155	294
6.	‘Pure’ water buyers (WB)	154	132	286
7.	Total number of respondents	293	287	580

Source: Author’s fieldwork 2004-05

3.0 High flat rate electricity tariff and groundwater markets in West Bengal

In this section I validate the first proposition that a sufficiently high flat rate electricity tariff as it currently exists in West Bengal (table 5) generates an efficient and pro-active groundwater market under which the water buyers benefit substantially through better service and lower water prices.

Table 5. Change in flat rate electricity tariff in West Bengal, 1995 to 2003

Year	Electricity tariff for shallow tubewells (Rs/year/tubewell)		Electricity tariff for submersible tubewells (Rs/year/tubewell)	
	North Bengal	Other districts	North Bengal	Other districts
1991	1100	1100	1100	1100
1995	1380	1700	1380	1700
1996	1660	2040	2500	3060
1999	2676	3284	4028	4932
2001	4064	5008	5080	6252
2003	4434	5460	5540	6810

Source: WBSEB records, various years

Electric WEM owners foster a pro-active and competitive water market in various ways. First, electric WEM owners facing high flat rate tariff are more likely to sell water diesel WEM owners as has been explained in section 1. That this logic is correct is brought out in table 4 where it is seen that while 89% of electric WEM owners report selling water, this figure is only 63% for diesel WEM owners.

Table 6. Hours of pumping and hours of water sold to others by type of WEM, 2003-04

Sr. No.	Type of WEM	Sample size	Average hours of pumping	% of hours of water sold to total pumping hours
1.	Diesel shallow tubewell (DST)	189	250.8	36.4
2.	Diesel submersible tubewell (DSB)	7	411.6	49.0
3.	Electric shallow tubewell (EST)	73	1649.3	52.3
4.	Electric submersible tubewell (ESB)	65	2151.7	79.7
5.	All	334	929.1	62.4

Source: Primary questionnaire survey in 40 villages, August to December 2004.

Second, not only are electric WEM owners more likely to sell water than their diesel counterparts, they also do so for longer number of hours as seen in table 6. That motive power of pump is the most important determinant of number of hours of water sold is clearly brought out by this OLS regression model where:

HOURS = fn{MOTIV, TWEM, GCA, ALTIRR, GWDEV }
Where, HOURS = Hours of water sold by an WEM owner in the year 2003-04
MOTIV= Dummy variable for the motive power of the pump, 0 if diesel, 1 if electric
TWEM = Dummy variable for the type of WEM, 0 if centrifugal pump, 1 if submersible pump
GCA = Gross cultivated area of the WEM owner (*bighas*) in 2003-04
ALTIRR = Dummy variable for presence of alternate sources of irrigation in the village, 0= No, 1= Yes
GWDEV = Dummy variable for level of groundwater development and trend in water level, 0= safe, 1= critical and semi-critical

Table 7. Determinants of hours of water sold in 40 villages in West Bengal, 2003-04

Sr. No.	Variables	Unstandardised coefficient B	Standardised coefficient β	t- value
1.	Constant	294.867*	-	4.420
2.	MOTIV (dummy)	879.972*	0.514	11.532
3.	TWEM (dummy)	702.358*	0.370	8.021
4.	GCA	-9.142*	-0.194	-4.908
5.	ALTIRR (dummy)	-105.445	-0.062	-1.595
6.	GWDEV (dummy)	332.600*	0.173	4.395
7.	Adjusted R^2	0.646		
8.	Durbin Watson value	1.544		
9.	Sample size	243		

Source: Author's calculations based on questionnaire survey conducted between August to December 2004.
* Denotes significance at 1% level

The result of the regression equation (table 7) shows that the motive power of pump is the most important determinant of actual hours of water sold by a pump owner, followed by the type of pump owned. This means that electric WEM owners with submersible pumps sell the largest volume of their pumped water, while diesel WEM owners with centrifugal pumps sell the least. Third, electric WEM owners also serve a larger number of water buyers and irrigate larger area per WEM than diesel WEM owners as table 8 shows.

Table 8. Number of water buyers served and area irrigated per WEM by type and motive power of WEMs

Type and motive power of WEMs	Number of WEMs	Average number of buyers served in 2003-04	Average area irrigated per WEM (acres)		
			Area belonging to WEM owner	Area belonging to water buyers	Total area irrigated per WEM
Diesel submersible (DSB)	4	47.5	3.6	19.2	22.8
Diesel centrifugal (DST)	93	11	2.2	4.8	7
All diesel	97	12.5	2.2	5.4	7.6
Electric submersible (ESB)	62	56.3	4.7	22.3	27
Electric centrifugal (EST)	61	21.1	3.7	8.8	12.5
All electric	123	38.9	4.2	15.6	19.8

Source: Author's calculations based on questionnaire survey conducted between August to December 2004.

Fourth, given the very different economics of water extraction from electric and diesel WEMs, electric WEM owners are able to sell water at much lower rates than diesel WEM owners. This difference has been further intensified due to rising diesel prices in recent years (Figure 3). In West Bengal, as a rule of thumb, diesel WEM owners prefer to charge an hourly water rate (Rs/hour), while the electric WEM owners prefer a crop and area based seasonal water charge (Rs/*bigha*/season). Table 9 shows that for water intensive and profitable *boro* paddy crop, diesel WEM owners charge almost Rs. 1000 to Rs. 1100/*bigha*/season more than electric WEM owners do.

