WATER MARKET IN THE TANK IRRIGATION SYSTEMS IN TAMIL NADU

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Abstract

Continued progress in water resources development in the future will depend upon the utilization of the existing irrigation potential. An irrigation tank is a small reservoir to catch and store water during rainy season and use it for irrigation during dry season. They recharge groundwater, which is not only a major source of drinking water for numerous rural and urban communities, but also serve as a supplementary source for tank water. Due to the loss in tank storage capacities, wells have become an important source of supplementary water. Since farmers initially use tank water for cultivation, the risk associated with getting adequate water, especially late in the season, has encouraged farmers to use wells for supplemental irrigation particularly later in the crop season. Since only a few farmers in the tank command area own wells, and there is a growing demand for well water, the well owners in most cases act like local monopolists. The study was undertaken with the objective to study the water market in the two districts of Tamil Nadu *viz.*, Sivagangai and Coimbatore. Inverse demand function, Output function and Cost function were used to study the monopolistic behavior of water market. The profit maximizing levels of well yield, price of water and hours of pumping are 4.6meters, Rs10 and 8.6 hours, respectively. Well owners maximize profits from water sales when the water level in the well is at about five meters and the price of pumping hour is Rs. 10 and this correspond to about nine hours of pumping per day from the well. Currently they pump only four hours per day and the water level in the well is about eight meter. Under these conditions, well water output can best be increased by having farmers install more wells and increased competition. With more wells, the demand for water from each individual well will fall, resulting in a lower well water price. Therefore there is a need to increase the number of wells in the tank command area in the study area up to threshold level.

Key words: *Tank irrigation systems, Supplemental well irrigation, Water market*

1. Introduction

Supplemental well irrigation is a crucial factor which determined the rice yield in tank irrigated area. Since farmers transplant the rice immediately after the start of first tank filling the risk associated with getting adequate water, especially late in the season, has encouraged the farmers to use wells for supplementary irrigation particularly late in the crop season. The limited number of wells present in the tank command areas leads to the existence of water market in the tank command area. As there are only a few well owners, they act like monopolists. Each well owner may be the only supplier of groundwater, at least for the group of farmers located around the well. Since the number of wells is limited in most tanks, monopolistic behavior is quite common. Well interference during pumping and recharge rates is reflected in water availability and price. Well owners maximize their profits with respect to the water supplies available and likely demands. Well owners cannot set price and quantity independently since price is determined by the supply and demand for water. Reduction in pumping (up to a certain level) can increase the water price resulting in higher profit. However the marginal cost of pumping is very low (as the electricity is free of charge in Tamil Nadu) and it only pays to reduce pumping in the range where demand is inelastic.

2. Materials and Methods

2.1 Literature review

2.1.1 Monopoly market

Monopoly is a market in which there is one seller of a product. The product has no close substitute. The cross-elasticity of demand with every other product is very low. He is a price-maker, who can set the price to his maximum advantage. In monopoly market, one firm controlled all the supply and set prices to suit it, at limited mainly by the availability of substitutes for its product (Roy *et al*., 1971). In this study, a monopoly market is recognized as a situation where there is a single seller and many buyers.

2.1.2 Groundwater utilization status and its market

Linsley *et al.* (1958) defined aquifer as a geological formation which contains water and transmits it from one point to another in quantities sufficient to permit economic development. Chow (1964) stated that usable ground water occurs in permeable geologic formation known as aquifers. According to Walton, (1990) ground water storage in deposits above aquifers permitted pumping for limited periods of time at rates greater than recharge. Many aquifers were limited in real extent and results in depletion of these aquifers. In a market, sellers were supposed to sell what they own or produce: in the case of water market, neither was the case. Water sellers neither owned nor produced the water they sell; all they sell were the services of well and also their irrigation equipments. The so called “water markets” were actually the lease markets for pumping equipment and a well. Ground water market were used to describe a localized, village level institutional arrangement through which owners of open or tube wells mounted with electric motor or diesel engine-supply irrigation service to other members of the community at a price. The sellers were typically private operators; but a state tube-well or a co-operatively owned tube well too may compete in water markets.

