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FARM POWER TARIFF POLICIES AND THEIR IMPACT ON GROUND WATER IRRIGATED FARMS

S. SELVARAJAN*

ABSTRACT

The impact of different farm power tariff policies, viz., unit pricing, flat rate tariff and free power supply schemes in terms of farm sizes and pumping capacities is analysed in case of ground water irrigated farms located within the surface irrigation command of Amaravathy river in south India. Impact analysis highlights that any power tariff policy that delinks the price from consumption is bound to introduce differential impact in favour of farms with relatively stronger resource base consisting of more than 2 ha holding size, owning more than one well, wells being deeper than 35 feet with high powered irrigation pumps of 7.5 HP and above. Targetting the beneficiaries with appropriate indicators of resource base through rational power pricing policies linked with electricity consumption levels is imperative to minimise the inequity in financial as well as economic distribution impact of current power tariff policies and to further facilitate the economic rationality of scarce resource use in the farm sector.

Introduction

The phenomenal increase in India's ground water resource development and use since third Five Year Plan onwards has resulted in its pre-eminence as the first major source of irrigated acreage as of now. In 1988-89, the ground water source alone accounted for half of the net irrigated acreage followed by canals (36 2%) and other sources. The pace of ground water resource development initiated during third Five Year Plan, has been sustained in 1970's and 1980's through several policy instruments like institutional credit facilities, pricing policies, technology development, infrastructural development etc., in the farm as well as non-farm sector. The role of input pricing, particularly energy pricing or to be more specific, electricity pricing policy in ground water resource

* Senior Scientist (Economics), Water Technology Centre, Indian Agricultural Research Institute, New Delhi-110 012.

development has acquired another dimension of social welfare during 1980's in which, several state governments have shifted from unit pricing policy to flat rate tariff structure and in recent years even to the extent of free power supply to agricultural pumpsets in states like Tamil Nadu. In Tamil Nadu, as on 1987-88, 1.73 million wells were irrigating a net area of 1.09 million ha as compared to 0.43 million ha irrigated by 0.54 milion wells during 1950. For the state as a whole, about two-third of the annual recharge is being exploited to bring obout more than one-third of the irrigated area under ground water source.[1] With more than 1.24 million energised pumpsets in 1989, the state's agricultural sector utilises 25.2 per cent of the total power consumption. The cost of ground water pumping under different electricity tariff policies and their resultant differential impact in terms of farm sizes and pumping capacities are the two main issues addressed in this paper.

Study Area

Amaravathy Reservoir Project (ARP), a major surface irrigation project of Tamil Nadu state in south India, was selected for this study. ARP was executed during second Five Year Plan to stabilize the existing irrigation facilities in 12,800 ha (old ayacut) and to provide additional irrigation facilities to 8770 ha (new ayacut). The irrigation period for the new ayacut served by a 64 Km long Amaravathy main canal (AMC) is for six months from August to January. The ground water resource development and use in this new ayacut supplements canal water utilization during canal flowing season and supports crops like sugarcane and other lightly irrigated crops during no-canal-supply season (February-July).

Data Base

For the present study, the middle section of AMC, commanding an area of 2263.65 ha with a network of 24 sluices/distributaries, was selected. The primary data was collected in 1984-85 from 120 farms[2]. The sample farms were selected in two stages. In the first stage, the total sample size of 120 farms were distributed among all the sluices/distributaries in proportion to their command area. In the second stage, the

1. Government of Tamil Nadu, Ground Water Investigation in Tamil Nadu, Madras : Public Works Department, Ground Water, 1981.
2. The data was collected for the post graduate research project entitled 'Water Use Planning In Amaravathy River Basin' submitted by the author to Tamil Nadu Agricultural University, Coimbatore, 1987.

sample farms allotted to each sluice/distributary were drawn in proportion to holding size-wise distribution of farms namely <1 ha, 1 to 2 ha and> 2 ha. The total sample of 120 farms, thus distributed, was post-stratified in terms of 83 ground water irrigated farms and five horse power categories of irrigation pumpsets for the present analysis. The secondary data on month-wise electricity consumption by each of 371 pumpsets operating in the command area collected for the period 1981-82 to 1983-84 were utilised for the present analysis. Further, discharge data measured from a sub sample of 31 irrigation wells, randomly selected in proportion to their strength in each horse power category, was used to link the ground water extraction with the secondary data on electricity consumption for the study area as as whole.

