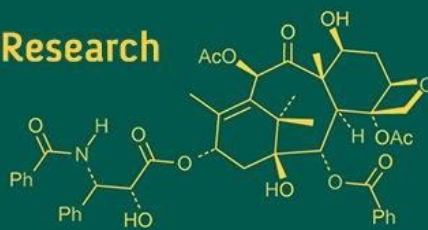
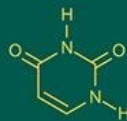


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Constraints in adoption of drip irrigation among the farmers of Tamil Nadu: An inquiry approach

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Abstract

Drip irrigation is a highly efficient water management system that has the potential to significantly improve water use efficiency and crop productivity, especially in water-scarce regions. However, despite its advantages, the widespread adoption of drip irrigation faces various constraints, including economic, technical, administrative, and socio-psychological challenges. This study focuses on the constraints encountered by farmers in Tamil Nadu, a state where the government has implemented several initiatives, such as the Tamil Nadu Irrigated Agricultural Modernization Project (TN-IAMP) and the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), to promote drip irrigation adoption. The research examines the barriers to effective implementation of drip irrigation in eight sub-basins of Tamil Nadu, selected based on the highest number of TN-IAMP beneficiaries. A total of 559 respondents from these sub-basins were surveyed to understand the key challenges they face in adopting and maintaining drip irrigation systems. The findings highlight significant economic constraints, such as high installation costs and limited access to credit, as well as technical issues like clogging of emitters and inadequate maintenance. The study also identifies administrative and socio-psychological barriers that hinder adoption. The paper concludes with recommendations for overcoming these challenges, including improved financial support, better technical training, and more efficient administrative processes, to enhance the sustainable adoption of drip irrigation in Tamil Nadu. However, its widespread adoption faces several constraints, categorized into economic, technical, administrative, and personal & socio-psychological barriers. Economic challenges, such as high initial installation costs, expensive equipment, and limited access to credit facilities, are significant deterrents for farmers. Technically, issues like frequent clogging of drippers, maintenance requirements, and inadequate awareness hinder effective use. Administrative constraints, including unreliable power supply, delays in subsidies, and the non-availability of spare parts, further exacerbate the adoption challenges. Additionally, personal and socio-psychological factors, such as lack of motivation, resistance to change, and frustration from previous system failures, prevent farmers from fully embracing the technology. Addressing these multifaceted barriers through targeted interventions and support systems is crucial for enhancing the adoption of drip irrigation, ensuring sustainable water management, and improving agricultural productivity in the region. The findings highlight the need for comprehensive policy reforms, improved access to financial resources, and increased farmer education to overcome these constraints.

Keywords: Drip irrigation; constraints; economic; technical; administrative; psychological

Introduction

Drip irrigation is widely regarded as a highly efficient method of water delivery for agricultural purposes, particularly in regions facing water scarcity. By providing water directly to the root zone, it minimizes losses due to evaporation and runoff, thereby optimizing water use efficiency and enhancing crop productivity. Despite its benefits, the adoption and effective implementation of drip irrigation systems face several constraints. These challenges span technical, economic, social, and environmental dimensions, often limiting its potential impact in various agricultural settings. Studies have highlighted that the high initial cost of installation, maintenance requirements, and the need for technical expertise are among the primary barriers to widespread adoption (Kumar *et al.*, 2017; FAO, 2020) [5, 3]. Additionally, smallholder farmers, particularly in developing countries, often struggle with limited access to financial resources and technical support, which hinders their ability to adopt and sustain such systems (Postel *et al.*, 2001) [6]. Other factors, such as the variability in water quality, clogging of emitters, and the lack of institutional support, further complicate the implementation process (Rajput & Patel, 2006) [7].

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Acknowledging its benefits, researchers from across the country have reported that drip irrigation is the better alternative for irrigating the row crops, mulched crops, orchards, gardens, greenhouses, nurseries and ornamental plantations as against the conventional surface irrigation systems (Anonymous, 2014) [1].

The Government of Tamil Nadu has offer more substantial subsidies through Tamil Nadu-Irrigated Agricultural Modernization Project (TN-IAMP), Micro Irrigation Scheme and Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) for drip irrigation development, mainly involving small and marginal farmers. Subsidies can be as high as 50-75 percent of the installation cost that makes development quite accessible to farmers.

