Economic Assessment of Irrigation Water markets in Tamil Nadu: Efficiency, Equity and Sustainability Perspectives

Dr.V.Raja*

***Assistant Professor, PG & Research Department of Economics, Pachaiyappas College for Men, Kanchipuram.**

Abstract

Water is vital input in agriculture, especially in semi-arid regions such as Tamil Nadu, where irrigation plays a crucial role in sustaining agricultural productivity. In the absence of adequate public irrigation infrastructure, informal irrigation water markets have evolved as an alternative mechanism for water distribution among farmers. This paper provides a economic analysis of irrigation water markets in Tamil Nadu, examining their structure, functioning and implications for agricultural efficiency, equity, and sustainability. Using both primary and secondary data, the study explores the determinants of water pricing, the nature of market transactions, and the welfare effects on buyers and sellers. Results reveal that while water markets improve access to irrigation and reduce risk for smallholders, they are constrained by inequitable access, groundwater depletion, and lack of regulation. The study concludes with policy recommendations for strengthening institutional frameworks, promoting efficient water use, and integrating community-based management to ensure long-term water sustainability.

Keywords: Irrigation Water Market, Water Pricing, Groundwater, Agricultural Efficiency, Tamil Nadu and Sustainability

Introduction

Water is one of the most critical natural resources for agricultural production. In India, nearly 80 percent of available freshwater resources are used for irrigation purposes (shah, 1993). Tamil Nadu, being one of the most water-stressed states, faces severe challenges in meeting irrigation demands due t erratic rainfall, over-extraction of groundwater and declining tank and canal irrigation systems. Consequently, farmers have developed informal irrigation water markets, where owners of wells and borewells sell water to neighboring farmers who lack direct access to irrigation sources.

The economic analysis of these water markets is important because it sheds light on how water scarcity is managed, how pricing mechanisms evolve and how such markets affect agricultural productivity and income distribution. While these markets enhance access for smallholders, they also raise concerns regarding equity and sustainability. This study aims to investigate the structure, determinants, and economic outcomes of irrigation water markets in Tamil Nadu. The concept of water markets has been widely studied in agricultural economics. Shah (1993) provided the earliest systematic analysis of groundwater markets in India, showing that they help smallholders accesss irrigation but also accelerate groundwater depletion. Meinzen-Dick (2002) emphasized the role of institutional frameworks in governing water transactions, suggesting that market mechanisms need policy oversight.

In Gujarat and Andhra Pradesh, water markets have evolved where groundwater owners sell irrigation water to nearby farmers on hourly or per-acre contracts (Saleth, 1996). Studies by Dhbash (2002) found that these markets reduce water stress but often operate under asymmetric power relations, with well owners dominating pricing. In Tamil Nadu, a few localized studies (palanisami & Easter, 2000) have shown that water trading exist mainly in well-irrigated regions like Coimbatore, Erode and Tiruchirapalli. These studies highlighted that water price depends on factors such as water availability, crop type, energy cost, and distance from the water source. However, limited research has systematically analyzed the economic performance and sustainability of these markets.

The declining availability of irrigation water in Tamil Nadu has led to reduced agricultural productivity and increased vulnerability among small and marginal farmers. traditional irrigation system have deteriorated and government interventions have been insufficient response, but their economic implications remain underexplored. Key issues include farmers. Thus, a comprehensive economic analysis is required to assess whether irrigation water markets contribute to efficiency and welfare or exacerbate inequality.

Objectives of the study

1. To study the nature and functioning of irrigation water markets in Tamil Nadu.

2. To analyze the determinants of irrigation water pricing and demand among farmers.

3. To assess the economic efficiency and welfare implications of water markets.

4. To identify challenges and policy constraints affecting market performance.

5. To suggest policy recommendations for promoting sustainable and equitable water use.

Methodology

The study focuses on three agriculturally intensive districts of Tamil Nadu – Coimbatore, Erode and Tiruchirapalli – where both groundwater-based and tank-based irrigation systems are prevalent. These regions have witnessed active informal water trading, Particularly among paddy, sugarcane and vegetable cultivators. Data were collected through a combination of primary surveys and secondary sources, Collected from 120 farmers, including 60 water sellers (well owners) and 60 water buyers, using structured questionnaires. Secondary data were gathered from the Directorate of Economics and Statistics (Government of Tamil Nadu), NABARD, and Central Ground Water Board reports. A stratified random sampling technique was employed to ensure representation of different farm sizes. The pricing models were used for the data analysis.