Ground Water Irrigated Farms and their Distribution

The distribution of 120 sample farms post stratified in terms of 83 well irrigated farms and five horse power categories of irrigation pumpsets is given in Table 1. It is observed that 69 per cent of the sample farms have wells to supplement the canal water availability which is restricted to only six months in a year. Given the uncertainty of the first release of

Table 1. Stratification of Sample Farm Holdings

(a) As per holding size

Holding size	Total sample	Farms with irrigation wells	Number of irrigation wells
Less than 1 ha	14	8	8
1 to 2 ha	48	27	29
More than 2 ha	58	48	71
Total	120	83	108

(b) As per irrigation pumping capacities

Holding size	Irrigation wells with					
	3 HP	5 HP	6 HP	7.5 HP	10 HP	Total
Less than 1 ha	6	2	—	—	—	8
1 to 2 ha	—	23	5	1	—	29
More than 2 ha	—	44	18	5	4	71
Total	6	69	23	6	4	108

canal water flow during the start of irrigation in August and also the water demand often mismatching the supply within the irrigation season, the role of ground water resource development and use has indeed become crucial during irrigation season itself, besides facilitating the growing of lightly irrigated crops and supporting sugarcane beyond the canal flowing season. The percentage of total sample farm holdings having irrigation well facilities has increased with the holding size. It is also worth noting that ground water irrigated farms with more than one well are more common in large holdings while it is few and none in small and marginal holdings.

As regards the irrigation pump capacities and holding sizes, it is seen that 3 HP pumpset is predominantly used in marginal holdings while 5 HP pumpsets dominate the small and large holdings. However, across the holding sizes, 63.9 per cent of the irrigation wells use 5 HP pumping capacity. The higher capacities of 7.5 HP and above are observed only in the case of farms operating more than 2 ha except in the case of one irrigation well in small holding category which is fitted with 7.5 HP pumpset.

Cropping Pattern

The area allocation among major crops/crop groups expressed as per cent of gross cropped area for different farms sizes is given in Table 2. The sample average is also compared with command area average estimated based on 12 years data. Paddy dominates the cropping pattern,

Table 2. Cropping Pattern in Selected Farm Holdings and AMC Command Area

Holding size	Per cent of gross cropped area under				
	Sugarcane	Paddy	Lightly irrigated	Rainfed crop	Current fallows
< 1 ha	6.5	43.8	31.1	12.6	6.0
1 to 2 ha	16.3	37.4	21.5	18.0	6.8
< 2 ha	28.9	41.6	15.1	9.1	5.3
All Sample*	20.8	39.8	21.1	12.4	5.9
Command area@	16.7	34.9	12.6	28.2	7.7

* for the year 1984-85

@ average for the years 1973-74 to 1984-85.

occupying more than one-third of gross cropped area in all farm sizes, the maximum allocation being observed in marginal farms. Lightly irrigated crops like groundnut etc., are next in importance to paddy in marginal and small holdings while sugarcane occupies the second position on large farms.

As the farm size changes from marginal to small category, area allocation for sugarcane incresaes, with reduction in the area allocated for paddy and lightly irrigated crops But the simultaneous increase in area under rainfed crops and current fallows suggests the strong preference for sugarcane, it being a remunerative cash crop supported by favourable input/resource management due to the tie-up arrangements with the sugar factory. Because of this, not only the area under paddy and lightly irrigated crops are readily released for sugarcane but in the process, the possibility of shifting some more irrigated area towards rainfed crops or current fallows is also observed. The direct relationship bettween holding size and per cent of sample farms with irrigation wells on the one hand, and pumping capacity and holding size on the other as observed in Table 1 suggests that, it is the ground water development and availability which is crucial for the crop allocation decisions. Again, it is the same ground water availability which this time sets the limit for irrigated crop area in order to release more water for sugarcane acreage and consequently influences the rainfed cropping/fallowing decisions also.

