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ENHANCING WATER USE EFFICIENCY AND AGRICULTURAL PRODUCTIVITY THROUGH DRIP IRRIGATION SYSTEMS (DIS): A CASE STUDY OF THENI DISTRICT, TAMILNADU

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ABSTRACT

This study undertook a comprehensive assessment of the socio-economic and agricultural impact of Drip Irrigation Systems (DIS) in the Theni District of Tamil Nadu. This research aimed to quantify the tangible benefits derived from DIS implementation, focusing on water use efficiency, crop yield enhancement, input cost reduction, and improvements in farm income. Furthermore, the study investigated the broader socio-economic implications on farming households, including changes in livelihood resilience, employment patterns, and living standards. Utilizing a mixed-methods approach, including surveys with DIS-adopting farmers and analysis of agricultural data, this research provided empirical evidence of the system's effectiveness. This study, conducted from December 2024 to May 2025, primarily gathered insights from Theni district farmers on drip irrigation's impact on water efficiency and productivity. This contemporary data was complemented by extensive secondary data from 2006-07 to 2021-2022 providing historical context for a comprehensive analysis.The farming community in Theni district was largely composed of male, elder farmers, primarily from Most Backward Class and Backward Class communities, practicing the Hindu faith. Most had an education up to higher secondary level and earned an annual family income between Rs.1,00,000 and Rs.2,00,000. A significant majority (65%) of farmers had fully adopted Drip Irrigation Systems. Farmers with larger landholdings (5+ acres) and higher family incomes (above Rs.2,50,000) showed a strong correlation with full DIS implementation, while smaller landholders and lower-income farmers were more likely to partially adopt. The most prominent benefits of DIS were significant reductions in water consumption (87% agreement) and increased cultivation yields (75% agreement). Improved income (65%) and lower electricity usage (56%) were also widely recognized advantages. Problems faced by farmers included high liquid agro-chemical costs (83%), issues with bribery and favouritism (89%), and complex loan procedures for DIS (84%). relatively stagnant or slightly declining trends in both gross/net area sown and irrigated over the period from 2006-07 to 2021-22. Regression analysis indicated that time alone did not significantly explain these variations. High initial investment and lack of post-sale technical support (both 68%) were also major concerns. The findings are expected to highlight the potential of DIS as a sustainable agricultural practice contributing to regional food security and rural development, while also identifying challenges and suggesting policy implications for wider adoption. It is suggested to streamline DIS loan processes and combat corruption. Local technical support centres for post-sale issues can be established. Practical training for farmers on DIS installation and maintenance is to be implemented. Additionally, the promotion of rural development for cost-effective liquid agro-chemicals is recommended. These steps are aimed at ensuring sustainable DIS adoption and improving farmer livelihoods.

(Key words: Drip irrigation, water use efficiency, agricultural productivity, sustainable agriculture and growth)

INTRODUCTION

Agriculture forms the backbone of the Indian economy, significantly contributing to the Gross Domestic Product and providing livelihoods for a majority of its population. Chand *et al.* (2020) showed that in Tamil Nadu, a southern state known for its agrarian prowess, the agricultural sector played a crucial role in sustaining rural economies and ensuring food security. Gokhale Institute of Politics and Economics 2022 the rapid depletion of ground water resources, unpredictable monsoon patterns, and the increasing demand for water from various sectors put immense pressure on traditional irrigation practices, which were often characterized by significant water losses due to evaporation, seepage, and inefficient delivery to crops. Globally, water resources occupy nearly three-fourths of the Earth's surface, with land covering the remaining parts. Out of the total global water approximately 97 per cent was saltwater found in oceans, while the remaining three per cent exists as fresh water. A significant portion of this freshwater, more than two-thirds, was frozen in the Arctic and Antarctic continents as ice. The remaining freshwater

