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IMPACT ASSESSMENT OF DRIP IRRIGATION ON AGRICULTURAL PRODUCTIVITY AND RESOURCE EFFICIENCY: A VILLAGE-LEVEL STUDY FROM KHAMMAM DISTRICT, TELANGANA, INDIA

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Abstract

Increasing water scarcity, declining groundwater levels, and rising input costs have intensified the need for efficient irrigation technologies in semi-arid regions of India. Drip irrigation, as a micro-irrigation technology, offers a promising solution by improving water-use efficiency and farm productivity. This study evaluates the impact of drip irrigation on agricultural productivity, resource-use efficiency, and farm economics at the village level in Khammam District, Telangana. The analysis is based on primary data collected through a structured field survey of 20 farmers adopting drip irrigation in Penuballi and Sathupally Mandals, complemented by secondary data from government reports and published literature. A comparative assessment between drip and conventional irrigation systems was carried out with respect to cropping intensity, yield performance, water, fertilizer, electricity, labour use, and cost of cultivation.

The results indicate that drip irrigation significantly enhances cropping intensity (2–4 crops per year) and crop yields (10–50%), while substantially reducing cultivation costs by ₹5,000–₹25,000 per acre. Farmers reported considerable savings in water use (40–50%), fertilizer consumption (20–50%), electricity usage, and labour requirements (around 45%). Despite the relatively high initial installation cost, most adopters recovered their investment within 3–5 years, even in cases of partial or no subsidy support. The findings underscore that drip irrigation is not only economically viable at the farm level but also contributes to long-term sustainability by conserving water, energy, and soil health. From a policy perspective, the study highlights the need for a uniform and inclusive subsidy framework, strengthened extension services, timely technical support, and the integration of fertigation and automation to maximize the benefits of micro-irrigation. Promoting drip irrigation as part of an integrated water-management strategy can play a critical role in enhancing farm incomes, improving resource efficiency, and ensuring climate-resilient agriculture in water-stressed regions like Telangana.

Keywords: Drip Irrigation, Agricultural Productivity, Resource-Use Efficiency, Farm Economics, Water Management, Telangana

1. Introduction:

Water is an indispensable natural resource, with no substitute for its primary applications in agriculture, industry, and human sustenance. In the agricultural sector, water is a vital input. Its availability and efficient use underpin food security and rural livelihoods. Worldwide and in India, pressure on fresh water resources is mounting: demand is fast approaching or exceeding sustainable supply and competition between sectors (agricultural, domestic, industrial) is intensifying. The rapid depletion of groundwater in many regions poses a significant threat to farming communities and necessitates the adoption of more efficient and resilient irrigation practices to sustain agricultural production.

Telangana is a fast-growing Indian state with a predominantly agrarian profile. According to the latest data, approximately 61.12% of its population (about 2.48 crore people) resides in rural areas, and agriculture remains the backbone of the state's economy. Surface irrigation, groundwater, and rain-fed sources constitute the water matrix for cultivation. Although major rivers such as the Godavari and Krishna traverse the state and underpin large-scale irrigation projects, much of agriculture remains dependent on erratic rainfall and groundwater extraction.

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The scale of the challenge is evident in several indicators. Telangana's irrigation sector has seen major investments: for example, the state of Telangana allocated Rs.23, 373 crore for the irrigation sector in its 2025-26 budget. This significant funding is intended to complete pending irrigation projects and bring more land under cultivation[1]. Meanwhile, land-use statistics show considerable room for growth in irrigation coverage. According to the report of the Socio-Economic Outlook of the Telangana State 2002, The stat's grow irrigated area (GIA) increased by nearly 123% between 2014-15 and 2020-21 (from approximately 25.28 lakh ha to 56.37 lakh ha)[2]. Due to the increased irrigation potential, the gross sown area also increased from 131 lakh aces in 2014-15 to 198 lakh acres in 2021-22, an increase of 51%. On the other hand the groundwater depletion is also a pressing issue: districts have observed declines to depths o over 10 meters in recent years in many places[3].