The World Bank Supported TN IAM (Irrigated Agriculture Modernisation) Project is the follow-up of IAMWARM (Irrigated Agriculture Modernisation and Water-Bodies Restoration and Management) Project, a project that has been so far making significant development impacts in the state through modernization of irrigation infrastructure improvement in water use efficiency with enhanced yields and productivity of agriculture in a climate resilient production systems, diversification towards high value crops, strengthening the institutional reforms through Participatory Irrigation Management (PIM) and Water Users Association (WUA). The TN-IAM project will take the policy and institutional development achieved under IAMWARM project to a new level and will serve as the key vehicle for implementing the Tamil Nadu Government agenda in further enhancing water and agriculture productivity in a sub basin framework.

This article delves into these constraints, drawing on existing research and case studies to provide a comprehensive overview of the barriers to the effective use of drip irrigation. By identifying these challenges, the aim is to propose actionable strategies to overcome them and promote the sustainable adoption of this technology.

Research Methodology

The study was conducted in Aliyar, Lower Vellar, Uppar, Sirumalaiyar, Sathiyar, Cauvery Delta Zone-Nagapattinam, Lower Coleroon-Aduthurai, Vridhachalam sub basins of Tamil Nadu state. These sub basins of Tamil Nadu covering major area under drip irrigation and the districts covered by these sub basins are shown in Fig: 1 and 2. From these sub basins all the TN-IAMP beneficiaries were selected for the study with complete sampling procedure. In this the beneficiaries with a total sample size of 559 were selected for the study. The respondents were personally interviewed with interview schedule. The data were tabulated and analyzed by using statistical tools like frequency, mean and ranking.



Fig 1: Tamil Nadu Map

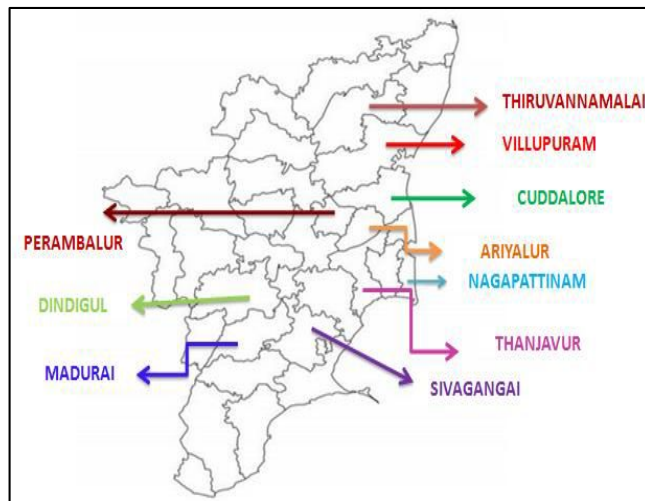


Fig 2: Districts covered under selected sub basins

Results and Discussion

Constraints were the challenges that the beneficiaries encountered during the adoption of drip irrigation technology. The constraints were divided into four categories, such as economical, technical, administrative and personal & socio-psychological constraints as shown in the Table (1-4) the major constraints faced by the respondents while using the drip irrigation are ranked according to mean value.

Economic constraints

Farmers face several economic constraints when adopting drip irrigation systems, including heavy initial installation costs and expensive equipment and spare parts. Many lack the capital needed to cover the entire area for drip irrigation, and the requirement for additional tanks to maintain proper pressure adds to the financial burden. Additionally, insufficient access to credit facilities and delays in receiving subsidies further hinder farmers' ability to invest in this technology, limiting its adoption and potential benefits.

Table 1: Distribution of respondents according to their economic constraints

S. No	Type of Constraints	Mean	Rank
A.	Economic Constraints		
1.	High initial expenses for installation drip irrigation system	3.47	IV
2.	High cost of equipment/ spare parts of drip irrigation system	4.30	II
3.	Lack of capital for covering entire area under drip irrigation system	4.58	I
4.	Addition tank required to get proper pressure	4.10	III
5.	Lack of credit facilities to farmers	1.82	VI
6.	Insufficient subsidy	2.78	V
7.	Delay in receiving subsidy	1.50	VII

From the above Table (1) it is shown that lack of capital to cover the entire area under the drip irrigation system ranked first in economic constraint with mean 4.58 the constraint farmers face is the inability to afford covering their entire agricultural land with drip irrigation. This suggests that even if some farmers can install the system partially, scaling it to all areas of their farms remains financially unfeasible due to a lack of capital. It points to a gap in either financial resources or support for expanding the system.