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was obtainable from land-based sources such as rainfall, water springs, and the melting of frozen ice. While water was a renewable resource, its proper storage and management by both public bodies and governments often fall short, leading to reckless wastage. Consequently, many parts of the Earth were affected by water scarcity, causing numerous unpleasant consequences. This directly impacts the water consumption levels of living things like humans, birds, and animals, significantly affects agricultural production, hinders sustainable development, and stresses the entire ecological system. Muthuswamy and Palanisami (2018) indicated that, as a result, farmers often struggled to achieve expected levels of agricultural production, leading to improper and unbalanced cropping patterns. Recognizing these challenges, the government has implemented various irrigation developmental activities and strategies aimed at conserving water resources. These initiatives were designed to enhance sustainable development within the agriculture sector, benefiting both current and future generations by securing water for cultivation. Nagaraj (2020) discussed that water was primarily stored through two methods: natural storage and man-made or artificial methods. Natural storage methods include groundwater aquifers, soil water, and natural wetlands. Artificial storage methods encompass small artificial ponds, tanks, reservoirs, and large dams. Narayanamoorthy and Palanisami (2024) stated that the Theni District, situated in the southern part of Tamil Nadu, epitomizes these agricultural challenges. Predominantly an agrarian district, its economic prosperity and the well-being of its farming communities were intimately linked to the success of its agricultural output.

This study, therefore, aimed to provide a comprehensive analysis of the impact of Drip Irrigation Systems (DIS) in the Theni District of Tamil Nadu. While the theoretical benefits of DIS were well-documented, there was a need for region-specific empirical evidence that quantified its actual impact on the ground. This research sought to bridge this gap by meticulously evaluating the system's influence on water conservation, crop yield improvements, and the economic well-being of farming households in Theni district. Beyond just agricultural metrics, the study delved into the broader socio-economic dimensions, assessing how DIS adoption affected livelihood resilience, farm labor patterns, and the overall quality of life for rural communities. By employing a robust mixed-methods research design, combining quantitative data analysis with qualitative insights from farmers, this study intended to offer a holistic understanding of the transformative potential of DIS. The findings were anticipated to offer valuable insights for policymakers, agricultural planners, and farming communities, guiding future strategies for sustainable agricultural development and water resource management in water-stressed regions.

MATERIALS AND METHODS

Indian agriculture, a cornerstone of the nation's economy, heavily relies on water resources. However, the sector, particularly in states like Tamil Nadu, faces severe challenges stemming from water scarcity, inefficient management, and the rapid depletion of groundwater. Traditional irrigation practices, such as flood irrigation, prevalent in regions like Theni District, are characterized by significant water losses, rendering them unsustainable. This inefficiency exacerbates the impact of unpredictable monsoon patterns, leading to either drought or floods, commonly termed the 'gambling of monsoon.' Consequently, a substantial portion of cultivatable land lacks adequate irrigation, leading to suboptimal crop yields, increased production costs, and an economic burden on farmers. This precarious situation necessitates the adoption of modern, efficient irrigation technologies to ensure agricultural viability, maintain food security, and improve the socio-economic conditions of farming communities in water-stressed regions like Theni. This study was founded on the collection of both primary and secondary data. The primary data collection phase ran from December 2024 to May 2025. During this period, direct insights were gathered from farmers and other relevant stakeholders in Theni District regarding their experiences, perceptions, and the impact of drip irrigation systems on their water use efficiency and agricultural productivity.To complement these contemporary findings, the study also incorporated extensive secondary data spanning a period of over a decade, from 2006-07 to 2021-2022. For primary data acquisition, a purposive sampling technique was meticulously chosen. The geographical focus of this research **was** the Theni district of Tamil Nadu, situated in the southern part of the state. Within Theni District, two specific blocks, Chinnamannur and Uthamapalayam, were selected for the sample survey. A total of 100 samples were systematically gathered by selecting 5 villages from each of these chosen blocks: Alagapuri, Pottaipuram, Pulikuthi, Eranampatti, and Muthulapuram from Chinnamannur block; and Gokilapuram, Lakshminayakanpatty, Rogappanpatty, T. Sindalaichery and U. Anmapatty from Uthamapalayam block. Ten respondents were drawn from each village. All selected respondents were own-land cultivators who have actively implemented Drip Irrigation Systems on their agricultural lands. The primary data collected should be subjected to Correlation and Cluster analysis to derive meaningful insights. Additionally, secondary data can be utilized from various relevant sources to provide a comprehensive contextual understanding and to support the primary findings.

