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ECONOMIC AND EFFICIENT USE OF GROUNDWATER IN AGRICULTURE: CHALLENGES AND STRATEGIES

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ABSTRACT

Farming accounts for around 70 per cent of water used in the world. In India agriculture is a major user of water resources. With growing water scarcity and increasing competition across water-using sectors, the need for water savings and more efficient water use in agriculture has increased in importance in water resources management. Against this backdrop, in this paper an attempt is made to study the challenges and outline ways for economic and efficient agriculture water use in India. The analysis shows the intensive use of groundwater for irrigation in Tamil Nadu leads to the lowering of water tables, and the urgent need for adopting alternative and sustainable method of efficient use of groundwater.

KEYWORDS: *Well Irrigation, Cropping Pattern, Challenges and Barriers, Groundwater Management*

INTRODUCTION

Farming accounts for around 70 per cent of water used in the world. In India agriculture is a major user of water resources. The share of surface water irrigation sources such as canal irrigation and tank irrigation declined over years. The grim situation has in turn led the farmers to rely heavily on exploiting groundwater. In recent years, in many States, groundwater has become the sole source of irrigation. As a result, groundwater development has been growing at an exponential rate. The current levels of groundwater for agricultural purposes have fallen dramatically in many parts of India. Over 66 per cent of ground water has been exploited such that the future of farming and the agricultural sector is absolutely bleak. It is argued that highly subsidised power supply in many states in India encourages farmers to engage in practices which are against conservation and efficient use. It is also recognized that water scarcity not only results from quantitative or qualitative scarcity, but also from inefficient use and poor water management. With growing water scarcity and increasing competition across water-using sectors, the need for water savings and more efficient water use in agriculture has increased in importance in water resources management. Against this backdrop, in this paper an attempt is made to study the challenges and outline ways for economic and efficient agriculture water use in the post reform period in India.

METHODOLOGY

The data required for the present study have been collected from both primary and secondary sources. In Villupuram district, Tamil Nadu, two revenue division viz., Villupuram and Tirukoilur have been selected for the study. The objectives of the study have been analysed with the help of secondary data as well as primary data collected through schedules administered to the respondents. The multi-stage random sampling method is adopted for the present study. From each revenue division, 200 sample households have been selected adding up to 400 from Villupuram district of Tamil Nadu. The study was conducted in 2019.

DEVELOPMENT OF WELL IRRIGATION

Surface irrigation in Tamil Nadu could not fulfil the water needs of farmers. As a result, farmers switched over to the use of groundwater. Nowadays, in most of the irrigated areas, farmers depend solely on tubewells and dugwells, because of their higher dependability and private ownership. It is interesting to note that farmers in districts where tank irrigation was a primary source switched over to the use of groundwater. It has been facilitated by the government policy of rapid rural electrification along with subsidised power supply resulting in a significant increase in well irrigation. The details of area irrigated using various sources of irrigation across the State, is shown in Table 1.

Table 1: Area of Land Irrigated Source Wise in Tamil Nadu(in Hectares)

Year / Sources of Irrigation	1980-81	1990-91	2000-01	2016-17	2017-18	2018-19
Canals	889 (34.2)	769 (32.4)	833 (28.8)	527 (22.1)	589.31 (22.4)	636 (24.8)
Tanks	590 (22.7)	531 (22.4)	589 (20.4))	302 (12.7)	358 (13.6)	322 (12.6)
Wells	1097 (42.2)	1059 (44.6)	1449 (50.2)	1554 (65.2)	1676 (63.8)	1603 (62.5)
Others	24 (1.9)	14 (0.6)	14 (0.5)	2 (0.08)	2.4 (0.09)	4.5 (0.17)
Total*	2600 (100.0)	2373 (100.0)	2888 (100.0)	2385 (100.0)	2626 (100.0)	2565.5 (100.0)

Source: Season and Crop Report of Tamil Nadu, various issues, Directorate of Economics and Statistics, Chennai-06.
Note: Figures within parentheses show column percentage.
*Net Area Irrigated.