High cost of equipment/spare parts of the drip irrigation system ranked second with mean 4.30 after the initial installation, the high cost of equipment or replacement of spare parts becomes a substantial financial burden. It ranks as the second most severe constraint, highlighting the recurring expenses that make the system less attractive to farmers, especially those with lower income.

Addition of a tank is required to maintain proper pressure ranked third with mean 4.10 drip irrigation systems often require the installation of additional infrastructure, like a water tank, to ensure proper water pressure. This adds to the installation complexity and increases costs. This issue is fairly common and poses a significant challenge in maintaining the efficiency of the system.

Heavy initial expenses for installing a drip irrigation system ranked fourth with mean 3.47 farmers face significant upfront costs when installing a drip irrigation system, which may be a deterrent for many. Even though it might have long-term benefits in terms of water savings and increased yields, the high initial investment is a major hurdle. This constraint is still notable but not the most pressing due to the subsidies provided through the scheme.

Insufficient subsidy ranked fifth with mean 2.78 there are subsidies available to assist farmers in adopting drip irrigation, many perceive the subsidy as insufficient.

It shows that even though the government or institutions may provide financial assistance, it doesn't cover a

significant portion of the expenses.

Lack of credit facilities for farmers ranked sixth with mean 1.82 while lack of credit is acknowledged as a constraint, it indicating that it is not the most urgent problem. However, without adequate credit facilities, farmers who lack upfront cash cannot invest in irrigation systems, limiting their adoption.

Delay in receiving the subsidy with seventh rank and mean 1.50 the delay in receiving subsidies ranks the lowest, indicating it is the least severe of the constraints. Nevertheless, such delays can lead to cash flow issues for farmers who depend on the subsidy to afford the irrigation system.

Technical constraints

Farmers encounter various technical constraints with drip irrigation systems, including the need for regular maintenance and repairs, which can be time-consuming. Common issues such as frequent clogging of drippers and micro tubes, poor quality of materials, and inadequate backup service exacerbate these challenges. Additionally, many farmers lack training and awareness of the benefits of drip irrigation, while improper water pressure affects discharge rates and can lead to leaks. The technology itself can be complicated, making it difficult to maintain proper water pressure and manage weeding within the rows, further complicating its effective use.

Table 2: Distribution of respondents according to their technical constraints

S. No	Type of Constraints	Mean	Rank
B.	Technical Constraints		
1.	Required time-to-time attention for minor repairs of drip equipments	4.16	II
2.	Frequent clogging of drippers and micro tubes	4.43	I
3.	Less quality of dripping material	2.49	VIII
4.	Satisfactory with backup service for drip system	2.72	VII
5.	Lack of awareness among the farmers regarding benefits of drip irrigation system	3.80	IV
6.	Improper pressure hinders discharge rate	3.55	V
7.	Problems of water leakages in the system	4.01	III
8.	Difficult to keep proper water pressure	3.11	VI
9.	Complicated technologies	2.30	IX
10.	Difficult in weeding within the rows	1.45	X

From the above Table (2) it shows that frequent clogging of drippers and micro tubes ranks first in technical constraint with mean 4.43 the most significant technical issue is the frequent clogging of drippers and micro tubes. This suggests that the system often gets blocked, reducing its efficiency and requiring regular maintenance. This is a critical issue that undermines the functionality of the entire system, making it the top technical barrier.

Required time-to-time attention for minor repairs of drip irrigation ranked second with mean 4.16 this constraint points to the need for constant monitoring and maintenance to address minor repairs in the system. Drip irrigation requires regular attention to keep it functioning properly, which can be time-consuming and difficult for farmers to manage, especially those with limited technical knowledge.

Problems of water leakages in the system ranked third with mean 4.01 water leakage is another major issue, ranking third. Leaks in the system not only waste water but also reduce the system's efficiency, leading to uneven water distribution to crops. Farmers face difficulty maintaining the system's integrity over time, making this a critical concern.

Lack of awareness among farmers regarding the benefits of drip irrigation ranked fourth with mean 3.80 a significant

portion of farmers are unaware of the potential benefits of drip irrigation, which limits its adoption. This lack of knowledge about how drip irrigation can improve water use efficiency and crop yields prevents widespread implementation, highlighting the need for better educational efforts.

Improper pressure hinders discharge rate ranked fifth with mean 3.55 maintaining proper water pressure is essential for ensuring that the drip system functions effectively. When the pressure is too low or inconsistent, it affects the discharge rate, leading to poor water distribution. This technical issue ranks fifth and is a recurring challenge for many farmers.