Based on the introduction provided, the primary objectives of this study were to conduct a comprehensive analysis of the impact of Drip Irrigation Systems (DIS) on water conservation in the Theni district of Tamil Nadu, to meticulously evaluate the influence of DIS adoption on crop yield improvements within the farming households of Theni district, to assess the economic well-being of farming households, specifically examining how DIS implementation affects input costs, farm income, and overall economic burden, to delve into the broader socio-economic dimensions of DIS adoption, including its effects on livelihood resilience, farm labor patterns, and the overall quality of life for rural communities in Theni district. Statistical tools Applied Correlation measures the strength and direction of a linear relationship between two quantitative variables. The most common type is Pearson's Product-Moment Correlation Coefficient (r). The formula for Pearson's r is:

r=[n∑x2−(∑x)2][n∑y2−(∑y)2]n(∑xy)−(∑x)(∑y)

where: n: Number of data pairs, ∑xy: Sum of the products of the paired x and y values, ∑x: Sum of the x values, ∑y: Sum of the y values, ∑x2: Sum of the squared x values, ∑y2: Sum of the squared y values. The value of r ranges from -1 to +1: r=+1: Perfect positive linear correlation, r="1: Perfect negative linear correlation, r=0: No linear correlation

Cluster analysis groups data points into clusters such that points in the same cluster are more similar to each other than to those in other clusters. A crucial part of this is defining "similarity" or "distance" between data points. One of the most commonly used distance metrics is Euclidean Distance. The formula for Euclidean distance between two points P1 =(x1 ,y1) and P2 =(x2 ,y2) in a 2-dimensional space is: d(P1 ,P2)=(x2 "x1)2+(y2 "y1)2 .

For data points with n dimensions, say P1 =(x11 ,x12 ,...,x1n) and P2 =(x21 ,x22 ,...,x2n), the Euclidean distance formula generalizes to: d(P1 ,P2)=i=1"n (x2i "x1i)2 This formula calculates the "straight-line" distance between two points in a multi-dimensional space, which is fundamental for many clustering algorithms like K-Means.

Regression Analysis in this context, it most commonly refers to Linear Regression, which models the linear relationship between a dependent variable and one or more independent variables. The general formula for a Simple Linear Regression model (with one independent variable) is: Y=a+bX - where: Y: The dependent variable (e.g., Gross Area Sown, Net Area Sown, Gross Area Irrigated, Net Area Irrigated in your study). This is what you are trying to predict or explain. X: The independent variable (in your case, likely 'Year' or 'Time'). This is the variable used to explain or predict Y. a: The Y-intercept (also called the constant or regression constant). This is the predicted value of Y when X is 0. b: The slope of the regression line (also called the regression coefficient). This represents the estimated change in Y for every one-unit increase in X.

RESULTS AND DISCUSSION

Table 1 provides a demographic and economic overview of the 100 surveyed farmers from Chinnamannur and Uthamapalayam blocks in Theni District, categorized by sex, age, community, religion, educational qualification, and income levels. The data reveals that the farming community in the study area was predominantly male (82%), with females constituting a smaller proportion (18%). In terms of age, the majority of respondents (56%) were found above 50 years (Elder) category, indicating a more mature farming population. The 25-50 years (Middle) group accounted for 24%, while those below 25 years (Young) make up 20%. Regarding community, Most Backward Classes (MBC) comprised the largest segment at 45%, closely followed by Backward Classes (BC) at 42%, with Scheduled Castes/Tribes (SC/ST) accounted for 13%. Religion-wise, an overwhelming majority were Hindu (87%), with Christians (12%) and Muslims (1%) forming smaller religious groups. For educational qualification, the highest percentage (45%) of farmers studied up to Higher Secondary Level, followed by Up to Elementary Level (19%), and Up to Secondary Level (15%). Diploma and Degree holders constitute 10% and 11% respectively. Pertaining to income, a significant 67% of respondents earned between Rs.1,00,000 - Rs.2,00,000 year^{-1} individually, while the total family income showed a similar trend, with 71% in the same bracket. A smaller proportion of both individual (26%) and family (15%) incomes were below Rs.1,00,000, and even fewer were above Rs.2,00,000 (7% individual, 14% family). Singh and Rakesh Kumar (2022) carried out a field experiment where the methods and irrigation scheduling had a crucial role in enhancing plant growth and crop yield. They also referred to the conventional sowing method of wheat and scheduling irrigation at an IW/CPE ratio of 1.2 as producing maximum yield and water productivity, which could be recommended for cultivation of wheat in sandy loam soils of Punjab.