Results and Discussion

Socio-economic Characteristics

Most farmers were smallholders, owning less than 2 hectares of land. Water sellers generally had higher income levels and owned borewells with subsidized electricity (Table,

1). Buyers, often marginal farmers, cultivated paddy, banana or sugarcane and depended entirely on purchased irrigation water. Nearly, 80 percent of water sellers used electricity powered pumps, benefitting from state electricity subsidies. Conversely, most buyers depended solely on purchased irrigation water for cultivation. Education levels also played a role in market participation 62 percent of sellers and 4 percent of buyers had completed secondary education or higher, reflecting that awareness and knowledge influence participation in informal water markets. These socio economic characteristics indicate that access to groundwater and financial capital largely determine the ability to participate as a seller in the irrigation water market.

Table 1: Socio-Economic Characteristics of Respondents (n=120)

Variable	Category/Description	Percentage (%)
Landholding size	Small & marginal (<2 ha)	65
	Medium (2–5 ha)	25
	Large (>5 ha)	10
Type of farmer	Water seller (well owner)	50
	Water buyer	50
Education level	Primary	28
	Secondary	47
	Higher secondary and above	25
Source of irrigation energy	Electricity	80
	Diesel	20
Crops cultivated (major)	Paddy, Sugarcane, Banana, Vegetables	78

Note: Majority of water sellers were smallholders with access to groundwater and subsidized electricity.

Nature of Water Market Transactions

Water markets in Tamil Nadu are predominantly informal and localized. Transactions occur either on : Hourly basis (Rs. 150 to Rs. 300 per hour) or Per-acre contract (Rs. 2500 to Rs. 4000 per acre per season). Payment is usually made in cash or crop share (e.g., $1/10^{th}$ of yield). Contracts are verbal based on trust and mutual understanding. Payments were mostly made in cash, though in some cases, especially for paddy cultivation, water buyers offered a share of produce (crop share of 10-15%) instead of cash payment (Table 2). Contracts were verbal and based on mutual trust, indicating an absence of formal regulation or written agreements. This informal nature keeps transaction costs low but creates potential for disputes in case of water shortage.

Table 2: Determinants of Irrigation Water Price (Regression Analysis Results)

Variable (Independent)	Coefficient (β)	Standard Error	t-value	Significance (p-value)
Constant (β_0)	85.6	15.4	5.55	0.000
Water quantity (Q)	-0.25	0.10	-2.47	0.015*
Distance (D)	3.12	0.75	4.16	0.000**
Energy cost (E)	4.85	1.10	4.41	0.000**
Crop type (C)	22.3	9.45	2.36	0.021*
R^2	0.74	--	--	--

Note: Dependent variable=price of irrigation water (Rs/ hour).
P<0.05, Signification; p < 0.01, Highly significant.

Determinants of water pricing

Regression results show that distance and energy cost have significant positive effects on water price (p<001). Water quantity and crop type also influence pricing crops like sugarcane or banana require higher water inputs leading to higher rates. Well yield and seasonal variation (summer scarcity) further affect pricing trends. The model had an R^2 value of 0.74, indicating that about 74 percent of the variation in water prices could be explained by these variables. These results show that market prices are mainly driven by cost based and physical factors, with minimal influence from institutional or social considerations.

Table 3: Comparison of Crop Yield: Irrigated (Buyer) vs. Non-Irrigated Plots

Crop Type	Average Yield (irrigated) (kg/acre)	Non-Irrigated (kg/acre)	% Increase in Yield
Paddy	2850	2300	23.9
Banana	9400	7100	32.4
Vegetables	6200	4800	29.2

Economic Efficiency

Comparison of irrigated vs. Non-irrigated plots reveals that access to purchased water increased yield by 18 to 25 percent for paddy and 30 percent for vegetables. Marginal Productivity of water was positive up to a threshold, indicating economic efficiency in water use under moderate trading volumes. This efficiency suggests that informal water markets help optimize resource allocation, allowing farmers without wells to maintain cultivation even during dry periods. It also demonstrates that market-based water allocation can improve aggregate agricultural output in water-scarce regions.

Environmental and Institutional Constraints

The analysis also highlighted several structural and environmental constraints:

Groundwater depletion: Over-extraction led to declining water tables, especially in Coimbatore and Erode districts.

Energy subsidies: Free or subsidized electricity encouraged excessive pumping, undermining sustainability.

