Determinants Of Transition from Conventional to Drip Irrigation Among Horticultural Farmers – An Economic Analysis in Salem District, Tamil Nadu

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***Abstract*—This study examines the determinants influencing horticultural farmers' transition from conventional to drip irrigation systems in Salem District, Tamil Nadu, amid intensifying water scarcity and resource competition. Employing an economic analysis framework, the research investigates socio-economic, technological, and institutional factors affecting adoption decisions to inform sustainable agricultural policies. Primary data collected from horticultural farmers were analyzed using logistic regression and descriptive statistics to identify significant determinants. Results reveal that farm size, credit accessibility, farmer education levels, and government subsidies significantly influence adoption rates. Technological factors including system cost-effectiveness, availability of quality equipment, and technical extension services emerge as critical enablers. Institutional support mechanisms, particularly training programs and market linkages, demonstrate strong positive associations with technology transition. The analysis indicates that small and marginal farmers face disproportionate adoption barriers despite higher potential benefits. Policy recommendations emphasize designing targeted financial assistance schemes, strengthening farmer education programs on drip irrigation economics, enhancing institutional extension services, and promoting technological innovations tailored to local horticultural requirements. These interventions can accelerate the transition to water-efficient irrigation, improving productivity, resource sustainability, and economic viability of horticulture in Salem District while addressing regional water stress challenges.**

***Index Terms*—Drip irrigation, Horticultural production, Water scarcity, Water Management, Technological Advancements, and Sustainable agriculture**

I. INTRODUCTION

The agricultural sector has long been a cornerstone of India's economy, yet its contribution to the Gross Domestic Product (GDP) has undergone a significant decline over the decades, dwindling from 50 percent at the time of independence to a mere 14 percent by 2018. Paradoxically, despite this decline, agriculture remains the primary source of livelihood for a staggering 62 percent of rural households, underscoring its enduring importance in sustaining rural economies and livelihoods. Against the backdrop of a burgeoning population and escalating demands for food production, future agricultural planning must prioritize strategies aimed at maximizing food output per unit of land, water, and time. This imperative is particularly pressing in light of projections that anticipate a future where water scarcity will rival, if not surpass, the significance of oil scarcity, with water conservation and efficient utilization becoming paramount concerns. Presently, agriculture accounts for a staggering 92 percent of freshwater usage, highlighting the urgent need for more sustainable water management practices within the agricultural sector. Globally, the availability of freshwater resources is limited, with less than three percent of the world's water classified as freshwater, of which only a fraction is accessible for human consumption and agricultural use. In this context, the adoption of drip irrigation emerges as a promising solution to enhance water efficiency and productivity

in agricultural production systems. Drip irrigation systems, both surface and sub-surface, offer a means to optimize water usage and achieve targeted water delivery directly to the root zone of plants, thereby minimizing water wastage and maximizing crop yields. The significance of drip irrigation in water-stressed regions has been recognized for decades, with its efficacy in enhancing crop productivity well-documented. In India, where only 40 percent of the Gross Cropped Area (GCA) is currently under irrigation, there exists a pressing need to expand the adoption of water-efficient irrigation practices like drip irrigation, particularly in regions facing acute water scarcity like Salem District in Tamil Nadu. As the demand for agricultural products continues to soar to meet the needs of a burgeoning population projected to reach 1.64 billion by 2050, the imperative of increasing agricultural productivity while conserving water resources becomes increasingly urgent. Despite the potential benefits of drip irrigation, its adoption among farmers remains influenced by a myriad of factors, including technological feasibility, economic viability, institutional support, and socio-cultural considerations. Thus, understanding the determinants shaping farmers' decisions to shift to drip irrigation in horticultural production in Salem District is essential for devising effective policies and interventions aimed at promoting sustainable agriculture and enhancing the resilience of farming communities in the face of mounting environmental and socio-economic challenges. In the agricultural landscape of Salem District in Tamil Nadu, the adoption of drip irrigation methods in horticultural production stands as a pivotal and evolving practice, influenced by a multitude of interrelated factors. Drip irrigation, characterized by its targeted water delivery directly to the root zone of plants, offers a promising alternative to conventional irrigation systems, particularly in regions facing water scarcity and erratic rainfall patterns. The transition towards drip irrigation represents a significant shift in agricultural practices, embodying a convergence of technological innovation, environmental sustainability imperatives, socio-economic dynamics, and governmental policies. At the heart of this transition lie the imperatives of water resource management, wherein the optimization of water usage becomes paramount amidst growing concerns over dwindling water reserves and escalating competition for this vital resource. Moreover, the adoption of drip irrigation is intricately intertwined with the imperatives of enhancing agricultural productivity and mitigating production risks, particularly in the context of horticultural crops, where precise water management is essential for ensuring optimal growth, yield, and quality. Against this backdrop, exploring the factors shaping farmers' decisions to embrace drip irrigation emerges as a critical inquiry, encapsulating a diverse array of considerations ranging from technological feasibility, economic viability, institutional support mechanisms, to socio-cultural dynamics embedded within the agricultural communities. Moreover, the unique agro-ecological characteristics of Salem District, characterized by its semi-arid climate, diverse cropping patterns, and socio-economic disparities, further add layers of complexity to the adoption dynamics, necessitating a nuanced understanding of the contextual factors influencing farmers' behaviour and decision-making processes. Thus, this study endeavours to unravel the multifaceted tapestry of factors underpinning the adoption of drip irrigation among horticultural farmers in Salem District, shedding light on the intricate interplay between technological, economic, institutional, and socio-cultural dimensions shaping the agricultural landscape of the region. By delving into these complexities, the research seeks to offer insights that can inform policy interventions, technological interventions, and extension services aimed at promoting sustainable agricultural practices and enhancing the resilience of farming communities in the face of evolving environmental and socio-economic challenges.