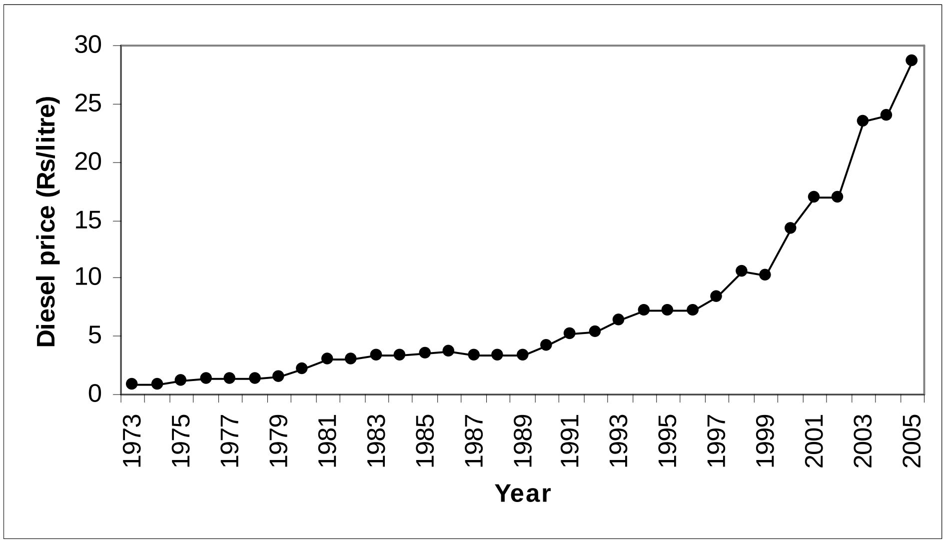
Table 9. Water prices for important crops as charged by electric and diesel WEM owners

Name of the crop	Mode of water pricing	Type of WEM and average water price		
		DST	EST	ESB
Any crop	Rs/hour	46.3 (290)	25.5 (61)	31.9 (15)
Boro paddy	Rs/bigha/season	1733 (11)	773 (75)	621 (87)
Aman paddy	Rs/bigha/season	634 (6)	447 (43)	200 (64)

Source: Author's calculations based on questionnaire survey conducted between August to December 2004. Figures in parentheses are the sample sizes.

Quite predictably then, cost of cultivation is lower for those water buyers who buy water from electric WEM owners than those who depend exclusively on diesel WEMs. *Boro* paddy is one of the most water intensive crops in West Bengal. It also happens to give considerably high and stable returns unlike orchard and vegetables crops whose high returns are subject to market vagaries. In view of high diesel prices, cultivation of *boro* paddy has become unremunerative, especially for the water buyers as table 10 shows. Ghosh and Hariss-White (2002) too voiced this concern when they found a "deep crisis in rice economy" – a crisis that has since then deepened in intensity and severity. As a consequence, diesel WEM owners and their water buyers have progressively given up *boro* paddy cultivation. In my sample of 40 villages, in as many as 20 villages, *boro* paddy is cultivated in less than 20 percent of the gross cropped area of the village. Of these, 18 villages have diesel WEM dominated type of water market.

Figure 3. Retail price of diesel in Kolkata, 1973 to 2005



Source: www.indiastat.com downloaded on 12th July 2006. At 2005 real prices.

Table 10. Cost of cultivation and net returns from boro paddy for diesel and electric pump owners and water buyers in West Bengal, 2003-04

Sr. No.	Crop	WEM type	Water transaction status	N	Yield (kilograms per hectare)	Cost of irrigation (Rs/bigha)	Cost of cultivation (Rs./hectare)		Net returns (Rs./hectare)	
							Cost of cultivation without including family labour	Cost of cultivation including family labour	Net returns without imputing family labour	Net returns after imputing family labour
1	Boro	Diesel	PO	55	5025	7448	17850	20190	9788	7448
2	Boro	Diesel	WB	28	5250	12998	23295	27075	5580	1800
3	Boro	Electric	PO	64	5475	1665	12383	14970	17730	15143
4	Boro	Electric	WB	61	5175	4628	15578	18225	12885	10238

Source: Author's calculations based on fieldwork in 40 villages in West Bengal, August to December 2004. PO = Pump owner, WB = Water buyer

From forgoing discussion, it emerges that electric WEMs promote prolific groundwater markets. In neo-classical economics literature, level of development of groundwater markets has been measured in terms of breadth and depth of water market transactions (Shah 1993). While there are several measures of depth and breadth of groundwater markets, here I have used one indicator of each to classify the 40 study villages into three levels of development, viz. highly developed, moderately developed and under developed groundwater markets. The indicator of breadth is percentage of gross irrigated area (GIA) in the village irrigated through privately purchased groundwater and that of depth is percentage of gross incomes of households derived from water selling and buying. The level of development of groundwater markets is related with the predominant type of WEM in that village. Table 11 shows that all the villages with highly developed groundwater markets invariably have electric WEM dominated irrigation economy.