Table 2 presented the distribution of respondents based on their land size and the extent of Drip Irrigation System (DIS) implementation across Chinnamannur and Uthamapalayam blocks, encompassing 100 surveyed farmers. The data indicated that the largest proportion of farmers, 47% (47 out of 100), possessed land holdings between 2 and 5 acres, with a nearly even distribution across both blocks. Farmers cultivating 1 to 2 acres and those with 5 to 10 acres each accounted for 20% of the total respondents. A smaller segment, 13% of the farmers, operated on above 10 acres. Regarding DIS adoption, a significant majority of 65% of the respondents had fully implemented the system across their lands. The remaining 35% reported partially implementing DIS, highlighting a strong overall adoption rate of advanced irrigation practices in the region. Suresh and Samuel (2020) focused on maximizing crop yield unit^{-1} of water consumed, emphasizing that DIS was a prime example of a technology that aimed to improve Water Use Efficiency by minimizing losses and delivering water precisely to the plant's root zone. WUE Theory was a crucial concept in agricultural and environmental science, particularly relevant to irrigation management and the study on DIS.

Table 3 elucidates the intricate relationship between the extent of Drip Irrigation System (DIS) implementation (partial versus full) and key socio-economic factors such as family income and land size among the surveyed farmers in Chinnamannur and Uthamapalayam blocks. The 'r (Sig) <0.05' indicated a statistically significant correlation for both family income and land size with DIS implementation, affirming that these relationships were not due to random chance. Analyzing Family Income in relation to DIS implementation revealed distinct patterns. For instance, farmers with an annual family income below Rs.1,00,000 were exclusively found among those with partial DIS implementation in both Chinnamannur (10%) and Uthamapalayam (20%). This suggested that lower-income households might have faced barriers to full adoption or preferred partial implementation due to financial constraints. Conversely, the majority of farmers earned between Rs.1,00,000 - Rs.2,50,000 either partially (24% in Chinnamannur, 16% in Uthamapalayam) or fully (50% in Chinnamannur, 52% in Uthamapalayam) implemented DIS. Notably, all farmers with an income above Rs.2,50,000 (16% in Chinnamannur, 12% in Uthamapalayam) had fully implemented DIS, indicating a strong positive association between higher income levels and complete adoption of the system. This strong correlation suggested that full DIS adoption was more prevalent and perhaps more economically viable for farmers with larger landholdings, enabling greater efficiency and returns on investment from the system. Overall, the data pointed towards a positive relationship where increased family income and larger land sizes were significantly associated with a higher likelihood of fully implementing Drip Irrigation Systems. Sathaiah and Chandrasekaran (2020) emphasized identifying and reducing all forms of water loss within the irrigation system. This included losses in conveyance (canals, pipes), application (evaporation, runoff from the field), and within the soil profile (deep percolation, unproductive evaporation from bare soil). High WUE was often achieved not just by water application alone, but by optimizing the interaction between water and other inputs.

Table 4 presented the cluster analysis of perceived DIS advantages among surveyed farmers. In Chinnamannur, three clusters emerged: Cluster 1 (16-40% agreement) reflected less universal benefits like social status and low agro-chemical usage. Cluster 2 (54-70% agreement) highlighted economic gains from low electricity usage, increased income, and cultivation. Cluster 3 (90% agreement) was characterized by significant water consumption reduction. In Uthamapalayam, four clusters were identified: Cluster 1 (80-84% agreement) combined increased cultivation and low water consumption. Cluster 2 (46-70% agreement) grouped low agro-chemical usage, increased income, and low electricity usage. Cluster 3 (26% agreement) focused on improved social status, and Cluster 4 (16% agreement) addressed "other improvements". Overall, water conservation and cultivation increase were consistently recognized benefits, while socio-economic and broader improvements showed varied, often lower, perceptions. Ahmed *et al*. (2019) studied that the effects of irrigation levels on the amounts of applied irrigation water, water consumptive use, water productivity on forage yield and its components, as well as its yield quality. The application of modern irrigation techniques, such as drip, bubbler, and sprinkler, was one of the modern irrigation techniques used to increase irrigation efficiency.