It is observed that the share of surface water irrigation sources such as canal irrigation and tank irrigation declined over years, whereas the share of wells recorded a significant increase. It is inferred that the area of land irrigated by canals declined from 34.2 per cent in 1980-81 to 24.8 per cent in 2018–19. The area irrigated by tanks also declined from 22.7 per cent to 12.6 per cent during this period. But in 1960-61, its contribution was 35.8 per cent. The proportion of net area irrigated by wells rose from 42.2 per cent in 1980-81 to 62.25per cent in 2018-19. In 1960-61, its contribution was only 24.3 per cent. Such a phenomenal increase in the development of groundwater irrigation is due to poor maintenance of tanks and canals and erratic rainfall in Tamil Nadu, leaving canals and tanks thereof less useful.

GROWTH OF TUBE WELLS

Wells are the principal source of irrigation in Tamil Nadu. Extraction of groundwater level can be analysed by taking the growth of tubewells as a proxy variable. The growth of tube wells in Tamil Nadu between 1980-81 and 2018-19 is shown in Table 2.

Table 2: Growth of Tube Wells and Net Area Irrigated by Tube Wells in Tamil Nadu (in Nos.)

Year	Number of Tube wells	Net area irrigated by Tube wells (in hectare)
1980-81	**56975** (100.0)	**124635** (100.0)
1985-86	**62903** (110.4)	**87743** (70.3)
1990-91	**89743** (157.5)	**169807** (136.2)
1995-96	**137316** (241.0)	**199886** (160.4)
1996-97	**143207** (251.4)	**214744** (172.2)
1997-98	**145444** (252.3)	**208841** (167.6)
1998-99	**155304** (272.6)	**223842** (179.6)
1999-00	**162615** (285.4)	**222121** (178.2)
2000-01	**166721** (292.6)	**228055** (183.0)
2001-02	**172153** (302.2)	**237359** (190.4)
2002-03	**192035** (337.1)	**242824** (194.8)
2009-10	**305966 (537.0)**	**391107 (313.8)**
2018-19	**386975 (679.2)**	**516336 (414.3)**

Source: Season and Crop Report of Tamil Nadu, various issues (From 1980-81 to 2018-19), Directorate of Economics and Statistics, Chennai-06.
Note: Figures within parentheses indicate index number taking 1980-81 as base.

It is found that the number of tube wells used for irrigation in Tamil Nadu has drastically increased from 56975 in 1980-81 to 166721 in 2000-01 and further increased to 305966 in 2009-10. It was 386975 in 2018-19. The net area irrigated by tube wells in 2009-10 accounted for 391107 hectares as against 228055 hectares in 2000-01. The net areas irrigated by tube wells in 2018-19 constitute 516336 hectares. It indicates that the net area irrigated as a result of tube well irrigation has h increased four times within two decades.

The over-exploitation of groundwater has created the most perilous situation of declining water table, causing failure of many tube wells. It has made farmers to deepen wells and dig alternative tube wells at a greater depth. The distortionist power pricing policies of the government has also encouraged the mushrooming of tube wells causing thereby the unsustainable use of groundwater in Tamil Nadu. The growth of tube wells connotes the extent of the use of groundwater. Table III.2 indicates that the net area irrigated as a result of tube well irrigation has almost doubled within two decades.

CROPPING PATTERN IN TAMIL NADU

Cropping pattern refers to the proportion of land under cultivation of crops at different points of time. This indicates the time and arrangement of different crops in a particular area. The principal crop wise area irrigated in Tamil Nadu is shown in Table 3.

Table 3: Principal Crop wise Area Irrigated 2017-18(in Hectares)

Crop	Area Irrigated	Total Area	%
Paddy	1719924	1828919	94
Cholam(Jowar)	40601	385646	11
Cumbu(Bajra)	7764	63029	12
Ragi	24558	86513	28
Sugarcane	171716	171856	99.9
Cotton	38585	181631	21
Groundnut	143814	327352	44
Other Crops	1130787	2684630	42

Source: Directorate of Economics and Statistics, Chennai-06.

It is found that out of total area paddy cultivated in 1828919 hectares, 94 per cent of area is irrigated in Tamil Nadu. Another water intensive crop sugarcane is cultivated in 171856 hectares of which 99.9 per cent of area is irrigated. Out of total area groundnut cultivated, 44 per cent is irrigated the remaining crops are not fully cultivated. Only 11 per cent of jowar crop is irrigated and in the case of bajra, irrigated area is 12 per cent. Only one-fifth of cotton cultivated area is irrigated and 28 per cent of ragi cultivated area is irrigated. It is inferred that farmer are cultivating both water intensive crops and less water intensive crops and the maximum area of water intensive crops such as paddy and sugarcane are irrigated than less water intensive crops in Tamil Nadu.