Table 11. Level and development of groundwater market and its relationship with motive power of pumps

Level of development of groundwater market	Number of villages	Pre-dominant type of WEM
Highly developed	19	10 villages have pre-dominantly ESB type of WEMs 9 villages have pre-dominantly EST type of WEMs All these villages have some number of diesel centrifugal type of WEMs
Moderately developed	13	12 villages have exclusively DST type of WEMs 1 village has only DSB type of WEMs None of the 13 villages have electricity for agricultural purposes
Under-developed	8	All 8 villages rely exclusively on DSTs, electricity is not available for agricultural purposes in these villages.

Source: Calculations based on primary data from questionnaire survey, August to December 2004.

Highly developed: Breadth > 50% and depth >25%; Moderately developed: Either breadth >50% but depth < 25% or breadth < 50%, but depth > 25%; Under-developed: Breadth < 50% and depth <25%

ESB= Electric submersible pumps, EST = Electric centrifugal pump, DST = Diesel centrifugal pump, DSB = Diesel submersible pump

So far, in this section, I have shown that electric WEM owners are more likely to sell water, sell a larger volume of their pumped water, service larger number of water buyers, irrigate larger amount of land and sell water at cheaper prices than their diesel WEM counterparts. All these facts ensure that water buyers in an electric WEM market are better off than water buyers in diesel WEM markets. Much of this, as I have argued in the first section of this paper, is due to the relatively high flat rate tariff that is in vogue in West Bengal. Very often, flat rate tariff is equated with very low or almost free supply of electricity. However, I argue that such low flat tariff offers no benefit to the water buyers. This is because under a low flat rate tariff, the WEM owner can justify the electricity bill s/he pays through self use of water – something s/he can not do when this tariff is sufficiently high.

My discussions with the respondents in 40 villages confirmed this hypothesis. Villagers recounted that there have been at least two types of changes in water market transactions over the last 20 years – direct water sales have become more important now as compared to land tenancy agreements in the past and cash transactions have largely replaced kind transactions[vii]. Both these changes were directly related to increase in electricity tariff. In the early years, profitability from *boro* paddy cultivation was very high because the input costs, including diesel costs and electricity tariff were low (see table 5 and figure 3). It was therefore more profitable for the WEM owners to lease-in land from prospective water buyers rather than sell water to them. Thus Webster (1999:340-41) working in early 1990s in West Bengal found that the WEM owners "…proceeded to offer to all those in the 12 acre command area the option of a *thika* contract for all lease of the land. What they do not offer is the option of purchasing water from them". However, direct water sales acquired importance in view of two changes, electricity tariff increased six-fold (table 5) and profitability from paddy cultivation either stagnated or declined[viii]. This changed the incentive structure for the water sellers, who now found direct water sale more profitable than leasing in land.

4.0 Impact of rapid rural electrification and continuation of high flat rate tariff on groundwater markets in West Bengal

As already stated earlier, only 10.1% of all WEM in West Bengal are electricity operated, while this figure is 51% for India as a whole. This makes West Bengal the state with lowest proportion of electric WEMs to total WEMs, even lower than the neighbouring states of Bihar (11.9%) and Orissa (27.3%). What will be the impact on groundwater markets in West Bengal if at least 50% of existing pump sets were electrified? Using secondary data from agricultural censuses and 54th round of NSSO (NSSO 1999) coupled with primary data and by making some fairly simple assumptions, I will provide a rough but realistic estimates of the impacts in this section. Some basic data that will be used to make these estimates are given in table 12.

Table 12. Some basic agricultural and irrigation statistics from West Bengal

Sr. No.	Indicator	Value	Year and source of data
1.	Net cultivated area ('000 ha)	5472	2003-04, GOI (2005)
2.	Net irrigated area ('000 ha)	2980	2003-04, GOI (2005)
3.	Gross irrigated area ('000 ha)	3521	2003-04, GOI (2005)
4.	Of which, area under groundwater irrigation ('000 ha)	1716	2003-04, GOI (2005)
5.	Total number of pump owning households ('000 numbers)	1174.3	1997-98, NSSO (1999)
6.	Number of electric pumps ('000)	118.6	1997-98, NSSO (1999)
7.	Number of diesel pumps ('000)	1055.7	1997-98, NSSO (1999)
8.	Number of households who hire irrigation services ('000)	3063.7	1997-98, NSSO (1999)
9.	Number of households with no access to irrigation ('000 numbers)	1519.0	1997-98, NSSO (1999)
10.	Average area irrigated by a 5 HP electric pump (hectare)	7.9	2003-04, Primary data from 40 villages in West Bengal

Source: As mentioned in last column of the table

Let me start by the assumption that government of West Bengal electrifies 50% of the existing WEMs without adding any new ones. Therefore, the number of electric pumps would increase from the present 0.12 million to around 0.59 million. What would be the impact of additional 0.47 million electric pumps on net irrigated area? Given that on an average one electric pump irrigates 7.9 hectare of land, an addition of 0.47 million pumps would lead to creation of an additional 3.7 million hectares (mha) of irrigable land. Assuming that only 50% of this potential would be actually irrigated[ix], this amounts to 1.85 mha of additional irrigated area. Thus net irrigated area of West Bengal would go up from 2.98 mha as of now to 4.83 mha. This would mean an increase in ratio of net irrigated area to net cultivated area from 54.5% (as it is now) to 88.0% simply by electrifying around half a million pumps.