Table 5 perceived advantages of Drip Irrigation Systems (DIS) as reported by 100 surveyed farmers across Chinnamannur and Uthamapalayam blocks in Theni District. Each advantage was broken down by the frequency and percentage of "Yes" and "No" responses. The data reveals that low level of water consumption was the most widely recognized benefit, with 87% of all respondents affirming it (90% in Chinnamannur, 84% in Uthamapalayam). This is closely followed by cultivation increased, agreed upon by 75% of farmers (70% in Chinnamannur, 80% in Uthamapalayam). Income increased was also a significant advantage for 65% of farmers (60% in Chinnamannur, 70% in Uthamapalayam), indicating economic improvements. Low level of electricity usage was reported by 56% of respondents (54% in Chinnamannur, 58% in Uthamapalayam), suggesting reduced operational costs. However, benefits like low level of agro-chemical usage were acknowledged by only 43% of farmers, implying a less universal impact in this area. Furthermore, social status improved was perceived by a mere 22%, and "other improvements" by only 14%, indicating these broader socio-economic benefits are less consistently experienced by the farmers.

Table 6 presents the results of a cluster analysis identifying the primary challenges encountered by farmers in implementing Drip Irrigation Systems (DIS) in Chinnamannur and Uthamapalayam blocks. This analysis groups farmers based on similar reported problems. In Chinnamannur block, Cluster 1 highlighted issues such as lack of skilled labor, insufficient training, and emitter blockage, with 50-58% of respondents acknowledging these problems. Cluster 2 focuses on financial and support-related challenges, including high initial investment, lack of technical support after sale, and insufficient subsidy, which a significant 66-76% of farmers reported. Cluster 3 reveals that high liquid agro-chemical costs, extensive loan procedures, and issues like bribery and favoritism are major deterrents, with 84-88% of respondents confirming these difficulties. For Uthamapalayam block, Cluster 1 again pointed and to emitter blockage, insufficient training, and lack of skilled labor, experienced by 46-58% of farmers. Cluster 2 identified high initial investment and lack of technical support as key problems for 68-70% of respondents. Cluster 3 emphasized high liquid agro-chemical costs and low subsidy levels, reported by 76-78% of farmers. Finally, Cluster 4 specifically addressed issues of bribery, favoritism, and cumbersome procedures, which 86-88% of farmers identified as significant barriers. Overall, high initial investment, lack of post-sale support, and bureaucratic/ costly inputs emerge as widespread problems across both blocks.

Table 7 specified challenges encountered by the 100 surveyed farmers in implementing Drip Irrigation Systems (DIS) across Chinnamannur and Uthamapalayam blocks. The most frequently reported issue was high liquid agro-chemical cost, affirmed by a significant 83% of all respondents (88% in Chinnamannur, 78% in Uthamapalayam). This indicates a substantial operational burden. Close behind, bribes and favoritism and lot of procedure to avail DIS loan were widespread concerns, with 89% and 84% of farmers respectively confirming these bureaucratic and transparency issues. Furthermore, high initial investment (68%) and no technical support after sales (68%) remained critical barriers, suggesting significant financial and post-installation support gaps. Less universal, but still notable, are insufficient training programs (53%), emitter blockage (51%), and lack of skilled labor (50%). Overall, the data underscored that financial, bureaucratic, and support-related challenges are the most pressing problems hindering effective DIS adoption.