Lack of formal regulation: Absence of legal recognition for water markets made dispute resolution difficult.

These findings indicate that while irrigation water markets contribute to short-term efficiency and welfare, they are unsustainable in the long run unless regulated and supported by institutional reforms.

Equity and Access

The Lorenz curve analysis revealed moderate inequality in water access (Gini Coefficient = 0.36). Well owners gained higher profits, but buyers also benefited from increased production and reduced risk of crop failure. Nevertheless, poorer farmers without credit access were excluded from the market due to upfront payment requirements. While inequality exists (since water sellers benefit more), water markets still enable many small farmers to access irrigation who otherwise would not have it.

Challenges and Sustainability Issues

Major challenges include over-extraction of groundwater leading to declining water tables. Power subsidy distortions, encouraging over-pumping, lack of legal framework for water trading and Inequality between sellers and buyers due to ownership concentration. These findings align with Shah's (2014) warning that unregulated groundwater markets may be economically beneficial in the short term but environmentally unsustainable in the long run.

Table 4: Major Challenges Identified in the Irrigation Water Market

Challenge	Description / Observation
Groundwater depletion	Declining water table levels, especially in Coimbatore and Erode
Electricity subsidies	Encourage over-pumping and wastage of water
Absence of formal regulation	Verbal contracts, lack of legal protection for buyers
Inequitable access	Wealthier farmers control borewells limiting market competition
Weak water user associations (WUAs)	Poor collective groundwater management practices

Conclusion

The study demonstrates that irrigation water markets in Tamil Nadu serve as an effective mechanism for reallocating scare water resources among farmers. They enhance irrigation access, improve productivity, and reduce production risks for smallholders. However, these markets are informal, unregulated and potentially unsustainable if groundwater extraction continues unchecked. Economic efficiency and equity can coexist only if institutional and policy reforms ensure sustainable use. Therefore, integrating water markets with community-based management and technology adoption is critical for the long term viability of Tamil Nadu's agricultural sector. The results confirm that irrigation water markets in Tamil Nadu are economically viable and socially significant but environmentally lfragile. They provide an adaptive mechanism for farmers to cope with water scarcity but the lack of governance structures risks overuse of groundwater.

The study shan's (193) observation that informal groundwater markets in India create "win-win" outcomes for buyers and sellers in the short term but require regulation to sustain long term benefits. In line with Palanisami and Easter (2000), the study also emphasizes that

water markets complement, not replace, public irrigation systems. Overall, the findings underscore the dual nature of irrigation water markets efficiency enhancing yet sustainability challenging highlighting the need for policy reforms that integrate economic incentives with resource conservation.

Policy Implications and Recommendations

1. Regulate and Formalize water markets: Establish local-level registration systems for water-sharing agreements to promote transparency and sustainability.

2. Promote water-use efficiency: Encourage adoption of micro-irrigation technologies (drip and Sprinkler) through targeted subsidies and training programs.

3. Energy pricing reform: Rationalize electricity subsidies for pump owners to discourage excessive groundwater extraction.

4. Community-based management: Strengthen water user associations (WUAs) to coordinate equitable distribution and collective well recharge initiatives.

5. Institutional support: Integrate water trading within broader agricultural policy frameworks and digital platforms (e.g., linking irrigation markets with e-NAM type systems for transparency).

6. Research and Monitoring: Continuous monitoring of groundwater levels and market functioning is essential to balance economic benefits with environmental sustainability.

References

Dubasj, N.K. (2002). *Tubewell capitalism: Groundwater development and agrarian change in Gujarat.* Oxford University Press.

Government of Tamil Nadu. (2023). *Agriculture policy note 2023-24*. Department of Agriculture and Farmerss' Welfare.

Meinzen-Dick, R. (2002). *Institutions and collective action in groundwater management.* In R. Meizen-Dick & M. Di Gregorio (Eds.), Collective action and property rights for sustainable development. IFPRI.

NABARD. (2022). *State focus paper: Tamil Nadu agriculture and water resources.* National Bank for Agriculture and Rural Development.

Palanisami, K., & Easter, K.W. (2000). Tank irrigation in the 21st century – What next? *Indian Journal of Agricultural Economics,* 55 (1), 25-39.

Shah, T. (1993). *Groundwater markets and irrigation development: Political economy and practical policy.* Oxford University Press.

Shah, T. (2014). Groundwater governance and irrigated agriculture. *Economic and political Weekly*, 49(52), 20-24.