Similarly with addition of half a million electric WEMs, area served through water sale would increase as would the number of water buyers who are served. On an average, a diesel WEM owners serve 12 water buyers per year, while electric WEM owners serve 38 water buyers (see table 8). Even assuming that each electric WEM owner would serve only 10 water buyers, the number of new water buyers who would be brought under the ambit of water markets would be staggering a 4.7 million. Right now around 25% of cultivating households (or 1.5 million households) does not have any access to irrigation (NSSO 1999). This scenario might as well change with electrification of tubewells in the state.

Earlier I had shown that water buyers who rely exclusively on diesel WEMs pay several times higher price for water than do water buyers from electric WEMs (Table 9 and 10). Quite obviously then, electrification of pumps would reduce the cost of cultivation for the pump owners and more so for the water buyers. Thus, simply by switching over from buying water from a diesel pump to an electric pump, a water buyer would earn an incremental income of Rs. 1000/*bigha* for *boro* paddy and Rs. 800/*bigha* for potato crop. This would signify almost a doubling of net income from every *bigha* of land cultivated. Yet possibly unaware of the benefits of groundwater markets fostered by flat rate electricity tariff, government of West Bengal (GoWB) is planning to revert to its earlier system of metered tariff. The implications of this would be dismal, as I shall show in the next section.

5.0 Implementation of proposed metered electricity tariff and its impact on groundwater markets in West Bengal

In this section, I will discuss the possible impact of change in the mode of electricity tariff from flat rate to metered tariff. On 31st of August 2005, Ganashakti – the official newspaper of the ruling CPI(M) party in West Bengal – published that the GoWB was planning to impose pro-rata metered tariff on irrigation tubewells[x]. For this purpose, three time slabs with differential tariff was declared (table 13).

Table 13. Proposed pro-rata electricity tariff for irrigation tubewells in West Bengal

Sr. No.	Time	Number of hours	Tariff (Rs./unit of electricity consumption)
1.	2200 hrs-0600 hrs	8	Re. 0.97/unit[xi]
2.	0060 hrs-1700 hrs	11	Rs. 1.55/unit
3.	1700 hrs-2200 hrs	5	Rs. 3.30/unit

Source: Ganashakti, 31st August 2005, Kolkata edition

In sharp contrast to flat rate electricity tariff, under a pro-rata system of power tariff, pump owners will not have any additional incentive to sell water to others. Therefore, there are good chances that under this system, a substantial portion of the current water buyers will lose their access to irrigation due to unwillingness of the pump owners to sell water. Even when water sellers choose to sell water[xii], price at which water is sold is likely to go up and water selling contracts might undergo a change.

I will now try to derive a quantitative estimate of these changes. For doing so, I will make a few assumptions. First, I will relax my first assumption, *viz*. pump owners will be unwilling to sell water and instead assume that they will continue doing so[xiii]. Second, I will assume average hours of irrigation for a crop will remain unchanged under flat rate tariff and pro-rata tariff[xiv]. Third, pump owners will first cultivate their entire land and sell only the 'surplus' water to others. Fourth, water sellers will try to maintain their water price to cost of water extraction ratio even after change in electricity tariff regime, i.e. they will try to realize the same profit for every unit of water sold[xv]. Finally, there are no constraints on full capacity utilisation of pumps. I will calculate the effect of change from flat rate tariff to metered tariff for *boro* paddy given that it is the single most important irrigated crop in West Bengal. I will generate three scenarios—first in which the pump owners pump only for those eight hours in the day when the electricity tariff is the lowest (@Re. 0.97/unit). In the second scenario, I will assume that pump owners are also willing to pump during those 11 hours in the day when the electricity tariff is Rs. 1.55/unit. In the third scenario, I will assume that pump owners are willing to operate their pumps for the entire 24 hours in a day, including those five hours when electricity tariff is Rs. 3.30/hour. In calculating cost, I will assume that overheads will remain fixed under flat rate and pro-rata tariffs. I will also assume that roughly 3.5 units of electricity are consumed for every hour of pump operation. I will compare the three scenarios mentioned above with the current scenario of water market under a fixed rate tariff. Table 14 shows the results of my calculations.