Difficult to keep proper water pressure ranked sixth with mean 3.11 maintaining proper water pressure throughout the system is a challenge, ranking seventh. If pressure fluctuates, it can affect the uniformity of water distribution. This issue is closely related to other concerns like improper discharge rates and system performance.

Satisfactory with backup service for the drip system ranked seventh with mean 2.72 farmers are dissatisfied with the backup service provided for drip irrigation systems. Ranked eighth, this indicates that when technical issues arise, the

support from companies or service providers is not adequate, leading to further frustrations and delays in resolving problems.

Less quality of dripping material ranked eighth with mean 2.49 poor quality of materials used in the drip system is a concern, making it a less pressing issue compared to other constraints. Low-quality materials may lead to frequent breakdowns and inefficiency, but this is not seen as a primary challenge by most farmers.

Complicated technologies ranked ninth with mean 2.30 the technological complexity of the system ranks tenth, meaning it is not a primary barrier. However, for some farmers, especially those less familiar with modern technology, drip irrigation may seem complicated, adding to the reluctance in adopting it.

Difficult in weeding within the rows ranked tenth with mean 1.45 ranked the lowest, this constraint suggests that the system makes weeding difficult due to the layout of the drip lines. However, it is considered a minor issue compared to

the more critical technical challenges like clogging and maintenance. The findings of the present study are similar to Badole (2014) ^[2] and Parihar (2017) ^[5] who reported that clogging of micro tube as constraints faced by majority of respondents.

Administrative constraints

Farmers face several administrative constraints in adopting drip irrigation systems, including inadequate and unreliable power supply, which complicates operations. There is a lack of proper training and timely availability of quality inputs, along with challenges in accessing spare parts at reasonable prices. The cumbersome procedures for obtaining loans and subsidies, combined with delays in their sanctioning, further hinder farmers' efforts. Additionally, the absence of timely technical guidance from experts exacerbates these issues, leaving farmers without the support they need to effectively implement and maintain drip irrigation systems.

Table 3: Distribution of respondents according to their administrative constraints

S. No	Type of Constraints	Mean	Rank
C.	Administrative Constraints		
1.	Inadequate and uncertainty in power supply	3.95	III
2.	Lack of proper training	1.93	VIII
3.	Non-availability of spare parts at proper time with seasonal rates	4.60	I
4.	Difficulty in getting timely availability of input	4.38	II
5.	Low quality of supplied inputs	3.76	IV
6.	Non-availability of technical guidance in time	3.34	V
7.	Rigorous procedure to get loan/subsidy	2.97	VI
8.	Delay in sanction of loan/subsidy	2.65	VII
9.	Lack of technical guidance from concerned scientists	1.50	IX

From the above Table (3) it shows that non-availability of spare parts at proper time with seasonal rates ranked first in administrative constraints with mean 4.60 the most severe administrative constraint is the non-availability of spare parts when needed, or the parts being too expensive. Farmers rely on these parts to maintain and repair their drip irrigation systems. The unavailability of reasonably priced spare parts makes it difficult for farmers to keep the system running, creating a major barrier to its adoption and maintenance.

Difficulty in getting timely availability of input ranked second with mean 4.38 this issue highlights the challenge farmers face in obtaining necessary inputs (such as fertilizers, and system components) in a timely manner. Without these inputs, the system cannot function optimally, and crops may suffer. This administrative delay hampers the efficient use of drip irrigation technology.

Inadequate and uncertainty in power supply ranked third with mean

3.95 unreliable power supply is a major constraint. Drip irrigation systems often rely on electric pumps to maintain water flow and pressure. In areas where power is inconsistent, farmers struggle to operate the system efficiently, leading to frequent interruptions in irrigation.

Low quality of supplied inputs ranked fourth with mean 3.76 farmers perceive the quality of inputs provided for the drip irrigation system (e.g., pipes, drippers, filters) as poor. Even if inputs are available, their substandard quality reduces the system's effectiveness, leading to breakdowns and higher maintenance costs. Ranked fourth, this reflects a significant frustration among farmers.

Non-availability of technical guidance in time ranked fifth with mean 3.34 this constraint highlights the lack of timely technical assistance for farmers. When farmers encounter problems with their drip irrigation systems, they often do not receive the necessary guidance from experts or technicians to resolve these issues. This delay can exacerbate existing problems and lead to further inefficiency.

Rigorous procedure to get loan/subsidy ranked sixth with mean 2.97 the cumbersome and bureaucratic process for obtaining loans or subsidies is a significant barrier, although it ranks sixth. Farmers may find it difficult to navigate the complex paperwork and requirements, leading to delays in receiving financial support for adopting drip irrigation systems.

