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RESEARCH ARTICLE

ECONOMICS OF IRRIGATION GROUNDWATER IN VANUR AND MARAKKANAM BLOCKS OF COASTAL TAMILNADU: ACCESS AND EFFICIENCY ANALYSIS

***Velmurugan, D. and Venkataraman, R.**

Department of Agricultural Economics, Annamalai University, Annamalainagar – 608 002

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ABSTRACT

Tamil Nadu is an agricultural state with water constraint and depends upon its available surface and groundwater resources for irrigation. More attention on groundwater irrigation was found in recent years in TamilNadu since more than 95 percent of surface water resources were exhaustively used.Of all the districts, the coastal districts though received high rainfall also found characterized by high groundwater extraction and water scarcity in post – monsoon period. For better insight regarding this,both physical and economic access and efficiency of irrigation ground water were done in this study in selected non – saline coastal blocks vizVanur (semi critical) and Marakkanam (over - exploited) of Villupuramdistrict in TamilNadu through sample farms (90 in each block). The regression analysis revealed that increase in irrigation cost influenced more decrease in magnitude of groundwater access in semi-critical (SC) block and comparatively less decrease in over exploited (OE). The economic access of ground water extracted for increase in water used was found high in OE than SC. Both the physical and economic efficiency of ground water use were found high in SC than OE block. Arriving at the more reduced magnitude of physical and economic ground water access in OE block and raised physical and economic efficiency of water use is essential. This may be possible by less water intensive cropping and other suitable coping strategies.

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INTRODUCTION

Ground water is an important source of irrigation and caters to more than 60 percent of the area irrigated in the country. On the basis of ratio of gross annual withdrawal of ground water to net annual recharge, the unsafe category falls with ratio greater than 70 percent. Nearly 72 percent of the districts in Tamil Nadu are now in the unsafe category. Of all the districts, the coastal districts through receive high rainfall, also characterized by high groundwater extraction and water scarcity in post - monsoon period. Irrigation sector which usually occupy major share in groundwater use also get highly affected in water scarce condition. Both physical and economicalaccess of irrigation groundwater might give better insight on ground water extraction in agricultural farms. Also water use efficiency could be measured by physical and economic efficiency. Hence an economic retrospect of both access and efficiency of irrigation groundwater study is done in this paper.

****Corresponding author: Velmurugan, D.***
Department of Agricultural Economics, Annamalai University, Annamalainagar – 608 002.

Sampling design

Selection of coastal region of Tamil Nadu was due to extensive resources exploitation as referred in literatures. Among the 13 coastal districts of Tamil Nadu, Villupuramdistrict is with highest net irrigated area by wells. For an efficient study at micro level, two coastal non-saline blocksviz-Vanur and Marakkanam of Villupuramdistrict were selected. Farm samples invariable of farm size as of negligible gross income variation were studied with 90 samples in each selected blocks through three randomly selected villages in each block. The Vanurblock is semi - critical (SC) and Marakkanam block is over-exploited (OE) regarding ground water exploitation categorization.

Semi-critical (SC): Groundwater extraction 70 to 90 percent of recharge. Over - exploited (OE): Ground water extraction more than 100 percent of recharge.

Method of Analysis

Regression analysis and required estimation methods were done.

Tools for estimating Access and Efficiency toirrigation groundwater

Physical Access to Groundwater

Functioning irrigation tube wells determined the access to ground water. Physical access in measured by the magnitude of groundwater used per ha of gross irrigated area. Physical access (Pa) to groundwater is regressed on average irrigation well yield and cost of water per hectare cm:

$$\text{Log Pa} = \text{LogA} + B_1 \text{ Log Wy} + B_2 \text{ Log Cw}$$

Where

Pa = Water used per hectare of gross irrigated area (Physical access)
Wy= Irrigation Well yield in ha cm
Cw= Cost of water per ha cm (Imputed)

Pa can also be considered as water used per farm. This was also regressed on water used for paddy to estimate the influence of water used for paddy, as paddy is a water intensive crop grown by a majority of the farmers.

