IWMI- TATA
Water Policy Program

6

Water Policy Research

Highlight

What Determines Pumping Behaviour of Tubewell Owners: Marginal Cost or Opportunity Cost?

Avinash Kishore
Shilp Verma

It is a common belief that flat tariff system leads to inefficiency in water and energy use in irrigation because it makes incremental cost of pumping negligible. However, in areas with vibrant water markets and rationed power supply, pumping behaviour is not determined by the incremental cost. Therefore, imposing unit rates by metering will not lead to increased efficiency.

Flat rate tariff can however ensure efficiency if tariff rates are reasonable and rationing is effective.

Download this paper from
http://www.iwmi.org/iwmi-tata

What Determines Pumping Behaviour of Tubewell Owners: Marginal Cost or Opportunity Cost?[1]

RESEARCH HIGHLIGHT BASED ON A PAPER TITLED:

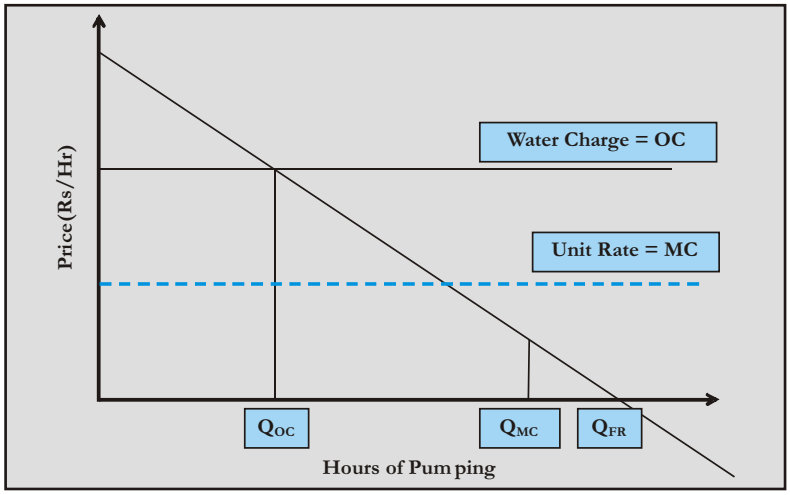
"PUMPING BEHAVIOUR UNDER DIFFERENT TARIFF REGIMES: THE ANAND SURVEY"

The flat rate tariff system is often blamed for groundwater overexploitation and for the inefficiencies in power and water use in groundwater irrigation. Flat tariff reduces the marginal cost (MC) of groundwater extraction to near zero which creates strong perverse incentives for farmers to indulge in profligate and wasteful use of energy and water. Moreover power consumption in agriculture remains unmeasured. This allows energy utilities to mask their inefficiencies and show them as agricultural consumption leading to siphoning off of power subsidies by unintended beneficiaries. It is also believed that the flat rate system favors large farmers and areas with rich aquifers.

For these reasons, both power and groundwater sector experts aggressively advocate a return to universal metering of agricultural power consumption. There is a strong belief that metering alone can reverse the fortunes of the power sector and can effectively stem the rapid depletion of groundwater. With metering there will be a marginal cost of groundwater extraction and that will check unproductive use of power and water. Besides, metering will help in better targeting of subsidies and make energy audit more accurate and transparent which is an essential first step to the reduction of inefficiencies in the power sector. Metering will also provide positive incentives for water and energy saving efforts and ensure greater equity between farmers and among different regions.

This paper counters the common belief that flat tariff system encourages inefficiency in use of energy and water. It hypothesizes that in areas where vibrant water markets exist, there will not be any significant difference between pumping behavior and water use efficiency of a pump owner paying for power at a flat rate and one paying at unit rate. In such areas, pump owners have an opportunity cost (OC) of pumping which is equal to the rate at which they can sell water in the market. Normally this opportunity cost is much higher than the marginal cost imposed by the unit rate and hence becomes the deciding criterion for the amount of irrigation to be provided in own field and the total annual pumpage. The argument can be graphically illustrated as in Figure 1.

Figure 1: Economics of Groundwater Pumping



[1] The research covered by this IWMI-Tata Research Highlight was carried out with generous support from Sir Ratan Tata Trust, Mumbai under IWMI-Tata Water Policy Programme. The research paper can be downloaded from the IWMI-Tata Website http://www.iwmi.org/iwmi-tata.

Table 1: Comparison between Flat Rate (FR) and Metered (PR) Pumpsets

No. of Observations		Pumpage (hours)		Hours/GIA		Units/GIA (KWh)	
FR	PR	FR	PR	FR	PR	FR	PR
32	51	1681.77	1916.31	52.18	59.48	630.79	678.1

In order to test this hypothesis, a field survey was conducted in Anand district of Gujarat; an area well known for its vibrant water markets. Anand has a large number of pumpsets of both flat and metered type. Data were collected from 51 pump owners with metered connections and 32 pump owners with flat rate connections.