Table 14. Economics of water extraction and water selling under fixed rate tariff and metered tariff for ESB type of WEM in West Bengal

Scenario	Cost of water extraction/hour (Rs/hour)			Total hours of operation in summer	Hours of operation per day in the season*	Total area irrigated (*bigha*)		Cost of water extraction in Rs/*bigha* **	Water price in Rs/*bigha*	w/ac ratio
	Electricity	Others	Total			Own	Others			
Current	2.79	2.0	4.79	1901	18.1	7.8	22.5	300.3	620	2.06
S 1	3.34	2.0	5.34	840	8.0	7.8	5.6	334.8	690	2.06
S 2	4.57	2.0	6.57	1995	19.0	7.8	24.0	412.0	850	2.06
S 3	6.02	2.0	8.02	2520	24.0	7.8	32.4	502.9	1036	2.06

Source: Author's fieldwork in 40 villages in West Bengal, August to December 2004.
Calculations based upon data collected for ESB type of WEM.
* Assuming there are 105 days in *boro* season.
** Assuming 62.7 hours of irrigation needed for one bigha of *boro* paddy

Table 14 shows that under scenario 1, when the pump owners can operate their pumps for only eight hours, irrigated area belonging to the water buyers will reduce drastically from 22.5 bighas to only 5.6 bighas in the summer *boro* season. In scenarios 2 and 3, when pump owners operate their pumps for 19 hours and 24 hours respectively in a day, while there will be no decline in the irrigated area of the water buyers, water prices will increase substantially. This will lead to reduced profits for the water buyers and share of irrigation cost to total cost of cultivation will go up thereby squeezing the already narrow profit margins of the farmers further.

Thus on the whole, it will be reasonable to conclude that metered tariff will lead to contraction in water market by stifling the very incentive that encourage pump owners to sell water and the proposed tariff rates would also almost certainly lead to increase in water price. Both of these will affect the small and the marginal farmers – who depend almost exclusively on the private groundwater markets for access to irrigation. There is indeed new evidence from Gujarat (Shah and Verma 2007) that shows that tubewell owners under metered tariff are less willing to sell water and sell at higher prices than those water sellers with flat rate tariff.

Private groundwater markets under a flat rate electricity tariff regime– though not perfectly efficient – have still resulted in fairly equitable outcomes as reflected in similar cropping intensity, cropping pattern and crop productivity of major crops among the pump owners and water buyers (table 15). Introduction of metered tariff will dampen the positive equity impact that these markets have created and sustained.

Table 15. Impact of groundwater market: Evidence from West Bengal

Sr. No.	Indicator	Pump owners	Water buyers
1.	Cropping intensity (%)	184.0	180.0
2.	Percentage area under water intensive boro paddy to GCA	24.1	22.8
3.	Percentage of area under profitable potato crop to GCA	8.0	8.1
4.	Productivity (kg/hectare) of boro paddy	5025	5025
5.	Productivity (kg/hectare) of potato	16200	18000
6.	Hired labour use (person days/hectare) for boro paddy	128.3	111.8
7.	Fertilizer use (kg/hectare) for boro paddy	501.0	467.8
8.	Gross income from crop cultivation (Rs/year/hectare)	31200	28582
9.	Sample size (Numbers)	294	286

Source: Author's fieldwork in 40 villages in West Bengal, August to December 2004

6.0 Will flat rate electricity tariff induce groundwater 'over-exploitation' in West Bengal?

It is often alleged that flat rate electricity tariff encourages 'over-exploitation' of groundwater and this has happened in many parts of arid and semi-arid India with hard rock or confined alluvial aquifers. Would the same happen in West Bengal? While movement of groundwater in aquifers is very complex and not amenable to simple generalizations, on the whole, from existing data it appears likely that West Bengal would not face problems of groundwater depletion on the scale witnessed elsewhere in India at least in the near future.

Of the total utilisable groundwater endowment of 27.4 billion cubic meters, only 11.3 billion cubic meters in abstracted annually in the state (WIDD 2004). None of the blocks in West Bengal fall under the 'over-exploited' category as defined by Groundwater Estimation Committee (GEC) 1984 and 1997 methodologies (CGWB 1998). West Bengal is also perhaps the only state in West Bengal where the number of critical and semi-critical blocks (also called dark and grey block under GEC 1984 methodology) came down from 100 to 38 once groundwater estimations were revised using GEC 1997 methodology. Anantha and Sena (2007) based on well monitoring data of SWID for last 28 years in Bhakuri-II gram panchayat of Murshidabad district found that even after continuous groundwater extraction in the last three decades, pre-monsoon water table is still within 6 meters below ground level and the rate of decline is only 9 cm per year in the pre-monsoon season. Given the current precipitation, recharge and assuming higher rate of growth in water extraction mechanisms and population, they extrapolated the groundwater levels in their study area and found that water tables would remain within 6-8 feet in pre-monsoon season for another 32 years, thereby implying that centrifugal pumps fitted on a shallow tubewell will suffice for *boro* paddy cultivation for at least another three decades. The same conditions hold in most of my study villages and much of West Bengal. This is because West Bengal receives very high average annual rainfall (1500 mm to 2500 mm), is underlain by mostly unconfined alluvial aquifers with high recharge potential and lies on one of the most prolific river aquifer systems in the world, viz. the Ganga-Meghna-Brahmaputra (GMB) basin. All these three factors ensure that groundwater is amply recharged during the post monsoon season. Therefore, concerns of over-exploitation of groundwater while true in parts of arid and semi-arid India with hard rock aquifers is far from so in the humid and sub humid GMB basin with unconfined alluvial aquifers. Indeed, the recommendations made by RBI (1984) that utilisation of groundwater offers an important window of opportunity for poverty alleviation in eastern India still remains valid– an opportunity that is in the danger of being missed due to high diesel prices and low rates of rural electrification.