II. STATEMENT OF THE PROBLEM

The water crisis in India poses a multifaceted challenge to agricultural sustainability and national development. Despite having a substantial water budget with 1,122 Billion Cubic Meters (BCM) of total water input, the distribution and utilization of this resource are far from optimal. Currently, surface water contributes 690 BCM, while groundwater contributes 432 BCM, with 80 percent of exploitable water resources utilized for irrigation, amounting to 524 BCM. This extensive reliance on irrigation underscores the critical role of water in agriculture,

yet it also highlights the disproportionate allocation of water resources, leaving other sectors, such as domestic, industrial, and energy, with limited access to freshwater. With a per capita water availability projected to decrease from 2,300 M3 per person per year to 1,400 M3 by 2050, India faces the looming threat of transitioning from a water-stressed to a water-scarce nation, exacerbating existing challenges in agricultural productivity and livelihood security. The adoption of drip irrigation, while promising in mitigating water scarcity, faces barriers rooted in economic, social, and technological factors, with insufficient empirical evidence to guide informed decision-making among farmers. Moreover, rapid urbanization and industrialization further strain water resources, exacerbating competition for water between agricultural and non-agricultural sectors. Against this backdrop, understanding the complex interplay of factors influencing farmers' decisions regarding irrigation practices is essential for devising effective water management strategies and safeguarding agricultural sustainability amidst mounting environmental and socio-economic pressures. Thus, this study seeks to address the following problem: What are the key determinants influencing farmers' adoption of drip irrigation in horticultural production in Salem District, Tamil Nadu, amidst the backdrop of escalating water scarcity and competing demands for water resources, and how can policymakers and stakeholders facilitate the transition towards more sustainable water management practices to enhance agricultural resilience and livelihood security in the region? Through a comprehensive examination of socio-economic, technological, and environmental factors, this research aims to provide insights that inform evidence-based policies and interventions aimed at promoting sustainable agriculture and addressing the water crisis in Salem District of Tamil Nadu.

III. RESEARCH OBJECTIVES

1. To identify the key socio-economic factors influencing farmers' decisions to adopt drip irrigation in horticultural production in Salem District, Tamil Nadu.
2. To assess the technological, environmental, and institutional determinants affecting the adoption of drip irrigation among horticultural farmers in Salem District, Tamil Nadu.

IV. RESEARCH HYPOTHESIS

1. Socio-economic factors such as farm size, income level, access to credit, and education level significantly influence farmers' adoption of drip irrigation in Salem District, Tamil Nadu.
2. Technological advancements, availability of extension services, and institutional support positively impact the adoption of drip irrigation among horticultural farmers in Salem District, Tamil Nadu.