Delay in sanction of loan/subsidy ranked seventh with mean 2.65 it is still an important administrative constraint. Even if farmers are eligible for financial aid, the long wait times for approval and disbursement can hinder their ability to adopt or expand drip irrigation on their farms.

Lack of proper training ranked eighth with mean 1.93 it still indicates that some farmers do not receive adequate instruction on how to use and maintain drip irrigation systems effectively. Proper training is essential for the successful operation of the system, and its absence can result in underutilization or improper use.

Lack of technical guidance from concerned scientists ranked ninth with mean 1.50 this constraint ranks lowest, suggesting that the lack of scientific advice is not as significant an issue compared to other administrative problems. However, in cases where farmers do need

specialized guidance, the absence of direct support from scientists can still pose a challenge, especially for those unfamiliar with the technology.

Personal and socio-psychological constraints

Farmers experience personal and socio-psychological constraints in adopting drip irrigation systems, including a

general lack of enthusiasm and motivation for implementing the technology. Many feel frustrated due to previous failures of drip irrigation systems, which can diminish their confidence in the method. Additionally, resistance from family members further complicates their willingness to invest in or adopt new practices, leading to hesitancy and reluctance to change established farming methods.

Table 4: Distribution of respondents according to their personal and socio-psychological constraints

S. No	Type of Constraints	Mean	Rank
D.	Personal and socio-psychological constraints		
1.	Lack of interest among the farmers regarding drip irrigation system	3.94	II
2.	Lack of motivation to adopt drip irrigation	4.20	I
3.	Frustration to failure of drip irrigation system in the field	2.62	III
4.	Resistance from family members	2.15	IV

From the above Table (4) it shows that lack of motivation to adopt drip irrigation ranked first in personal and socio-psychological constraint with mean 4.20 the most significant personal barrier is the lack of motivation among farmers to adopt drip irrigation. Even if the technology is available and beneficial, farmers may not feel driven to implement it due to various reasons like uncertainty about the benefits, fear of failure, or lack of external encouragement. This indicates that many farmers are not actively seeking to change their irrigation practices, despite potential advantage.

Lack of interest among farmers regarding the drip irrigation system ranked second with mean 3.94 this constraint reflects a general lack of enthusiasm or willingness among farmers to adopt the system. This could be due to skepticism about its effectiveness, doubts about long-term gains, or a reluctance to change traditional farming methods. The lack of spirit might also be tied to previous negative experiences or the influence of neighboring farmers who haven't adopted the system.

Frustration due to failure of drip irrigation system in the field ranked third with mean 2.62 this constraint indicates that when the drip irrigation system fails or does not work as expected, it leads to frustration among farmers. This frustration could stem from technical issues, high maintenance requirements, or the system not delivering expected results. Past negative experiences or system failures can demotivate farmers from continuing to use or expand drip irrigation on their farms.

Resistance from family members ranked fourth with mean 2.15 ranked lowest, this constraint reflects resistance from family members regarding the adoption of the drip irrigation system. This resistance may arise due to financial concerns, fear of changing traditional farming methods, or doubts about the system's effectiveness. While it is not as significant as the other personal barriers, it still plays a role in influencing decision-making, especially in family-run farms where major decisions are often made collectively.

Conclusion

The adoption of drip irrigation systems in Tamil Nadu faces multifaceted constraints spanning economic, technical, administrative, and personal & socio-psychological challenges. Among economic constraints, the lack of capital to cover the entire area under drip irrigation, high costs of equipment, and additional infrastructure requirements emerged as significant barriers. Technical issues such as frequent clogging of drippers, the need for regular maintenance, and water leakage further hinder the effective

use of the system. Administrative constraints, including the non-availability of spare parts at reasonable prices, delays in receiving inputs, and inadequate power supply, exacerbate the challenges faced by farmers. On a personal level, a lack of motivation and interest, coupled with resistance from family members and frustrations from past failures, limits the willingness to adopt this technology.

Addressing these constraints requires a holistic approach involving financial support through subsidies and credit facilities, technical training, and awareness campaigns to highlight the benefits of drip irrigation. Administrative reforms to streamline loan and subsidy processes and ensure the timely availability of quality inputs are equally crucial. With targeted interventions and support, the adoption of drip irrigation can be enhanced, leading to sustainable agricultural practices and improved water use efficiency in Tamil Nadu.

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