In the large farms, it is interesting to observe that area allocation under sugarcane is further increased and this is achieved through reduction in area under lightly irrigated crops as well as by shifting some of the area from rainfed cropping and current fallows. Again linking our observation in Table 1, wherein, not only higher irrigation pump capacities but also number of farms having more than one irrigation well being more common in large farms, it is pertinent to infer from Table 2 that with more ground water augmentation, the large farms are able to increase the area allocation under sugarcane without requiring to release any resources that are committed for paddy cultivation. Consequently, the area under paddy allocation remains even higher than that of small farms. On the contrary, despite the substantial augmentation of ground water resource development through additional wells and higher horse powered pumpsets in large farms, still 14.4 per cent of the gross cropped area is under rainfed crops/current fallows. This is largely due to the fact that it is not the ground water availability per se which limits the gross irrigated area in large farms but the power availability which sets the upper limit in terms of ground water pumping/application and thereby influencing the area allocation decisions under rainfed cropping and current fallowing.

Energy Consumption and Discharge Pattern of Irrigation Wells

The command area has 371 wells with electric motors, 135 wells with oil engines and 20 wells with bullock bailing mhots for lifting ground water for irrigation. Further from the sample of 108 irrigation wells, a sub sample of 31 irrigation wells was studied in detail by recording the time taken for filling up the known volume of water trough by operating the lifting device, based on which the level of ground water discharge was assessed and aggregated[3] for the command area as a whole. The average electricity consumption pattern for each of the 511 electrified wells based on the three years data was aggregated and classified into different horse power categories for further analysis. The details of wells in the command area, their energy-wise distribution and extraction pattern in sample farms are presented in Table 3.

Table 3. Energy Consumption and Discharge Capacity of Selected Irrigation Wells in AMC Command Area

HP of motor	No. of wells in command area	No. of sample farms with irrigation wells	Depth range of irrigation wells (feet)	Energy consumption[a] (KWH/year)	Average discharge	
					m^3/hr	m^3/KWH
3	44	6 (3)	20-30	1654	22.2	9.9
5	301	69 (18)	30-40	2391	30.0	8.0
6	135	23 (8)	22-35	3361	33.8	7.5
7.5	24	6 (1)	35-45	6179	37.2	6.6
10	7	4 (1)	40-50	8982	50.5	6.8
5.28[b]	511	108 (31)	20-50	2852[b]	31.0[b]	7.9[b]

Figures in the parentheses indicate the number of sample wells selected for discharge measurements in each horse power category.

[a] Average for three years (1982-84).

[b] Weighted mean per irrigation well for the command area.

3. For the purpose of aggregating different water lifting devices, one bullock bailing mhote was equated to one fourth of 5 HP electric motor based on the ratio of water extraction. Oil engine motor was taken as equal to that of electrical motor with same horse power. The wells in the command area with different water lifting devices were thus categorised as 511 electrified wells for further analysis.

A perusal of Table 3 reveals that while the weighted mean of energy consumption per well per year for the command area is 2852 KWH, there exists wide variation across the horse power categories. While a direct relationship between irrigation pump horse power and annual average electricity consumption is observed throughout, the rate of increase in electricity consumption is increasing particularly in higher horse power categories Next it is important to relate the depth range of irrigation wells with pumping capacity. It is seen that, in general, depth of irrigation wells is higher with higher horse powered pumping units even though there is some overlapping between different horse power categories. This is mainly due to the fact that apart from the depth of well, its location in terms of either ground water acquifer or nearness to artificial recharge facilities will determine the physical capacity of the water output of a well.

Pumping Cost of Well Water in AMC Command Area

Using the discharge measurements from 31 irrigation wells, electricity consumption data for each of the wells in the command area, and primary data from 108 irrigation wells, the cost of pumping well water is estimated and aggregated for the command area, the results of which are given in Table 4. In this estimation only variable cost is considered and all other fixed costs remain same for different pricing policies. It is seen from the table that on an aggregate average basis for the command area as a whole, the variable cost of pumping one ha cm of water is highest in unit rate system (Rs 4.62) followed by flat rate tariff system (Rs 4.48) and obviously least (Rs 2.72) under free power supply scheme. It is interesting to observe that with the shifting from unit rate system prevailed until 1984-85 to flat rate power tariff, the ground water irrigated farms realised marginal benefit to the tune of Rs 32 per well per year on an aggregate average basis. While this benefit to ground water irrigated farms under flat tariff system expressed in terms of revenue foregone by the electricity board may still favourably compare with the possible reduction in the cost of administrative mechanism to impose unit rate pricing system, it is neverthless only one dimension, the other dimensions being the resultant impact on cropping pattern, benefit distribution, scarce resource deployment etc., need to be considered while objectively evaluating the impact of such policy changes. The shifting from flat rate power tariff to free power supply scheme subsequently benefitted the ground water irrigated farms to the tune of Rs 396 per well annually.