In this study groundwater market is perceived as an act of selling and buying of groundwater at a price and well owners are considered as local monopolists. And also the use of ground water as supplementation to tank water under different level of tank supply and an attempt was made to find out the price of water; hours of pumping and well yield.

2.2 Methods

Two districts were purposively selected in Tamil Nadu, wherein Sivagangai from southern part and Coimbatore district from North-western part represent the Tanks with Wells and Wells only typologies. 113 farm households and 27 farm households who involved in purchasing of water in Tank with wells typology and Wells only typology respectively were selected for this study.

2.2.1. Estimation of inverse demand, cost and output functions

The limited number of wells present in the tank command area leads to the existence of water market in the tank command area. As there are only a few well owners, they act like monopolists. Each well owner may be the only supplier of groundwater, at least for the group of farmers located around the well. Since the number of wells is limited in most tanks, monopolistic behavior is quite common. Well interference during pumping and recharge rates is reflected in water availability and price. Well owners’ maximize their profits with respect to the water supplies available and likely demands. Well owners cannot set price and quantity independently since price is determined by the supply and demand for water. Reduction in pumping (up to a certain level) can increase the water price resulting in higher profit. However the marginal cost of pumping is very low (as the electricity is free of charge) and it only pays to reduce pumping in the range where demand is inelastic.

Henderson and Quant (1971) explained the basic principle used by considering a case of bilateral monopoly in the market for a produced good Q_2, the buyer uses Q_2 as an input to produce Q_1, according to his production function $q_1 = h(q_2)$. He sells Q_1 in a competitive market at the fixed price p_1. The seller uses a single input X for the production of Q_2. He buys X in a competitive market at the fixed price r. Assume that his production function can be expressed in inverse form as $x = H(q_2)$.

For this study the water is considered as a commodity in the market and solved for the equations of inverse demand function, output function and cost function derived from the field survey data specified as follows.

Inverse demand function: Pp = f (Qp)

Output function: Qp = g(WY)

Cost function: AC = h(Qp)

With derived inverse demand, output and cost functions, the profit function arrived as given below and equate its first derivative to zero will give the maximum profit level.

$$Л = (P_p * Q_p) – (AC * Q_p) - FC$$

$$= f(Q_p).\ Q_p – h(Q_p).\ Q_p – FC$$

$dЛ/dQ_p = f'\ Q_p + f – h'Q_p – h = 0$ and by substituting Q_p in the equation , the value of well yield (Wy) can be arrived.

Where,

Л = Profit in Rs

P_p =Price of pump water in Rs/hr

Q_p –Quantity available for pumping in hrs

AC = average cost of pump water in Rs/hr

FC =fixed cost in Rs/hr.

3. Results

Table 3.1 Water buyers in Tank with wells and in Wells only typologies

Farmers	Tank with wells		Wells only	
	Number of farmers purchasing water	*Price Rs/hr	Number of farmers purchasing water	*Price Rs/hr
Marginal farmers	53	17	0	-
Small farmers	57	18	13	15
Large farmers	3	35	14	22
Total	113	*18	27	*18.60

*weighted average of the price

Table 3.2 Annualized cost and average cost of pumping hour in different typologies

Particulars	Typology	
	Tank with wells	Wells only
Average annualized cost (Rs) [10]	11,560	14,750
Average annual pumping hours*	1,116	1,378
Average cost/ pumping hour (Rs)	10.35	10.70
Average cost per irrigation per ha	176	203
Price of water in the water market (Rs) per irrigation per ha	306	354

*Pumping hours was calculated from the survey data. During survey, the pumping hours per day frequency of irrigation in a week and months of irrigation were collected from the farmers. Based on this information month-wise pumping hours was calculated from January to December, 2006/07 cropping year and the average was taken for computation.