While availability of groundwater is not a problem in the context of West Bengal, arsenic contamination of groundwater is. In view of this, government of West Bengal has decided to ban groundwater lifting in 54 blocks of the state (Anandabazar Patrika, 2007). However, in the absence of provision of alternate means of irrigation and livelihoods, this measure is likely to be counter-productive as the following argument shows. First, there is no clear cut evidence that directly links arsenic contamination with the quantum of groundwater extraction (for summary of debate on whether arsenic contamination is human induced, i.e. pyrite oxidation theory or natural, i.e. oxy-hydroxide reduction theory, see Fazal et al. 2001). Second, as of now, there is no evidence to suggest that irrigation with arsenic rich water causes contamination of rice or wheat grains (Norra et al. 2005)[xvi] and thus, arsenic poses only a grave drinking water threat. Third, rather fortunately, various low cost techniques exits for effective removal of arsenic from drinking water (Jakariya et al. 2005) and some of these are now being widely adopted in the affected regions in West Bengal and Bangladesh. Fourth, another body of literature that links nutrition level with arsenic poisoning finds that there is a negative co-relation between socio-economic status, education, level of nutrition and symptoms of arsenic poisoning (Mitra et al. 2004, Rehman et al. 2006 and Maharajan et al. 2007). The policy implication that follows is that in the long term, overall socio-economic development and improving nutritional status of people would be an important tool for minimizing ill effects of arsenic, though in the short term, providing arsenic free drinking water through low cost technologies that are already available would be crucial. Fifth, another extensive body of literature shows that in the context of India, states with high agricultural growth rates also achieved high levels of poverty reduction (Dutt and Ravallion 1998, Palmer-Jones and Sen 2003) and that groundwater irrigation has played a crucial role in agricultural growth in those states (Dains and Pawar 1989, Repetto 1994). Linking these five arguments together brings us to an important conclusion, viz. banning groundwater irrigation for containing arsenic contamination is entirely misplaced because in the absence of any other alternate sources of irrigation and livelihoods, the farmers would become nutritionally poorer and hence all the more susceptible to arsenic poisoning than ever before. A better policy therefore would be to promote socio-economic development and given that West Bengal has ample groundwater and population is largely agrarian, groundwater irrigation can boost agricultural growth and improve the living conditions of the people as this paper shows.

7.0 Conclusion and policy implications

So far in this paper I have shown that high flat rate electricity tariff in regions of high rainfall and alluvial aquifers creates and sustains an efficient and equitable groundwater market under which both water sellers and buyers benefit. However, most of the benefits of groundwater markets are enjoyed by a small section of rural population who have access to electric operated WEMs either as owners or buyers, while the majority of West Bengal's farmers are getting squeezed by high diesel costs and stagnant paddy prices. There is already evidence from across the state that irrigated area is shrinking in response to high diesel prices as is the production of *boro* paddy (Mukherji 2006b, Sarkar 2006). The hardest hit, are the small and marginal water buying farmers who depend on diesel WEMs. The clear conclusion is that there is an urgent need for electrification of irrigation tubewells in West Bengal. Equally urgent is the need for continuation of the flat rate tariff system, which incidentally the government of West Bengal is planning to discontinue by 2008 and introduce metered tariff in its place[xvii]. I have argued in this paper that switching to metered tariff would have negative impact on the poor and marginal water buying farmers. In this section, I will also argue that flat tariff need not necessarily mean higher subsidies or lesser revenue than metered tariff.

Having said that, are there any practical supply constraints to rural electrification in West Bengal? It seems not. West Bengal is among the few states in India with surplus electricity with an installed electricity generation capacity of 5680 MW. A number of power projects with an aggregate capacity of 2270 MW too are in various stages of completion (IBEF 2006a). This year West Bengal State Electricity Board (WBSEB) offered to sell electricity to the state of Andhra Pradesh which was reeling under a severe electricity crisis during the *rabi* season. Similarly, GoWB has also offered to sell electricity to neighbouring Bangladesh. Curiously enough, the GoWB which is willing to sell electricity to farmers in other states and countries has adopted an indifferent attitude to its own farmers and rural areas. This is quite evident from the following statistics. First, only 10.1% of WEMs in West Bengal are electrified (NSSO 1999) as against 89% in Karnataka, 88% in Maharashtra and 84% in Andhra Pradesh and a national average of 51%. Second, agriculture contributes to 27% of the state GDP in West Bengal, but it consumes only 7% of electricity, while industry contributes only 22% of the GDP but consumes 42% of electricity. In Punjab agriculture contributes to 38% of the state GDP and consumes 29% of electricity (IBEF 2006b). Third, only 5.5% of rural dwellings are electrified as against the national average of 26.9% (NCAER 2004). Finally, average per capita electricity consumption in West Bengal is only 164 KWH as against 703 KWH in Punjab and the national average of 300 KWH (NCAER 2004). When diesel prices were cheap and subsidised (see Figure 3), the impact of lack of rural electrification was not felt severely by the farmers in West Bengal. This is because water tables being shallow, diesel centrifugal pumps could be easily used in lieu of electric pumps – something that cannot be done in regions of deep water tables such as in north Gujarat and southern India. Water tables are still within 30 feet in most of West Bengal, yet use of diesel pumps have been rendered uneconomical due to high diesel prices. It is now that the impact of lack of rural electrification is been severely felt. To make matters worse, the GoWB, as mentioned earlier, is planning to meter irrigation tubewells. Most often metering is justified on grounds of financial unviablity of the SEBs and over-exploitation of groundwater. None of these are valid concerns in West Bengal, while concentrated rural poverty in land of abundant groundwater is a legitimate cause for concern. Opponents of flat tariff often equate flat tariff with low tariff. But here I argue that it need not necessarily be so.