The Table 8 illustrates the trend and growth of gross and net area sown, and gross and net area under irrigation facilities in Tamil Nadu's agricultural development from 2006-07 to 2021-22 (all figures in '000 hectares). Over this period, the average gross area sown was approximately 5,789 '000 hectares, with a maximum of 6,192 in 2021-22 and a minimum of 5,129 in 2016-17. The net area sown averaged around 4,827.56 '000 hectares, fluctuating between a maximum of 5,129 in 2021-22 and a minimum of 4,347 in 2016-17. Similarly, the gross area irrigated showed an average of 3,340 '000 hectares, peaking at 3,788 in 2021-22 and dipping to 2,845 in 2016-17. The net area irrigated averaged 2,763.44 '000 hectares, with a high of 2,964 in 2011-12 and a low of 2,385 in 2016-17. The Compound Growth Rate (CGR) indicates a slight negative trend for Gross Area Sown (-0.004) and Gross Area Irrigated (-0.008), while Net Area Sown and Net Area Irrigated showed no significant growth (0.000). This suggests a relatively stagnant or slightly declining trend in the overall area under cultivation and irrigation facilities over the analyzed period, despite yearly fluctuations.

Table 9 presents the regression analysis resulted for key agricultural indicators in Tamil Nadu, including Gross Area Sown, Net Area Sown, Gross Area Irrigated, and Net Area Irrigated facilities. Both Linear and Log-linear models were applied to understand their trends. The R^2 values (0.052 for Linear, 0.178 for Log-linear) suggest that these models explain only a small proportion of the variance in Gross Area Sown. Similarly, Net Area Sown also lacks statistical significance in both models (Sig > 0.10), with low R^2 values (0.173 for Linear, 0.178 for Log-linear) implying limited explanatory power. Regarding Gross Area Irrigated, both the Linear and Log-linear models also did not demonstrate statistical significance (Sig > 0.27), and their R^2 values (0.084 for Linear, 0.070 for Log-linear) were quite low, meaning these models poorly explain the variations. However, for Net Area Irrigated, the Linear model approaches significance (Sig = 0.058), and the Log-linear model was also close (Sig = 0.064), suggesting a weaker but potentially discernible trend. The R^2 values for Net Area Irrigated (0.233 for Linear, 0.224 for Log-linear) were comparatively higher, indicating that these models explained about 22-23% of the variability. The negative 'b' coefficients in the Log-linear models for Gross Area Sown, Net Area Sown, and Net Area Irrigated suggest a slight inverse relationship with time, though not always statistically significant.

This study concluded that the impact of Drip Irrigation Systems (DIS) in Theni District, Tamil Nadu, clearly demonstrated its dual nature as both a promising solution and a system fraught with implementation hurdles. While DIS was highly effective in reducing water consumption (87% positive response) and boosting cultivation yields (75% positive), its adoption was significantly influenced by farm size and income, with larger landholders and wealthier farmers showing higher rates of full implementation. The research underscored that the benefits of DIS, particularly economic ones like increased income, were largely recognized. However, the path to widespread and equitable adoption was obstructed by formidable challenges. These included the high cost of liquid agro-chemicals (83% concern), pervasive issues of bribes and favoritism (89% concern), and complex, time-consuming procedures for obtaining DIS loans (84% concern). Furthermore, the lack of post-sale technical support and insufficient training programs presented ongoing operational difficulties. To truly leverage DIS for sustainable agricultural development across Theni District, comprehensive interventions were required to address these financial, bureaucratic, and support-related impediments, ensuring its accessibility and efficacy for all farming segments. Based on this, it was suggested and recommended to streamline the DIS loan application process by reducing bureaucratic procedures and ensuring transparency, actively combating issues of bribery and favoritismby 2022. Furthermore, establish dedicated local technical support centers for post-sale assistance, addressing common issues like emitter blockage and providing prompt solutions. Develop and deliver comprehensive, practical training programs for farmers on DIS installation, maintenance, and efficient agro-chemical usage, specifically targeting the identified lack of skilled labour and insufficient training by 2024. Finally, promote research and development of cost-effective and efficient liquid agro-chemicals suitable for DIS.