Table 4. Estimation of Cost of Pumping Well Water in AMC Command Area.

1. Total number of wells in the command area	=511
2. Total horse power	=2697
3. Total electricity consumed[a] (million KWH)	=1.46
4. Average horse power per well	=5.28
5. Average electricity consumed per well (KWH/year)	=2852
6. Average electricity consumed per well (KWH/hour)	=3.94
7. Average number of working hours per well per year	=723.9
8. Average ground water extraction[b] (m^3/KWH)	=7.9
9. Average hourly ground water extraction per well (m^3)	=31.1
10. Average annual ground water extraction per well (m^3)	=22531
11. Average annual ground water extraction per well per HP (m^3)	=4267
12. Variable cost[c] of pumping 4267 m^3 of well water :	
Annual cost of lubrication oil and grease etc., @ Rs 113.05 for 22531 m^3 of water per year (Rs)	=21.41
Annual pump repairs & maintenance @ Rs. 500 for 22531 m^3 of water per year (Rs.)	=94.69
Annual electricity charges for 4267 m^3 of water (=1 HP) under flat tariff system (Rs.)	=75.00
Total	=191.10

Variable cost of pumping 1 ha cm of water under (Rs.)

Flat tariff system	=4.48
Unit rate system	=4.62
Free power supply	=2.72

[a] Based on secondary data, averaged for three years

[b] Based on discharge measurements in selected irrigation wells

[c] Based on primary survey data of sample farms.

Differential Impact of Electricity Tariff Policies

The financial impact of varying electricity pricing policies on an aggregate average basis discussed in the preceding sections does not highlight the distribution of such impacts across different categories in terms of horse power, holding size or depth of wells. In view of the direct relationship generally observed among these three classifications, the discussion in this section is limited to the differential impact vis-a-vis horse power categories which more or less reflects the other two classifications as well.

A perusal of Table 5 indicates widespread disparity in the financial impact across different horse power categories. At the minimum level of electricity consumption, the financial impact is positive only in horse power categories of 7.5 and above while with maximum level of electricity consumption, the financial impact is positive in all horse power categories when the policy is shifted from unit rate to flat rate. However the positive benefit is substantial in higher horse power categories which means large farm holdings with irrigation wells deeper than 35 feet are able to extract maximum benefit ranging from Rs 82 to 937 per well per year. On an average, the financial impact of flat rate is negative or negligible in case of small and marginal farms which are to a large extent limited by the physical capacity of water output of well as compared to the large farm holdings particularly those who are able to relax this physical limit through further deepening and shifting to higher horse powered irrigation pumps and thereby derive maximum benefit from the flat rate power tariff policy. The recent shift from flat rate to free power supply still retains inequal impact distribution in favour of resource endowed large farm holdings although in lesser magnitude as compared to the shift from unit rate to flat rate. On the contrary the shift from unit rate to free power supply scheme distinctly confers maximum benefits to large farm holdings with higher pumping capacities and little or no change in the small and marginal farm holdings as compared to the shift from flat rate to free supply scheme. Thus while the unit rate power pricing policy seems to be relatively rational in linking the cost to energy consumed, the other two policies namely flat rate power tariff and free supply policies while delinking the cost from energy consumption partially have conferred miximum benefit to the farms with stronger resource base, the consequence of which is further manifested in their production activities.

Flat Tariff Versus Unit Pricing Policy : Financial Impact Distribution

For asessing the distribution of negative financial impact following the switch over from unit rate to flat tariff system, the cut-off level of electricity consumption is estimated for different horse power categories under flat tariff system based on the then prevailing unit rate of Rs 0.15 per unit and all those wells within the command area that have registered average annual electricity consumption less than the cut-off level consumption are identified. Further the same approach is extended to classify the 108 sample irrigation wells in terms of different holding sizes also and the results are presented in Table 6.