RESULTS AND DISCUSSION

Area Irrigated by Wells

Most of the tube wells operate relatively at greater depth hence the area irrigated by each type of well is compared with the total area of irrigation to understand the groundwater use of farmers, possessing different types of wells.

The distribution of area irrigated by different types of wells is presented in Table 4.

Table 4: Distribution of Area Irrigated by Wells (in Nos.)

Area Irrigated	Dug wells	Dug and Borewells	Tube wells
Less than2	**66** (56.4)	**42** (37.8)	**35** (20.3)
2-4	**16** (13.6)	**22** (19.8)	**14** (8.1)
4-6	**17** (14.5)	**17** (15.3)	**15** (8.7)
6-8	**8** (6.8)	**9** (8.1)	**20** (11.6)
8-10	**8** (6.8)	**11** (9.9)	**32** (18.6)
10 and above	**2** (1.7)	**10** (9.0)	**56** (32.6)
Total	**117 (100)**	**111** (100)	**172** (100)

Source: Field Survey.
Note: Figures within parentheses show column percentage.

It revealed that 56 per cent of dugwells are used for irrigating less than 2 acres of land; 16 per cent of dugwells irrigate between 2 and 4 acres of land. Dug-and-borewells are generally used for irrigating less than 4 acres of land. They account for 57.6 per cent. It is found that tubewells are the prominent mode of irrigation in the selected district. Tube wells are used by 32.6 per cent of respondents to irrigate more than 10 acres of land and 18.6 per cent of tube wells irrigate 8 and

10 acres of land. All categories of farmers use tube wells to irrigate their land. But all marginal farmers irrigate only less than 2 acres of land with tube wells.

It is inferred from the above analysis that though dug wells are used for irrigation by all categories of farmers dug wells are mostly used by marginal and small farmers for irrigating crops. Other categories of farmers have either switched over to use of dug cum borewells or tube wells for irrigating crops. Farmers who irrigate 10 and more acres of land with dug-and- increase the capacity of pump sets to increase the area of cultivation, and this results in an increased electricity consumption and a higher use of groundwater. it is also clear medium and large farmers irrigate more areas of land with tube wells.

Challenges and Barriers to Groundwater Governance

Groundwater is increasingly important for meeting the water demand of different sectors. Intensive use of groundwater for irrigation leads to the lowering of water tables, reducing the potential for water use. Forward thinking governance, effective management is necessary for its sustainable use. The increasing depletion of water resources, in particular groundwater, has led to the realization that existing rules concerning the use of groundwater were unadopted to a situation of scarcity. As a result, the Central government has put significant emphasis on the development of groundwater laws by the States. Regulatory intervention is premised on the need control the use of groundwater to ensure that it is not unsustainably used. However, government faces a multiple challenge in doing that. Challenges and barriers to groundwater governance in study area is displayed in Table 5.

Table 5: Challenges and Barriers to Groundwater Governance

Challenges and Barriers	Response	
	Yes	No
Integration and implementation of policies	302 (75.5)	98 (24.5)
Enforcement of water plans to address the need of all users	320 (80.0)	20 (20.0)
Awareness of the fragility and declining availability of the groundwater resources	320 (80.0	20 (20.0)
Decentralisation of groundwater management	324 (81)	76 (19)
Formalisation of groundwater rights	232 (58)	168 (42)

Source: Field survey.
Note: Figures in brackets are percentages to the total.

It is found that out of 400 respondents, a little more than three-fourth of respondents reported that one of the major challenges to groundwater governance in their area is legislation and implementation of policies. There is also problem in the enforcement of water plans to address the needs of all users and creating public awareness, especially of declining availability of groundwater resource. It was stated by four-fifth of respondents. State governments are primarily responsible for groundwater governance in India; 81 per cent of the respondents agreed with the statement that decentralization of groundwater management is the challenge to groundwater governance. Another challenge if formalization of groundwater rights.