We found that, contrary to general expectations, the average annual pumpage was marginally higher for pump owners paying unit rates. Moreover, for similar cropping patterns and gross productivity values, hours of irrigation provided per unit gross irrigated area were also higher for metered pump owners. We calculated the total energy used to irrigate each unit of gross irrigated area by both categories of pumpsets. These calculations show that a farmer with a metered pumpset uses greater amount of energy for irrigating each hectare of gross irrigated area compared to a farmer with flat rate based pumpset (Table 1).

The average annual pumpage was also found to be marginally higher for pumpsets with metered connections. However, both Levene's test for equality of variances and t-test for equality of means show that the differences between variances and means are not significant at 5% significance level for all parameters (Table 2). This means that whatever difference in averages we have encountered is only a chance occurrence and there exists no significant difference between the behaviour of pump owners who have metered connections and those who have flat rate connections. This shows that metered tariff regime alone does not make any difference to the efficiency of groundwater irrigation.

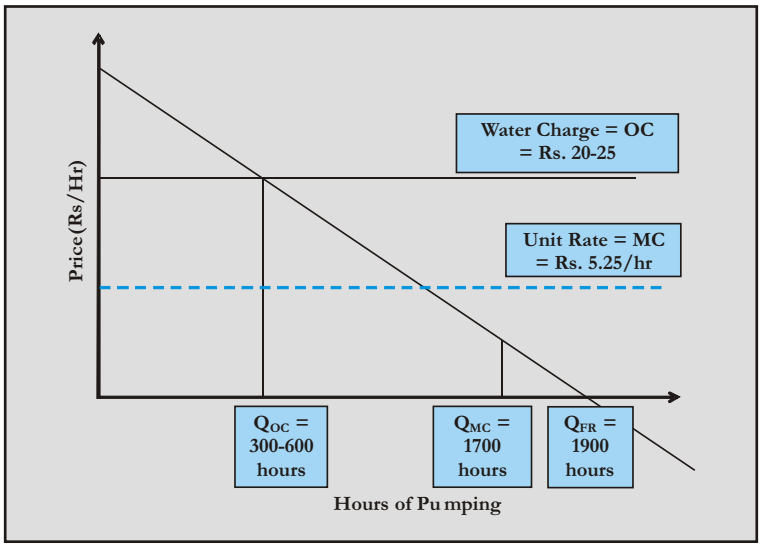
The phenomenon becomes clearer if we add values obtained from the study to Figure 1. Unit rates for agriculture are as low as Re. 0.50 and Re. 0.70 in Gujarat for general and *tatkaal*[2] connections respectively. This means that a pump owner with a 10 HP pumpset in Anand will incur Rs.3.73 or Rs 5.22 per hour as cost of pumping (depending on the type of connection) while at the prevailing water rates in the local water market,

Table 2: t-test for Equality of Means

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig.(2-tailed)
PUMPAGE	Equal variances assumed	2.428	.123	- 1.961	81	.053
HRSBYGIA	Equal variances assumed	.079	.078	-.697	81	.488
UNITSBYG	Equal variances assumed	1.632	.205	-.524	81	.602
RATEBYHP	Equal variances assumed	1.511	.223	-1.635	81	.106

[2] *Tatkaal* (instant) connections are special connections acquired after paying speed charge to the electricity board. These connections are metered and have to pay a higher unit rate than a regular connection.

Figure 2: Opportunity Cost vs. Marginal Cost for a 10 HP Pumpset



When would Flat Rate Lead to Inefficiencies?

In situations where the groundwater supply far exceeds the irrigation demand because of high pump density and unrestricted power supply, demand will become a limiting factor very soon as there would be very few buyers. In such cases the opportunity cost of pumping will be insignificant and the marginal cost of pumping will become the opportunity cost. If there is a flat rate regime this opportunity cost will be almost zero and this will lead to overuse and inefficiencies in both energy and water use.