Table 1. Socio economic conditions of respondents

Indicators	Cluster / Grouping	Blocks				Total	
		Chinnamannur		Uthamapalayam			
		Freq.	%	Freq.	%	Freq.	%
Sex	Male	42	84	40	80	82	82
	Female	8	16	10	20	18	18
Age	>25 Years (Young)	9	18	11	22	20	20
	25 – 50 Years (Middle)	14	28	10	20	24	24
	Above 50 Years (Elder)	27	54	29	58	56	56
Community	BC	19	38	23	46	42	42
	MBC	24	48	21	42	45	45
	SC/ST	7	14	6	12	13	13
Religion	Hindu	44	88	43	86	87	87
	Christian	5	10	7	14	12	12
	Muslim	1	2	0	0	1	1
Educational	^Elementary Level	8	16	11	11	19	19
Qualification	^ Secondary Level	11	22	4	8	15	15
	^Higher Sec. Level	21	42	24	48	45	45
	Diploma	4	8	6	12	10	10
	Degree	6	12	5	10	11	11
Respondents'	BelowRs.1,00,000	9	18	17	34	26	26
Income	Rs.1,00,000- Rs.2,00,000	36	72	31	62	67	67
(Per Year)	Above Rs.2,00,000	5	10	2	4	7	7
Total family	Below Rs.1,00,000	5	10	10	20	15	15
Income (Year^{-1})	Rs.1,00,000- Rs.2,00,000	37	74	34	68	71	71
	Above Rs.2,00,000	8	16	6	12	14	14

Source: Survey Data (Freq. – Frequency: % - Percentage distribution)

Table 2. Respondents' land size and DIS implementation

Indicators	Cluster / Grouping	Blocks				Total	
		Chinnamannur		Uthamapalayam			
		Freq.	(%)	Freq.	(%)	Freq.	(%)
Land Size	1 – 2 Acres	9	18	11	22	20	20
	2 – 5 Acres	23	46	24	48	47	47
	5 – 10 Acres	12	24	8	16	20	20
	Above 10 Acres	6	12	7	14	13	13
DIS	Partially	17	34	18	36	35	35
Implementation	Fully	33	66	32	64	65	65

Source: Survey Data

Table 3.Relationship between DIS implementation with economical factor and land size

Indicators	Cluster / Grouping	Chinnamannur – Implementation of DIS						Uthamapalayam – Implementation of DIS						r (Sig)
		Partial		Fully		Total		Partial		Full		Total		
		F	%	F	%	F	%	F	%	F	%	F	%	
Family Income	Below Rs.1Lakh	5	10	-	-	5	10	10	20	-	-	10	20	
	Below Rs.1Lakh- Below Rs.2.5Lakh	12	24	25	50	37	74	8	16	26	52	34	68	<0.05
	Above Below Rs.2.5Lakh	-	-	8	16	8	16	-	-	6	12	6	12	
Land Size	1–2Acres	9	18	-	-	9	18	11	22	-	-	11	22	
	2–5Acres	8	16	15	30	23	46	7	14	17	34	24	48	
	5–10 Acres	-	-	12	24	12	24	-	-	8	16	8	16	<0.05
	Above10Acres	-	-	6	12	6	12	-	-	7	14	7	14	

Source:Survey Data F–Frequency, %- Percentage distribution, **r** – Karl Pearson Correlation Analysis, Sig-Significance

Table 4.Cluster analysis and advantages in DIS

Block	Cluster	Variables	Yes Range (%)	No Range (%)
Chinnamannur	**1.**	Social status improved, low level of agro-chemical usage and other improvements	16–40	60–84
	2.	Low level of electricity usage, income increased and cultivation increased	54–70	30–46
	3.	Low level of water consumption	90	10
Uthamapalayam	**1.**	Cultivation increased and low level of water consumption	80-84	16–20
	2.	Low level of agro-chemical usage, income Increased and Low level of electricity usage	46–70	30–54
	3.	Social status improved	26	74
	4.	Other improvements	16	84

Source: Survey Data

Table 5. Advantages in DIS

Indicators		Chinnamannur Freq.	Chinnamannur %	Uthamapalayam Freq.	Uthamapalayam %	Total Freq.	Total %
Income increased	Yes	30	60	35	70	65	65
	No	20	40	15	30	35	35
Social status improved	Yes	9	18	13	26	22	22
	No	41	82	37	74	78	78
Cultivation increased	Yes	35	70	40	80	75	75
	No	15	30	10	20	25	25
Low level of water consumption	Yes	45	90	42	84	87	87
	No	5	10	8	16	13	13
Low level of agro-chemical usage	Yes	20	40	23	46	43	43
	No	30	60	27	54	57	57
Low level of electricity usage	Yes	27	54	29	58	56	56
	No	23	46	21	42	44	44
Other improvements	Yes	8	16	6	12	14	14
	No	42	84	44	88	86	86