Economic Access to Groundwater

Economic access is measured as groundwater extracted (in hacm) per rupee of amortized cost of irrigation = [Water used]+[Amortized cost of irrigation]

The economic access is regressed as

$$\text{Log Ea} = \text{Log } \delta + B1 \log \text{Wuf} + B2 \text{ Log Wa}$$

Where
Ea = Economic access in hacm per rupee of amortized cost of irrigation.
Wuf = Water used on the farm in hacm
Wa= Average area irrigated per well

Economic access to groundwater resource is also regressed on gross irrigated area per farm.

$$\text{Log Ea} = \text{Log } \mu + B2 \log \text{GIA}$$

Where Ea = Economic access
GIA = Gross irrigated area

Physical efficiency

Physical efficiency of irrigation ground water used (for crops) is measured asPhysical water productivity (qtl).

Physical water productivity (qtl) =Crop yield(qtl)/Water used (hacm)

Economic efficiency

Economic efficiency of irrigation ground water used (for crops) is measured in terms of

- Net income per ha cm of water used per crop
- Average Net income per ha per crop

Calculation: 1) Net income per ha cm of water used per crop

$$= \frac{\text{Average Net income per ha from the crop}}{\text{Water used (ha cm)}}$$

Where, water used (ha cm) = No. of irrigation x Depth of irrigation (cm)

Water used for total area (ha cm) =

$$\frac{\text{Area irrigated} \times \text{No.of irrigations percrop} \times \text{No.of hrs per irrigation} \times \text{AverageYieldof wellin hacm}}{10117126}$$

2) Average Net income per ha per crop (Rs/ha)
= (Gross income – cost of cultivation)

Amortized cost of Irrigation ground water

To arrive at the annual share of groundwater irrigation cost, the well investment was amortized as follows.

Amortized cost of Tube well = Amortized installation charges + Amortized water pumping charges+ other amortized cost (Accessories and maintenance)

Amortised installation charge = [Drilling cost at recent prices x $(1\times i)^{AL}\times i] \div [(1+i)^{AL} -1]$

Where,

AL = Average Tube well life (here 10 years)
I = Interest rate (here 7 percent)

Amortised water pumping charges = [Pumping cost at recent prices $x(1+i)^{AL}\times i]\div[(1+i)^{AL} -1]$

RESULTS AND DISCUSSION

The focus of details collected among samples regarding groundwater extraction as shown in table-1gives the background information related to irrigation ground water access.

Estimation of Irrigation Ground Water Extraction details use among samples in study blocks

Estimation of GW extraction was by the volume of GW used per hectare of Gross Irrigated Area (ha cm). This was found by estimation in the selected blocks among the samples by weighted averages in shallow and deep GW extraction wells separately and shown in Table 1. Both shallow and deep wells were operated in SC block and only shallow wells in OE block. The yield of bore wells was found to be the major factor making the difference in exploitation level. The population of wells is also shown in the table. Both the well population and depth of wells may rely on the ground water recharge of rainfall received in both the study blocks.

Estimation of Physical Access for Ground Water Irrigation in Sample Farms

Physical access in terms of volume of GW used per hectare of gross irrigated area was found to be influenced by well yield and cost of GW extracted significantly. The regression analysis of the values for the sample farms revealed the results as shown in Table 2. The well yield also imposes more positive significant influence on magnitude of GW used in SC block compared to the less positive significant influence in OE block.

Table-1. Estimation of Irrigation Ground Water Extraction details among samples in study blocks

S.No	Particulars	Weighted mean of all samples	
		SC block	OE block
1.	No. of wells		
	a)Shallow TW	47	90
	b)Deep TW	43	-
2.	Average GW used per ha of gross irrigated area (Y) (ha cm)		
	a)Shallow TW	90.40	97.98
	b)Deep TW	96.47	-
3.	Average days pumped in a year (nos.)		
	a)Shallow TW	220	284.5
	b)Deep TW	220	-
4.	Average hours pumped in a day (nos.)		
	a)Shallow TW	8	7
	b)Deep TW	8	-
5.	Yield of bore wells in lts/hr.		
	a)Shallow TW	5200	4978
	b)Deep TW	5546	-
	Norms of CGWB Average GW draft permitted :		
	a)Shallow TW	90 ha cm	90 ha cm
	b)Deep TW	150 ha cm	-