3.1 Price of water, pumping hours and well yield

For different level of water prices and varying pumping hours in the study area, it is important to know at what level of pumping (Q_p) and water price (P_p) well owners maximize their profit. Using the fitted inverse demand, and output and average cost (AC) functions, and solving the equations for well yield (WY),

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[10] Groundwater cost at Tank with wells situation

Capital cost (C) = Rs 80000

Capital Recovery Factor (CRF) = $\frac{0.11(1.11)^{20}}{(1.11)^{20}-1}$ =0.125

Annualized cost (A) = CxCRF

= Rs 80000 x 0.125=10000

Repair and Labor cost = Rs 1560

Total cost = Rs 11560

Annual pumping hours = 1116

Average cost = Rs10.35/hour

For Well situation

Capital cost is 100000, as there are bore , tube wells;

Repair and labor cost =Rs 2250

annual pumping hours = 1378

Inverse demand function: Pp = 25.24 – 1.655 Qp**

(1.622) (0.62)

Output function: Qp = - 0.237 +2.19 WY*

(.784) (1.07)

Cost function: AC = 7.001* – 0.591 Qp***

(0.49) (0.193)

***, **, * indicate significance at one, five and 10 per cent level.

Figures in parenthesis are standard errors.

4. Discussion

4.1 Groundwater use in tank irrigation systems

Water purchase, sales and their price could show the scarcity and importance of water in the study area. It can also explain the details performing to the nature of water sales and the extent of water scarcity in the study region. The details of the water buyers and the price paid per pumping hour are given in Table 3.1. Out of the total farmers selected for the study, 113 and 27 farmers were water buyers in Tank with wells and Wells only typologies respectively.

Price per pumping hour differs with locations of the wells, its depth and the monopoly behavior of the well owner which ranged from Rs. 10 to Rs. 50 per pumping hour in the study area. Majority of the large farmers owned wells and a few of them do not own wells. As they are large farmers, the well owners might fix a higher rate for them and also due to the location of those wells, they paid a higher rate for a pumping hour in the study area. On an average a farmer from Tank with wells typology pays Rs. 18 per hour and in the case of Wells only typology, it is Rs. 18.60 per hour (Table 3.1).

4.2 Cost of pumping

The annualized cost of wells was computed to find out the average cost of irrigation in Tank with wells and Wells only typologies. The cost of irrigation depends on the type of well (dug well, dug cum bore well, tube well), current status of well, year of construction, average age or life of well and the discount rate. The value of electric motor and the annual repair charges were also included for the computation of annualized cost of irrigation.

The average annualized cost of wells was higher in Wells only typology than in Tank with wells typology (Table 3.2). Even though a higher annual pumping hours is observed in Wells only typology, the average cost of pumping was also higher than in the Tank with wells typology. This may be due to the depth of water table which is more in Wells only typology and most of the farmers have bore wells, dug cum bore wells and tube wells. The water table is very deep and the cost of construction is also high.

Seller of groundwater in the Tank with wells situation earns a profit[11] of Rs. 130 per irrigation per ha by providing one irrigation to the sugarcane crop (assuming one irrigation for a hectare takes 17 hours of pumping). In wells only situation, a profit of Rs. 151 per ha is earned by providing one irrigation to the sugarcane crop (assuming one irrigation for a hectare takes 19 hours of pumping). This

[11] Profit = (Price of irrigation per ha – Cost of irrigation per ha)

Price of irrigation per ha = Number of hours taken to irrigate per ha x price of water per pumping per hour.

Cost of irrigation per ha = Number of hours taken to irrigate per ha x Average cost per pumping.

higher charge for well irrigation is due to higher demand for groundwater in both Tank with wells and Wells only situations.

4.3 Price of water, pumping hours and well yield

The profit maximizing levels of WY, Pp and Qp are 4.6meters, Rs10 and 8.6 hours respectively.

Well owners maximize profits from water sales when the water level in the well is at about five meters and the price of pumping hour is Rs. 10 and this correspond to about nine hours of pumping per day from the well. Currently they pump only four hours per day and the water level in the well is about eight meter.

5. Conclusions

Well owners maximize profits from water sales when the water level in the well is at about five meters and the price of pumping hour is Rs. 10 and this corresponds to about nine hours of pumping per day from the well. Currently they pump only four hours per day and the water level in the well is about eight meters in the beginning of the tank season and fall drastically resulting in lesser pumping from the wells. Under these conditions, well water output can best be increased by installing more wells and the demand for water from each individual well will fall, resulting in a lower well water price. Therefore there is a need to increase the number of wells in the tank command area in the study area up to the threshold level.

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