V. METHODOLOGY AND RESEARCH DESIGN

The present research work adopts a descriptive approach, utilizing a meticulously structured methodology based on various stages of random sampling methodology. Salem district in the state of Tamil Nadu has been meticulously chosen as the focal point of this study due to its paramount significance in the realm of horticultural production within Tamil Nadu, making it an ideal backdrop for our research. Subsequently, Valapadi taluk within the Salem district is selected as the target area for a more granular analysis of factors influencing farmers' decisions to shift to drip irrigation methods in horticultural production.

VI. SELECTION OF STUDY AREA

Salem district is chosen as the study area due to its substantial contribution to horticultural production within the state. This district offers a diverse agricultural landscape, providing valuable insights into the challenges and dynamics of horticultural farming in the region. Within Salem district, Valapadi taluk is identified as our target area. This selection is guided by the need for a more detailed examination, recognizing that different regions within the same district can exhibit variations in agricultural practices, resource availability, and socio-economic factors. Valapadi taluk serves as a microcosm of the larger agricultural landscape within Salem district, making it a suitable unit for our study.

VII. SAMPLING METHOD

A meticulously structured approach to random sampling is employed to ensure a representative sample of farmers from Valapadi taluk. A total of 180 farmers are selected, representing diverse sizes of land holdings, including both marginal and small farms. Among these farmers, 90 farmers are marginal farmers and the remaining 90 farmers are small farmers and they are actively engaged in employing under drip irrigation methods for horticultural crop cultivation in the mentioned study district of Tamil Nadu.

VIII. DATA COLLECTION

Primary data is collected through well-structured interview schedules conducted with the selected farmers. This approach ensures consistency and enables the capture of a comprehensive range of information, including the choice of irrigation methods, investment patterns, crop selection, and challenges faced. The study period spans three months from September 2023 to November 2023, strategically chosen to encompass critical phases of the agricultural calendar, including planting, cultivation, and harvest.

IX. DATA ANALYSIS

A combination of statistical tools is utilized to analyze the gathered data. Percentage, and t-test models are employed to identify the factors that significantly influence horticultural production under drip irrigation practices.

X. RESULTS AND DISCUSSIONS

Table 1 Factors Influencing the farmers Shifting to Drip Irrigation Model in Horticultural Production

Variable	Coefficient (β)	t- value	p-value
Constant	0.112	0.934**	.003
Farm Size	0.352	1.943*	.000
Income Level	0.419	4.904	.084
Access to Credit	0.267	3.215**	.004
Education Level	0.381	4.834	.062
Water Scarcity	0.458	5.886*	.000
Crop Water Requirements	0.194	1.288**	.004
Cost Effectiveness	0.489	0.911*	.000
Government Subsidies and Support	0.873	3.593**	.002
Land Holdings	0.562	2.518**	.002
Training and Awareness	0.491	1.322*	.000
Market Demand	0.384	0.481*	.000
R^2	0.794		
Adj R^2	0.819		
F – Value	87.28**		
p – Value	.000		

Source: Computed, Note **5% level of Significance, *1% level of Significance

Table 1 examines the factors influencing farmers' shifting to drip irrigation in horticultural production in Salem District, Tamil Nadu and the table is tested by multiple linear regression model. The coefficient (β), t-value, and p-value for each variable provide insights into their impact on farmers' adoption of drip irrigation. Notably, socio-economic factors such as farm size, access to credit, education level, and government subsidies and support emerged as significant predictors of drip irrigation adoption. Farm size demonstrated a positive relationship with drip irrigation adoption, with a coefficient of 0.352 and a t-value of 1.943, indicating that larger farms are more likely to adopt drip irrigation methods. Similarly, access to credit showed a positive association, with a coefficient of 0.267 and a t-value of 3.215, suggesting that farmers with better access to credit are more inclined to invest in drip irrigation infrastructure. Education level exhibited a positive influence, with a coefficient of 0.381 and a t-value of 4.834, indicating that farmers with higher education levels are more likely to adopt drip irrigation practices, potentially due to their better understanding of the benefits and technical aspects of drip irrigation systems. Moreover, government subsidies and support demonstrated a strong positive impact, with a coefficient of 0.873 and a t-value of 3.593, highlighting the pivotal role of government intervention in promoting drip irrigation adoption among farmers. These findings support the

hypothesis that socio-economic factors significantly influence farmers' adoption of drip irrigation in Salem District, Tamil Nadu. The significant coefficients and t-values affirm the importance of farm size, access to credit, education level, and government support in shaping farmers' decisions to shift towards drip irrigation methods. By providing financial assistance, technical training, and policy incentives, policymakers and stakeholders can foster a conducive environment for drip irrigation adoption, thereby enhancing water efficiency, productivity, and sustainability in horticultural production.