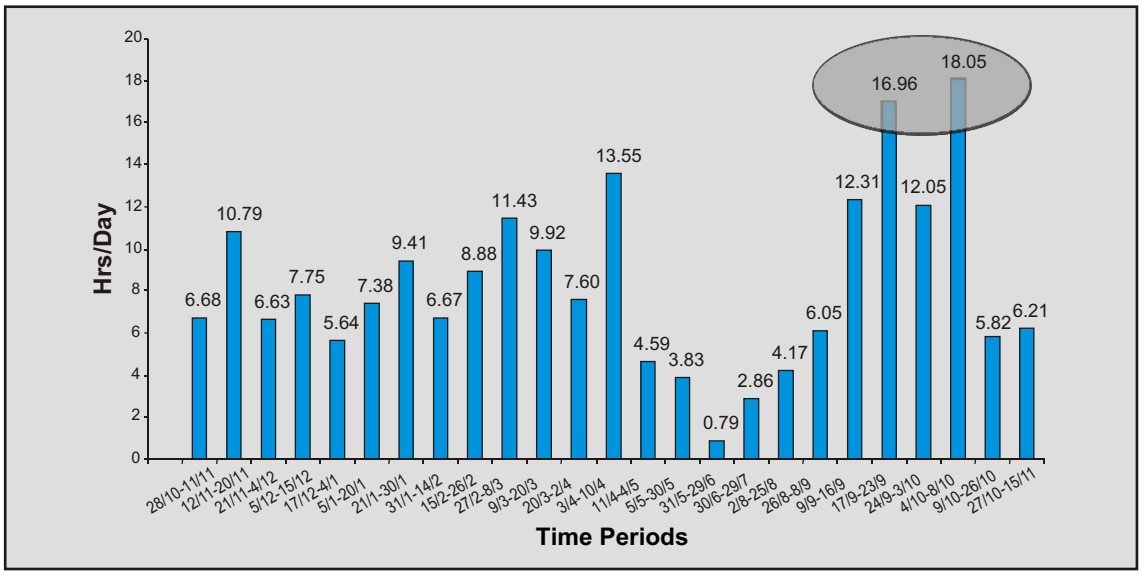
he will earn Rs. 20-25 per hour by selling water. He will keep using the pumpset to irrigate his own crops until his perceived incremental returns from an additional hour of pumping are higher than the rate at which he can sell water in the market. This is the point Q_{OC} in Figure 2 which is around 300-600 hours for a typical pump owner in the study area. Beyond this point, he will run the pumpset to cater to the water market. Since the market rate of water is much higher than the energy cost under the current tariff regime, he will keep pumping as long as there is demand in the market and power is available to meet the demand. In most of the situations, power availability becomes the limiting factor as power supply to agriculture is restricted to eight hours a day in Gujarat.

It is for these reasons that high tariff rates and effective rationing are essential for a functional flat rate regime. High flat rate raises the fixed cost, dissuading overinvestment in pump capital. With effective rationing it ensures that pump capacity remains a scarce resource in the water market to be allocated to its most productive use. The flat rate system in Gujarat scores poorly on both counts. The tariff is extremely low and has not been revised for more than a decade. In fact, in real terms it has gone down from the time when it was fixed last even while the cost of energy supply has gone up manifolds. Our study shows that, at the current pumpage levels in Anand, the effective unit cost of energy is as low as Re. 0.39 for a pump owner while the utility's cost of energy supply to agriculture is around Rs. 2.50 per unit (Table 3).

Table 3: Break-even Pumpage at Current Tariff Rates

Pump-Size (in HP)	@ Rs. 0.50/Unit (Hrs/Yr.)	@ Rs. 0.70/Unit (Hrs/Yr.)	Per Unit Realization (in Rs.)
0-7.5	938.33	670.24	0.394
> 7.5	1340.48	957.48	

Figure 3: Rationing and Pumpage per Day



Any flat rate regime can be viable only if the delivery of goods or services is rationed to a level which the tariff can purchase. The Gujarat Electricity Board (GEB) has a policy of supplying power to agriculture for eight hours a day. However, data collected from daily records of pump owners show that GEB has not been able to enforce rationing strictly. Farmers frequently use phase splitting capacitors to run their pumpsets even beyond scheduled hours, especially during peak agricultural seasons (Figure 3).

There is an urgent need to transform the present dysfunctional power supply and pricing system to ensure a viable power industry and sustainable irrigated agriculture. The transformation should focus on rationalizing the power tariff rate and developing and enforcing a smart power supply schedule which takes the seasonal nature of agricultural demand in consideration.

Concluding Remarks

The logic for metering is undeniable but implementing universal metering is a difficult and costly task in itself. Moreover, our study clearly shows that creating marginal cost in itself does not bring efficiency in water use in irrigation especially if the unit rates are as low as Re. 0.50 – 0.70. At these rates there may be a slight increase in the revenue earned by energy utilities like the Gujarat Electricity Board (GEB) but even this increase will be largely offset by increase in costs incurred in reading meters, disbursing and collecting bills, and monitoring pilferage. Also, if marginal cost were the real driving force for efficiency measures, all diesel pumpsets would have been highly efficient as they incur a very high marginal cost. However, studies done in eastern India suggest that diesel pumpsets are even more inefficient than the electric pumpsets (Dom et al, 2001)[3]. This indicates that marginal cost, even if high is not enough in itself to bring energy efficiency in groundwater irrigation.