Source : Survey Data

Table 6. Cluster analysis and problems in DIS

Block	Indicators	Yes Range (%)	No Range (%)
Chinnamannur	Lack of skilled labour, insufficient training andawareness programme and emitter blockage	50– 58	42–50
	Initial investment high, no technical supportafter sale and insufficient subsidy	66– 76	24–34
	Liquid agro-chemical cost high, lot of procedure to avail DIS loan and Bribe and favouritism	84– 88	12–16
Uthamapalayam	Emitter blockage, insufficienttraining and awareness and lack skilled labour	46– 58	42–54
	Initial investment high and No technical support after sale	68– 70	30–32
	Liquid agro- chemical cost high and low subsidy	76– 78	22–24
	Bribe and favouritism and lot of procedure	86– 88	12–14

Source: Survey Data

Table 7. Problems in DIS

Cluster / Grouping		Blocks				Total	
		Chinnamannur		Uthamapalayam			
		Freq.	(%)	Freq.	(%)	Freq.	(%)
Initial investment high	Yes	33	66	35	70	68	68
	No	17	34	15	30	32	32
Liquid agro-chemical cost high	Yes	44	88	39	78	83	83
	No	6	12	11	22	17	17
Emitter blockage	Yes	23	46	28	56	51	51
	No	27	54	22	44	49	49
Lack of skilled labour	Yes	25	50	25	50	50	50
	No	25	50	25	50	50	50
No technical support after sales	Yes	34	68	34	68	68	68
	No	16	32	16	32	32	32
Insufficient training programme	Yes	24	48	29	58	53	53
	No	26	52	21	42	47	47
Bribes and favouritism	Yes	46	92	43	86	89	89
	No	4	8	7	14	11	11
Insufficient subsidy	Yes	38	76	37	74	75	75
	No	12	24	13	26	25	25
Lot of procedure to avail DIS loan	Yes	40	80	44	88	84	84
	No	10	20	6	12	16	16

Source: Survey Data

Table 8. Trend and growth of gross and net area sown, gross and net area irrigation facilities in agricultural development in Tamil Nadu

(hects. in '000)

Year	Gross area sown	Net area sown	Gross area irrigated	Net area irrigated
2006-07	5843	5126	3309	2889
2007-08	5815	5062	3252	2864
2008-09	5824	5043	3393	2931
2009-10	5572	4892	3238	2864
2010-11	5753	4954	3348	2912
2011-12	5890	4986	3519	2964
2012-13	5140	4544	2991	2643
2013-14	5897	4714	3311	2679
2014-15	5995	4819	3394	2726
2015-16	6074	4833	3575	2833
2016-17	5129	4347	2845	2385
2017-18	5730	4639	3278	2627
2018-19	5672	4582	3183	2565
2019-20	5942	4738	3410	2672
2020-21	6156	4833	3606	2764
2021-22	6192	5129	3788	2897
Average	5789	4827.5625	3340	2763.4375
Maximum	6192	5129	3788	2964
Minimum	5129	4347	2845	2385
CGR	-0.004	0.000	-0.008	0.000

Source: Computed data

Table 9. Regression results for gross area sown, net area sown gross area irrigated and net area irrigated facility in agricultural development in Tamil Nadu

Commodity	Model	Regression Co–Efficient			R	R^2	Adj R^2	Sig
		a	b	t				
Gross area	Linear	-165.264	46.188	.877	.228	.052	-.016	.395
sown	Log-linear	51.688	-.009	-1.739	.422	.178	.119	.104
Net area sown	Linear	363.815	-96.469	-1.713	.416	.173	.114	.109
	Log-linear	51.688	-.009	-1.739	.422	.178	.119	.104
Gross Area	linear	-11.620	.006	1.131	.289	.084	.018	.277
irrigated	Log-linear	-138.582	41.751	1.023	.264	.070	.003	.324
Net area	Linear	48.299	-.014	-2.061	.483	.233	.178	.058
irrigated	Log-linear	308.683	-87.244	-2.009	.473	.224	.168	.064

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