Can the flat rate tariff be so fixed so as to ensure that total revenue generated from agricultural consumption of electricity would be same as those under proposed metered tariff rate? Yes, it can be as the following calculations show. Right now, the GoWB has fixed three slabs of electricity tariff at the rate of Re. 0.97/unit during night, Rs. 1.55/unit during off-peak day time and Rs. 3.30/unit during peak evening hours (see table 13). Assuming that a WEM operates for the entire 24 hours in a day and 3.5 units of electricity are consumed in an hour, the weighted average electricity tariff per hour of operation would be around Rs. 6/hour. When translated to flat tariff, this would amount to a staggering Rs. 52650/year/WEM – an amount that none of the pump owners could afford to pay. But then, the very assumption that WEMs operate for 24 hours in a day for 365 days in a year is fallacious. In fact, the electric submersible and centrifugal tubewells operate on an average for only 128 or 129 days in a year and that too for only 13 to 16 hours per day with major seasonal variations (table 16).

Table 16. Average annual numbers of hours of operation of ESBs and ESTs in West Bengal

			Electric submersible pumps (N= 72)			Electric centrifugal pumps (N =73)		
Sr. No.	Seasons	Duration	Number of days WEM was used	Average number of hours/day	Total hours	Number of days WEM was used	Average number of hours/day	Total hours
1	Kharif	Middle of June to middle of November (150 days)	27	10	270	33	12	396
2	Rabi	Middle of November to middle of February (90 days)	13	7	91	12	5	60
3	Summer	Middle of January to middle of May (120 days)	89	20	1780	83	14	1162
4	All year	360 days	129	16.5	2141	128	13	1618

Source: Author's fieldwork in 40 villages in West Bengal, August 2004 to December

The table above shows that 130 days in a year are all that a farmer needs electricity to meet his/her own and their water buyers' irrigation requirements. Most of this irrigation (70 to 80%) is used in the summer months of *boro* paddy cultivation. Given that ESBs are used for only 129 days in a year and for 16.5 hours on an average, the total revenue under the proposed metered tariff that the GoWB would realize would be to the amount of Rs. 10,000 or so[xviii]. Right now the flat rate tariff for ESBs is Rs. 6810/ ESB/year. This amount can be progressively raised to around Rs. 10,500/ESB/year. This would mean that same revenue as that under metered tariff may be generated without giving up the benefits that high flat rate tariff offers. In order to recoup an electricity bill of Rs.10,500/ESB/year, an ESB owner would have to sell water to around 16.0 *bighas* of boro paddy (@ Rs. 650/bigha/year, see table 9), while in fact at present they sell water to almost 34.0 *bighas* of land in summer *boro* season. Based on the actual hours of usage, table 17 proposes flat tariff for ESBs and EST and recommends that this flat tariff be charged in three installments as it is been done currently in West Bengal. If the flat tariff is also adjusted to seasonal water use, then the only discontent against flat tariff that the farmers have, *viz*. that they have to pay even when they do not pump water would be taken care of. This table makes a very important point; viz. flat tariff may be set at a level at which the gross revenue generated would be no less than revenue generated under metered tariff.

If in addition, transmission lines supplying electricity to agriculture is separated from those of domestic and rural industries, as has been done under the *Jyotirgram Yojana* in Gujarat (Shah and Verma 2007), and agricultural electricity is metered at the transformer level, then the major complain of energy and financial auditors that flat rate tariff leads to accounting problems would also be taken care of.

Table 17. Revenue that would be realized under the GoWB's proposed metered tariff rates and authors' suggested flat tariff rate in West Bengal (in Rs/WEM/year)

Sr. No.	Seasons	Revenue realised under GoWB's proposed metered tariff	Suggested flat rate tariff	Difference	Revenue realised under GoWB's proposed metered tariff	Suggested flat rate tariff	Difference
		Electric submersible WEMs			Electric centrifugal WEMs		
1	Kharif	1026.3	2000	973.7	1612.4	2000	387.6
2	Rabi	308.9	1500	1191.1	203.7	1000	796.3
3	Summer	8756.3	7000	-1756.3	4955.9	4500	-455.9
4	All year	10091.5	10500	408.5	6772.0	7500	728.0

Source: Based on actual hours of pumping as given in table 17 and proposed meter tariff rates as given in table 13.