These trends underline the fact that conventional irrigation systems and water extraction practices are becoming unsustainable in Telangana's semi-arid climate. In response, micro-irrigation technologies such as drip irrigation have emerged as critical components of the state's strategy to improve water-use efficiency, reduce energy and input costs, and stabilize yields. Drip irrigation systems deliver water slowly, directly to the root zone, reducing losses due to evaporation and percolation and maintaining soil moisture at optimal levels. In India, drip irrigation has been implemented since the early 1980s, and its adoption in regions like Telangana offers the potential to address multiple interlinked challenges: crop productivity, water conservation, energy efficiency, and long-term farmer profitability.

Given this backdrop, a systematic assessment of how drip irrigation affects farm performance, input-use efficiency, and resource sustainability is timely land important, especially at the village and field levels. This paper sets out to evaluate the impact of drip irrigation technology on agricultural productivity, efficiency of water, electricity and fertilizer use, and the economic viability of adoption in a rural Telangana context.

2. Drip/Micro-Irrigation Area Spread in India and Telangana

In India, adoption of micro-irrigation (which includes both drip and sprinkler systems) has expanded significantly under the Per Drop More Crop (PDMC) component of Pradhan Mantri Krishi Sanchayee Yojana (PMKSY). Centrally Sponserd Scheme of Per Drop More Crop (PDMC) scheme is being implemented since 2015-16. The scheme focuses on enhancing water use efficiency at farm level through Micro Irrigation, namely, drip and sprinkler irrigation systems. From 2015-16 to 2021-22, the scheme was implemented as a component of **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)**. From 2022-23, the scheme is being implemented under **Pradhan Mantri Rashtriya Krishi Vikas Yojana (PMRKVY).** Between FY 2015-16 and FY 2023-24, approximately 83.46 lakh hectares of farmland were brought under micro-irrigation across india[4]. Of this, about 46.37 lakh hectares were under drip irrigation[5]. Under PDMC Scheme, financial assistance is provided to farmers for installation of micro irrigation systems @ 55% and 45% of the unit cost to small and marginal farmers and other farmers respectively. NITI Aayog conducted an evaluation study of PDMC scheme in the year 2020. The study revealed that the scheme is relevant in achieving national priorities such as improving on-farm water use efficiency, enhancing crop productivity, generating employment opportunities, overall income enhancement of farmers etc.

[1] https://www.newindianexpress.com/states/telangana/2025/Mar/20/telangana-budget-2025. -rs-23373-crore-outlay-for-irrigation-sector? "Telangana Budget 2025:
[2] https://www.thenewsminute.com. "Telangana's irrigated area has increased: What roles have ..."
[3] https://timesofindia.indiatimes.com/- "Groundwater level in Telangana dips further as state digs ..."
[4] . https://www.pib.gov.in/PressReleasePage.aspx?PRID=2003188 "micro irrigation - PIB"
[5] . https://www.pib.gov.in/PressReleasePage.aspx?PRID=2112401 "drip and sprinkler irrigation through PMKSY - PIB"

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In Telangana, up to FY 2022-23, the state horticulture department reports that 8.32 lakh hectares across 8.22 lakh farmers were covered under micro-irrigation (Drip/Sprinkler) under the state's micro-irrigation project[6]. These data reflect a substantial scaling up compared with earlier figures for the state, for example, around 0.73 lakh ha by 2003-04. Such growth underscores the significant momentum that micro-irrigation technologies have gained in India and Telangana, thereby reinforcing the importance of assessing their impact on productivity, resource-use efficiency, and farm economics.

3. Need for the Study

Despite the impressive increases in micro-irrigation coverage, especially drip irrigation, the actual farm-level evidence on its performance, particularly for different crops, across farm-size categories, and for small and marginal farmers remains relatively limited. Many studies have addressed water-saving potentials, yield effects, and cost reductions in experimental or demonstration plots, but fewer have captured real-world adoption conditions, resources-use improvements (Water, Electricity, and Fertilizer) and economic viability under typical farming systems in states like Telangana.

Given that Telangana now has over 8.3 lakh ha under micro-irrigation, understanding how this adoption translates into tangible benefit (and what constraints persist) is timely for guiding policy, subsidy design farmer training, and technology dissemination strategies. Moreover, differentiating outcomes between drip and conventional irrigation systems provides valuable insights for sustainable agricultural development in semi-arid regions.