Table 5. Differential Impact of Electricity Tariff Policies

HP	Energy consumption (KWH/year)			Financial impact on ground water irrigated farms (Rs/well)				
				Unit rate to flat rate			Flat rate to free supply	Uuit rate to free supply
	Minimum	Maximum	Average	Minimum	Maximum	Average		
3	1061	2097	1654	—66	90	23	225	248
5	1612	3014	2391	—133	77	—16	375	359
6	2105	3741	3361	—134	111	54	450	504
7.5	4291	9125	6179	82	807	365	563	927
10	7163	11244	8982	324	937	597	750	1347

Based on three years data (1982-84)
Unit rate is @ Rs. 0.15 per KWH of electricity consumed
Flat rate is @ Rs. 75 per horse power per year
Unit rate to free supply is worked out based on average energy consumption

Table 6. Distribution of Irrigation Wells with Negative Financial Impact under Flat Rate Power Tariff System

Particulars	Irrigation wells with negative financial impact			
	3 HP	5 HP	6 HP	Total
I. Within command area				
Number of cases	24	146	41	211
Per cent to total	11.4	69.2	19.4	100
Per cent to all wells	54.5	48.5	30.4	41.3
II. Within the sample				
Number of cases	4	32	10	46
Per cent to total	8.7	69.6	21.7	100
Per cent to all wells	66.7	46.4	43.5	42.6
III. Distribution within the sample				
Less than 1 ha	4	1	—	5 (62.5)
1 to 2 ha	—	17	2	19 (65.5)
More than 2 ha	—	14	8	22 (31.0)

Per cent to all wells refers to all irrigation wells under each horse power category.

Figures in the parentheses indicate percentage to all irrigation wells under each holding size.

For the command area as a whole, 41.3 per cent of irrigation wells have registered negative financial impact based on three years data on electricity consumption following the shift in electricity tariff policy from unit rate to flat tariff. This is despite the fact that study area covered in this paper is served by canal irrigation system during six months in a year. Within the sample ground water irrigated farms, 42.6 per cent of irrigation wells fall below the cut-off level consumption, and thereby registering negative financial impact. Classified in terms of size of holding, it is observed that 64.9 per cent of the small and marginal farm holdings recorded negative financial impact as against 31 per cent in large farm category. Again in terms of horse power categories, 78.3 per cent of the sample irrigation wells with horse power less than or equal to 5.0, corresponding to a well depth ranging from 20 to 40 feet, registered negative financial impact following the shift in power tariff policy towards flat rate system. This further reinforces the earlier inferences in preceding sections that the ground water irrigated farms having a holding sizes of more than 2 ha, by virtue of stronger resource base, are able to appropriate maximum financial benefits arising from the shift in power tariff from unit to flat tariff system. Also, as is evident from the cropping pattern in sample farms, such an advantage has been favourably translated to capture the economic benefits too which is likely to further widen the total impact distribution between different sizes of farm holding.

Conclusion and Policy Implications

Given the inverse relationship between ground water irrigated farm sizes and ground water discharge of irrigation wells per unit of electricity consumed and the direct relationship between holding sizes and average ground water discharge per unit of time observed in the study area, any power tariff policy that delinks the price from consumption is bound to introduce differential impact in favour of farm holdings with relatively stronger resource base. Both the flat rate power tariff policy as well as free power supply policy contributes to differential impact wherein maximum financial as well as economic benefits are captured by holding sizes more than 2 ha, owning more than one well, being deeper than 35 feet with high powered irrigation pumps of 7.5 horse power and above.

Despite the fact that the existing rates are abysmally low (both for unit as well as flat rate tariff) and hence do not reflect either scarcity value of power or ground water that is pumped, the inequity in the distribution of social welfare resulting from the delinking of electricity charges from consumption, is appalling inview of our similar such experience in another area namely surface irrigation management. While strengthening the resource base of small/marginal farms through deepening of well and appropriate energisation of pumpsets can minimise the inequity in the benefit distribution impact of flat rate power tariff policy, it would in no way facilitate the deployment of scarce resources based on their scarcity value in alternative uses. This calls for targetting the beneficiaries through rational power pricing policies which should be linked to the appropriate indicators of resource base on the one hand and electricity consumption levels on the other.