** @ 5% significant level

Table 2. Estimation of Physical access to ground water irrigation insample farms

S.No	Particulars	SC Block	OEblock
1.	Intercept	5.38	7.45
2.	Well yield (x_1) ha cm	2.48	2.08
3.	Cost of ground water per ha cm (x_2) (Imputed)	-0.28**	-0.23**
4.	R^2 value	0.83	0.85
	No. of samples	90	90

Table 3. Estimation of physical efficiency of ground water use in paddy cultivation among samples of selected blocks

S. No.	Particulars	SC Block	OE Block
1.	Water used (ha cm) (Average)	65.2	75.1
2.	Paddy yield (qtl) (Average)	29.9	28.5
3.	Water applied (ha cm) S.no(1/2)	2.17	2.63
4.	Physical water productivity (qtl) S.no(2/1)	0.46	0.38

Table 4. Economic Access for ground water irrigation among sample farms (hacm/rupee)

S.No.	Particulars	SC block	OE block
1.	Intercept	-7.52	-8.90
2.	Water used per farm per year (ha cm) (x_1) (log of 'y' value of physical access)	0.81*	0.92**
3.	Average area irrigated per well	-0.04**	0.04**
	R^2	0.87	0.96

**Significant @ 5% level, * Significant @10% level, Number of samples = 90 (each block)

Table 5. Estimation of Economic Efficiency of Ground Water in paddy among Samples

S.No.	Particulars	SC block	OE block
1.	Net income per ha cm of water used in Rs.	1,240	1,194
2.	Average Net income per ha of crop in Rs (Average of two seasons.)	10,402	6,014

The decrease in quantum of GW used depending on increase in cost of GW was found to be comparatively low in OE block than SC block (SC). Thus the GW extraction response to increase in the cost of extraction was more sensitive in SC block compared to OE block. Though the physical access of GW estimation was found important from resource use point of view, physical efficiency interms of crop output per unit of GW used is economically important.

Estimation of physical efficiency of ground water use in paddy cultivation among samples of selected blocks

The physical efficiency of GW use or the GW productivity in agriculture was measured by water use efficiency (WUE) and shown in Table 3, both in terms of water used per unit of output and output per unit of water consumed for the major crop paddy for the samples studied.

It was found that the physical water productivity for paddy ie. the paddy output per ha cm of water used was comparatively more (0.46 quintals) among the samples of SC block than that of OE block (0.38 quintals). It could be inferred that higher the water used (OE block), the result was lower efficiency in terms of output. Hence the physical efficiency of GW use in paddy cultivation was found higher in SC block (SC) compared to that of OE block.

Economic Access for ground water irrigation among sample farms (hacm/rupee)

Economic access of GW irrigation among samples were in terms of GW extracted in ha cm per rupee per farm and was found to be influenced significantly by total water used per farm per year. The regression analysis of the values for the samples presented in Table 4 showed that among the samples

of two blocks, one percent increase in water used per farm per year resulted in 0.81 percent increase in GW extracted per rupee per farm for SC block and 0.92 percent for OE block. Thus the samples of OE block reveal high exploitation than that of SC block.

Estimation of Economic Efficiency of Ground Water in paddy among Samples

The economic efficiency of GW used were estimated for different farm categories among samples for paddy crop in'SC' and 'OE' blocks and shown in Table 5. It could be noticed that both the net income per ha cm of water used and net income per ha of paddy among the samples was found to be higher in SC block than that of OE block. These results of economic efficiency table was found in accordance with the results of physical efficiency (Table 3) discussed earlier.

Conclusion

The yield of bore wells was found to be the major factor making the difference in exploitation level.The well yield imposes more positive significant influence on magnitude of GW used in SC block compared to the less positive significant influence in OE block. Higher the water used (OE block), the result was lower efficiency in terms of output. One percent increase in water used per farm per year resulted in 0.81 percent increase in GW extracted per rupee per farm for SC block, 0.92 percent for OE block.Both the net income per ha cm of water used and net income per ha of paddy among the samples was found to be higher in SC block than that of OE block. The results of economic efficiency was found in accordance with the results of physical efficiency.

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