4. Objectives of the Study

1. To examine the impact of the adoption of drip-irrigation technology on agricultural productivity, for example, in fruit and vegetable crops by comparing fields with drip systems versus conventional (Non-Drip) irrigation in Telangana.
2. To assess the efficiency of resource usage (namely water, Electricity, and Fertilizer) under drip-irrigated crops compared with non-drip irrigated crops. (Focusing on fruit and vegetable cultivation).
3. To evaluate the economic viability of drip irrigation systems for farmers across different crops and farm-size categories, including the initial installation cost, operational savings, yield gain, and pay-back period.

5. Methodology

5.1. Research Design

The present study adopts a descriptive and analytical research design to assess the impact of drip irrigation on agricultural productivity, resource use efficiency and cost economics at the village level in Khammam District, Telangana State, India. Both Primary and Secondary sources of date were utilized to ensure the robustness and reliability of the analysis.

5.2. Data Sources

5.2.1. Secondary Data

Secondary data were collected from multiple credible sources such as government publications, the Department of Agriculture and Horticulture (Government of Telangana), Academic Journals, Research Reports, and Official websites related to micro-irrigation schemes such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and Telangana State Micro Irrigation Project (TSMIP). These data helped in contextualizing the research and understanding the trends in drip irrigation adoption at both state and national levels.

[6] . https://horticulturedept.telangana.gov.in/?utm "TGMIP"

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5.2.2. Primary Data

Primary data formed the core of the analysis and were collected through a field survey using a structured and pre-tested questionnaire. The survey was conducted among 20 farmers who had adopted the drip irrigation system. A purposive sampling method was employed to select respondents based on their adoption status and availability of reliable records. The study covered two Mandals that are Penuballi and Sathupally of Khammam District in Telangana.

5.3. Study Area

The selected study area represents a semi-arid agro-climatic region with a predominance of horticultural and cash crops. The villages were chosen based on the prevalence of drip irrigation adoption under the Telangana State Micro Irrigation Project (TSMIP) or independently. The list of sample villages and the number of farmers interviewed from each are presented below.

Table No. 1
Mandal wise and Village wise number of formers interviewed in Khammam Dt.

District	Mandal	Village Name	Number of Farmers Interviewed
Khammam	Penuballi	Gangadevipadu,	09
		Bayanna Gudem,	02
		V.M. Banjar	01
	Sathupally	Kakarlapalli	04
		Sathupally	02
		Satyam Peta	01
		Rangapuram	01
Total			**20**

Source: Field Survey, 2024.

5.4. Data Collection Procedure

Data were collected through personal interviews with farmers using a semi –structured questionnaire. The questionnaire included both quantitative and qualitative variables, covering:

1. Socio-economic characteristics of farmers. (Age, Education, Landholding, Income, etc.)
2. Crop-specific data. (Type of Crops, Yield, and Input Use)
3. Irrigation details. (Source of Water, Duration and Frequency of Irrigation)
4. Cost Structure and Profitability Analysis.
5. Information on Fertilizer, Pesticide and Electricity usage;
6. Farmer perceptions on advantages, constraints, and maintenance of the drip system.

All data were carefully verified through field observation and cross-checked with data available at local agricultural officers.

5.5. Analytical Framework

The data collected were analyzed using descriptive statics, including Percentage Analysis, Averages, and frequency Distribution, to evaluate the socio-economic characteristics and resource use patterns of the sample farmers. Further, Comparative Analysis was performed between drip and non-drip irrigation systems to identify differences in Water use efficiency, Cost of cultivation, Yield levels and Input cost savings (Fertilizer, Electricity land Labour). The study also examined the economic viability of the drip irrigation system by analyzing the benefit-cost ration (BCR), payback, and net returns per hectare.

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5.6. Limitations of the Study

While the study offers valuable insights, it is limited by the small sample size and purposive sampling design, which may not fully represent all farmers in the district. Nevertheless, the findings provide indicative evidence on the economic and agronomic impact of drip irrigation in similar agro-ecological conditions.

6. Review of Literature

Drip irrigation, a key component of micro-irrigation technology, has been widely recognized as an efficient and sustainable method for enhancing agricultural productivity, conserving water, and optimizing input use. Over the years, research studies have consistently demonstrated its potential to improve yield, reduce cost, and promote environmental sustainability. The following section reviews both classical and contemporary research on drip irrigation with a focus on its impact on productivity and resource efficiency in the Indian context.