[3]Dom,G.J. *et al.* 2001. Improved fuel efficiency of diesel irrigation pumpsets in India. Volume V No. 3. Energy for Sustainable Development.

IWMI-Tata Water Policy Program

The IWMI-Tata Water Policy Program was launched in 2000 with the support of Sir Ratan Tata Trust, Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations.

Through this program, IWMI collaborates with a range of partners across India to identify, analyse and document relevant water-management approaches and current practices. These practices are assessed and synthesised for maximum policy impact in the series on Water Policy Research Highlights and IWMI-Tata Comments.

The policy program's website promotes the exchange of knowledge on water-resources management, within the research community and between researchers and policy makers in India.

IWMI-Tata WATER POLICY PROGRAM
Elecon, Anand-Sojitra Road
Vallabh Vidyanagar, 388120, Gujarat, India
Telephone: 91-2692-229311-12-13
Fax : 91-2692-229310
E-mail: iwmi-tata@cgiar.org
Website: http://www.iwmi.org/iwmi-tata

IWMI
International Water Management Institute

FUTURE HARVEST
IWMI is a Futures Harvest Center
Supported by the CGIAR

HEADQUARTERS
127 Sunil Mawatha, Pelawatte, Battaramulla, Sri Lanka
Mailing Address : P. O. Box 2075,Colombo,Sri Lanka
Telephone : +94 1 787404,784080 ; Fax : +94 1 786854
E mail : iwmi@cgiar.org

REGIONAL OFFICE FOR ASIA
(Bangladesh, China, Nepal and Sri Lanka)
127 Sunil Mawatha, Pelawatte, Battaramulla, Sri Lanka
Mailing Address : P. O. Box 2075,Colombo, Sri Lanka
Telephone : +94 1 787404,784080,1 ; Fax : +94 1 786854
E mail : iwmi-asia@cgiar.org

CHINA
Center for Chinese Agricultural Policy,
Chinese Academy of Sciences
Building 917,Datun Road, Anwai, Beijing,100 101, China
Telephone : +86 -10 64889440,64856535,64856837
Fax : +86 -10 64856533
E mail : j.wang@cgiar.org

NEPAL
GPO 8975 EPC 416, Kathmandu, Nepal
Telephone : +977-1 535382 (Ext. 486)
Mobile Tel : 9810 - 22573 ; Fax : +977-1 523996
E Mail : d.pant@cgiar.org

REGIONAL OFFICE FOR AFRICA
141, Cresswell Street, 0184 Silverton, Pretoria, South Africa
Mailing Address: Private Bag X813,Silverton 0127, South Africa
Telephone : +27-12 - 845 9100 ; Fax : +27-12 - 845 -9110
E Mail : iwmi-africa@cgiar.org

KENYA
C/o. ICRAF, United Nations Avenue, P. O. Box 30677, Nairobi, Kenya
Telephone : +254 - 2 - 524751,524000 ; Fax : + 254 -2 - 524001
E Mail : f.gichuki@cgiar.org

GHANA
IWMI Ghana,CSIR campus,Odei Block,
Airport Res. Area, Accra
IWMI Ghana, PMB CT 112, Cantoments, Accra, Ghana
Telehone : +233-(0) 21-784752/53/54 ; Fax : +233-(0) 21-784752
E mail : iwmi-ghana@cgiar.org

REGIONAL OFFICE FOR INDIA
C/o. ICRISAT, Patancheru, AP 502 324, India
Telephone : +91-40 -329-6161 ; Fax : +91-40 - 324-1239
E mail : iwmi-india@cgiar.org

REGIONAL OFFICE FOR PAKISTAN, CENTRAL ASIA AND MIDDLE EAST
12KM Multan Road, Chowk Thokar Niaz Baig,
Lahore 53700,Pakistan
Telephone : +92 - 42 - 5410050-53(4 lines) ; Fax : +92-42-5410054
E mail : iwmi-pak@cgiar.org

UZBEKISTAN
Apartment NO.103,Home No.6,Murtazaeva Street,
Tashkent 700000, Uzbekistan
Telephone : +998 - 71-1370445 ; Fax : +998 -71-1370317
E mail : v.hornikova@cgiar.org

REGIONAL OFFICE FOR SOUTHEAST ASIA
(Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines,Thailand,Vietnam)
P. O. Box 1025, Kasetsart University Jatujak,
Bangkok 10903,Thailand
Telephone : +66 2 561- 4433 ; Fax : +66 2 561-1230
E mail : iwmi-sea@cgiar.org