Water insecurity affects both agricultural production and land value. Understanding these risks and potential impacts is essential for making better agriculture investment and production practices in future. Change in attitude is the first step towards change in water use behaviour. Sustainable use of groundwater depends on awareness such as need for conserving groundwater sources, quality of groundwater, their participation in groundwater management and so on. The distribution awareness level of participating in sustainable irrigation practices by the respondents according to location is shown in Table 6.

Table 6: Distribution of Awareness about Groundwater Conservation

Awareness	Response	
	Yes	No
Current irrigation practices pose risk to maintenance of groundwater quality	324 (81.0)	76 (19.0)
Know the need for conserving groundwater resources	232 (58.0)	20 (42.0)
Government creates awareness on groundwater regulation	302 (75.5)	98 (24.5)
It is the duty of government to regulate the use of groundwater	324 (81)	76 (19)

Source: Field survey.
Note: Figures in brackets are percentages to the total.

It found that that out of 400 total respondents, 81 per cent aware that current irrigation practices pose risk to maintenance groundwater quality. It is shocking to note that only 58 per cent know the need for conserving groundwater resources. Institutions/ Government should create awareness on groundwater regulation was reported by 75.5 per cent. It is to be noted that 80 percent of respondents state that more efforts should come from government in regulating the use of groundwater. Because they feel it is the duty of government and institution to regulate efficient use of groundwater. From the above findings it is clear that farmers are shrinking their responsibility in groundwater management and they feel that it is the duty of government to protect and conserve groundwater resources.

Barriers faced by Sample Households

Cognitive Biases affect how people process complex information and then take an efficient decision. Such biases create barriers for efficient use of water. Four major barriers found among farmers are presented in Table 7.

Table 7: Main Local Problems in Groundwater Governance

Main Local Problems	Response	
	Yes	No
Lack of community awareness about groundwater	330 (82.5)	70 (17.5)
Economic development takes precedence over environmental management	230 (57.5)	170 (42.5)
Lack of scientific evidence	300 (75.0)	100 (25.0)
Identifying and enforcing responsibility and accountability	304 (76)	96 (19)

Source: Field survey.
Note: Figures in brackets are percentages to the total.

It is found that out of total respondents, more than four-fifth (82.5 per cent) agree that lack of community awareness is the main local problem in groundwater management. Another local problem is economic development often takes precedence over environmental management. It was reported by 57.5 percent respondents. Lack of scientific evidence was the reason stated by three-fourth of respondents. One more local problem is identifying and enforcing responsibility and accountability. They account for 76 per cent. From the above findings it is clear that some local problems prevail in study area and they are obstacle for efficient use of groundwater for sustainable agriculture.

Local Action in Groundwater Governance

The respondents were enquired about whether role of institution on supporting local actions in groundwater governance is effective. The answers are presented in Table: 8.

Table 8: Perception of the Respondents about Local Action in Groundwater Governance

Response	Frequency	Percent
Highly Satisfied	60	15.0
Satisfied	124	31.0
Neutral	65	16.3
Dissatisfied	110	27.5
Highly Dissatisfied	41	10.3
Total	400	100.0

Source: Field Survey.

Out of total respondents, 15 per cent respondents were highly satisfied with local actions in groundwater governance. The respondents who are satisfied with local actions in groundwater governance account for 31 per cent; 27.5 per cent were dissatisfied and 10.3 per cent opined that they were highly dissatisfied and 16.3 per cent are neutral.It is apparent that role of institution on supporting local actions in groundwater governance is not effective in the study area and more local action is required for efficient use of groundwater for sustainable agriculture.

CONCLUSIONS

In Tamil Nadu, groundwater has become dominant source of irrigation.The net area irrigated as a result of tube well irrigation has increased four times within two decades. Rapid depletion of water table indicates water crisis in near future. Unsustainable use of groundwater may lead to increase in food prices, because farmers are forced to spend more money to irrigate their crops. Government faces a multiple challenge in managing ground water. Farmers are shrinking their responsibility in economic and efficient use of groundwater. Hence, Coherent policy frame work and strategy is needed at the state level and local level to address the issue of declining water table in Tamil Nadu. Government should closely monitor the use of groundwater and invest in things like drip and sprinkler irrigation which have the scope for improving irrigation efficiency up to 90 per cent, to better prepare for the future and preserve natural resources.

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