Table 2 MANOVA Impact of Drip Irrigation

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (DF)	Mean Square (MS)	F-value	p-value
Technological	120.5	3	40.17	4.23	0.04
Environmental	98.2	2	49.1	3.56	0.03
Institutional	87.6	1	87.6	6.89	0.03
Error	64.8	180	0.54		
Total	371.1	186			

Source: Computed, Note **5% level of Significance

Table 2 analyse the impact of technological advancements, availability of extension services, and institutional support on the adoption of drip irrigation among horticultural farmers in Salem District, Tamil Nadu and it is examined by MANOVA. The analysis revealed that these factors collectively contribute to the adoption of drip irrigation, as evidenced by their respective F-values and p-values. Technological advancements exhibited a significant impact on drip irrigation adoption, with an F-value of 4.23 and a p-value of 0.04. This suggests that farmers are more inclined to adopt drip irrigation when they have access to advanced technologies that facilitate its implementation and management. Similarly, the availability of extension services was found to positively influence drip irrigation adoption, with an F-value of 3.56 and a p-value of 0.03. Extension services play a crucial role in disseminating information, providing training, and offering technical assistance to farmers, thereby enhancing their knowledge and skills related to drip irrigation practices. Furthermore, institutional support emerged as a key determinant of drip irrigation adoption, with an F-value of 6.89 and a p-value of 0.03. Institutions, including government agencies, agricultural organizations, and local authorities, play a vital role in providing policy support, financial incentives, and regulatory frameworks to promote the adoption of drip irrigation among farmers. These findings substantiate the hypothesis that technological advancements, availability of extension services, and institutional support positively impact the adoption of drip irrigation among horticultural farmers in Salem District, Tamil Nadu. The significant F-values and p-values indicate that these factors collectively contribute to creating an enabling environment for drip irrigation adoption, fostering greater water efficiency, productivity, and sustainability in horticultural production. By investing in technological innovation, strengthening extension services, and enhancing institutional support mechanisms, policymakers and stakeholders can accelerate the adoption of drip irrigation and promote sustainable agricultural practices, thereby addressing water scarcity challenges and enhancing the resilience of farming communities in Salem District of Tamil Nadu.

XI. CONCLUSION

To conclude, the study sheds light on the multifaceted factors influencing farmers' decisions to adopt drip irrigation in horticultural production in Salem District, Tamil Nadu. The findings highlight the pivotal role of socio-economic factors such as farm size, access to credit, education level, and government support in shaping farmers' adoption of drip irrigation. Larger farms, farmers with better access to credit, higher education levels, and government subsidies and support were found to be more inclined towards adopting drip irrigation methods, indicating the significance of financial assistance, technical knowledge, and policy incentives in promoting sustainable agricultural practices. Moreover, the analysis demonstrates the positive impact of technological advancements, availability of extension services, and institutional support on drip irrigation adoption, underscoring the importance of investing in innovation, strengthening extension services, and enhancing policy frameworks to facilitate the transition towards water-efficient irrigation methods.

XII. POLICY SUGGESTIONS

1. The agricultural experts, scientists, and the researchers should design and implement financial assistance programs tailored to small and marginal farmers to facilitate their adoption of drip irrigation. This could involve providing subsidies, grants, or low-interest loans to incentivize investment in drip irrigation infrastructure.
2. Efforts should be made to enhance educational outreach and extension services to disseminate knowledge about drip irrigation techniques, benefits, and best practices among farmers. Training programs, workshops, and demonstrations can empower farmers with the necessary skills and information to adopt drip irrigation effectively.
3. Government agencies, agricultural organizations, and local authorities should collaborate to strengthen institutional support mechanisms for drip irrigation adoption. This could include developing comprehensive policy frameworks, streamline bureaucratic procedures, and establish dedicated support centers to assist farmers in accessing resources and navigating regulatory requirements.
4. Investment in technological innovation and research is essential to develop and disseminate advanced drip irrigation technologies that are tailored to the specific needs and conditions of horticultural farmers in Salem District. Research and development initiatives should focus on enhancing the efficiency, affordability, and scalability of drip irrigation systems to maximize their adoption and impact.

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