To conclude, in this paper I have made a case for electrification of irrigation pumps in West Bengal and continuation of the high flat rate electricity tariff. In the absence of either, the agrarian economy of West Bengal would be plunged into a serious crisis. Symptoms of this crisis are already evident in the form of massive discontent among the farming community that this author had the scope of witnessing first hand during her fieldwork in 2004-05. These voices of discontent are often suppressed by the ruling Left Front government through its co-option of the only peasant body in the state, viz. the Krishak Sabha (Basu 2001, Mukherji 2006a) and come to the fore only when trigger events like the land acquisition in Singur and Nandigram occur. At a time when the GOI is planning to offer free broadband internet services to its rural population (Economic Times 2007), it is indeed distressful that the GoWB is unable to offer even basic rural electrification to its farmers in spite of the fact that it is a surplus producer of electricity and is planning to sell electricity to other states and neighboring countries.

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Endnotes

[i] This is because large farmers generally own more than one pump and very often these pumps have higher horse power.

[ii] Some of this evidence will be presented in this paper.

[iii] Though selling of water is a profitable business, it comes with its share of hassles. These include often waking up in the middle of the night (when electricity comes) to switch on the pump and provide irrigation to the water buyers, pursuing water buyers to cough up water charges, dealing with various complaints of the water buyers and at times even spoiling one's reputation in the village if one is too pro-active in pursuing defaulters.

[iv] For example, in a recent conference organised by the Central Groundwater Board at New Delhi, the Director of the SWID justified the introduction of West Bengal Groundwater Resources (Management Control and Regulation Act 2005) on grounds of "…noticeable falling trend in the groundwater level during summer", (Ray Chowdhury 2006:221) which incidentally data from their own organization refutes (see WIDD 2004). Similarly, representatives from the Central Groundwater Board based at Calcutta Regional Office (Kar, Gawri and Choudhary 2006) titled their paper as "Over-exploitation of aquifers: Need for proper planning, management tactics, awareness and legislation (examples from West Bengal and Orissa)" – a curious enough title in those two states of India where groundwater is under-utilized rather than 'overexploited'.

[v] Those pump owners who neither bought nor sold water (PO), and those who sold water to others but did not buy any (WS), those who both sold and bought water (SB), and those who did not sell water but bought water from others (PB).

[vi] WEMs may be classified according to the motive power (diesel vs. electric) or water pumping technology (centrifugal pumps vs. submersible pumps).

[vii] In as many as 18 out of 40 villages in my sample, respondents reported that payment for water for irrigating paddy (especially *boro* paddy) in kind was prevalent in their villages and almost all the WEM owners said that they preferred land lease in the past. Fujita (2004:9), based on a comparative study of villages in Bangladesh and West Bengal too concluded that "(I)t seems that just as in the case of Bangladesh, the dominant mode of transaction in the groundwater market in West Bengal also experienced a drastic change from seasonal tenancy to water sales with cash payment".

[viii] Time series data on cost of cultivation of paddy in West Bengal shows that it has gone up by 55% to 81% from 1991 to 1997(depending on various estimates of cost of cultivation), while paddy prices have declined in terms from 1995 to 2003, thereby squeezing farmer's profits.

[ix] This is because there would be several natural constraints to expansion in irrigation and therefore not all additional potential created would be utilized.

[x] However, this proposed change which was to take place during 2006-07 financial year has not been implemented so far. The current proposal is to meter all tubewells by 2008.

[xi] 1 unit = 1 kilowatt hour (KWH)

[xii] In a rural society where pump owners and water buyers live in close proximity to one another, water sellers might not be able to refuse to sell water due to societal and moral pressure. However, under such circumstances, they might sell water as an act of favour. The terms of transaction then become distinctly in water sellers favour.

[xiii] I make this assumption because there is no way in which I could predict which WEM owners will refuse to sell water after a switch-over and who will not.

[xiv] This assumption is made for the sake of simplicity of calculations. It is highly possible that with overall increase in unit costs of pumping, water sellers will use water more efficiently than before.

[xv] Available evidence from Gujarat (Shah and Verma 2007) and common sense logic says that water sellers under metered tariff regime will have a higher water price to cost ratio than their counterparts facing flat tariff regime.

[xvi] However, there is some evidence to show that arsenic may be up taken by paddy straw (Norra et al. 2005), making it possibly unsuitable for use as fodder and also by some vegetables, especially green leafy vegetables (Farid et al. undated).

[xvii] West Bengal Electricity Regulatory Commission (WBERC) has made metering mandatory for all consumers irrespective of type of usage vide a notification No. WBERC/A-41/1/0672 dated 13th July 2006 that reads as follows: " *In exercise of the power conferred the second proviso to sub-section(1) of section 55 of the electricity act 2003 (36 of 2003), the West Bengal Electricity Regulatory Commission hereby notifies that, no license shall supply electricity after 31st March 2008 to any class or classes of persons in West Bengal, except through installation of correct meters in accordance with the regulations made in this behalf by the Central Electricity Authority*". This act warrants a daunting task of installation of meters to about 120 thousands tubewells around the state by 31st March 2008

[xviii] This assumes that WEM's are operated during 8 hours at night when the tariff is Re 0.97/unit and 8.5 hours when the tariff is Rs. 1.55/unit.