6.1 Early Studies and Foundational Research

Sivanappan (1994), in his pioneering article ***"Prospects of Micro-Irrigation in India",*** observed that micro-irrigation could save 40-80% of water, while increasing crop yields by up to 100%, particularly in horticultural crops. The study emphasized that drip irrigation is technically feasible and socially acceptable for small, marginal, and large farmers alike.

Narayanamoorthy (1997) reported that the drip method of irrigation helps reduce the over-exploitation of groundwater, mitigating the environmental issues often associated with surface irrigation such as waterlogging and soil salinity.

Narayanamoorthy (2003, 2005) and Postel et al. (2001) found that drip irrigation significantly reduces water use by 30-70%, while improving yields and profits, particularly in water-intensive crops such as sugarcane, grapes, and banana.

Qureshi (2001), Sivanappan (2002), and Namara et al. (2005) highlighted that drip irrigation not only conserves water but also reduces tillage needs, increases fertilizer-use efficiency, and enhances product quality. **Reddy and Satyanarayana (2005)** demonstrated that micro-irrigation could achieve irrigation efficiencies of up to 95%, compared to 50-70% under traditional surface methods.

6.2. Technological Efficiency and Economic Impacts

Kumar (2005) identified that the adoption of micro-irrigation systems is influenced by economic and institutional factors such as electricity pricing, access to credit, and the availability of technical support.

Dhawan (2008) consolidated findings from several earlier studies (including Narayanamoorthy, Qureshi, and Namara) and confirmed that drip irrigation systems consistently enhance water-use efficiency and farm incomes, particularly in groundwater-dependent regions.

Suresh Kumar and Palanisami (2010) further found that drip irrigation increases the irrigated area and cropping intensity. In their study, the proportion of area irrigated by wells to total cropped area increased from 82% to 98% after drip irrigation adoption. Similarly, **Palanisami, Mohan, Kakumanu, and Raman (2011)** observed that although micro-irrigation has expanded in India, adoption levels remain below potential due to high installation costs, limited technical knowledge, and inconsistent subsidy schemes. They recommended a uniform subsidy structure and improved training to boost adoption rates.

6.3. Contemporary Studies (2020-2024)
Recent research continues to confirm the positive impacts of drip irrigation on productivity, profitability and environmental sustainability.

Bhattacharya and Bar (2024) conducted a comparative analysis of micro-irrigation systems in India and concluded that drip irrigation has become an indispensable tool for addressing water scarcity and improving agricultural resilience. Their study emphasized that drip irrigation enhances water, energy, and fertilizer efficiency, generates rural employment, and stabilizes farm incomes across various agro-climatic zones.

Banik and Korav (2024) examined drip irrigation in wheat and vegetable cultivation and reported significant improvements in crop growth parameters such as plant height, leaf area index, and dry matter accumulation. They observed that drip irrigation increased water productivity while reducing water use per unit of production by nearly 50% compared with conventional flood irrigation.

Ravi Kumar, Reddy and Rao (2023) analyzed the economic and environmental benefits of drip irrigation in south India and found that drip systems led to 25-35% higher yields, 30-40% lower energy consumption, and considerable fertilizer savings in horticultural crops like chilli, mango and citrus. Similarly, **Patel and Singh (2022)** found that drip irrigation improved water-use efficiency by 60-70% and reduced fertilizer leaching losses by up to 35%, particularly in semi-arid regions cultivating vegetables such as tomato and brinjal.

6.4. Synthesis of Literature
The reviewed literature consistently demonstrates that drip irrigation contributes significantly to improving agricultural productivity, water conservation, and input-use efficiency. The technology reduces cultivation costs, optimizes resource utilization, and enhances the sustainability of farming systems. Despite its proven advantages, the adoption of drip irrigation remains uneven across India due to constraints such as high initial costs, inadequate awareness, and regional disparities in subsidy structures.

Given Telangana's rapid expansion of micro-irrigation coverage from under 1 lakh hectare in 2003-04 to over 8.3 lakh hectares by 2022-23. The present study aims to provide an empirical, village-level assessment of the impact of drip irrigation on productivity and resource efficiency in Khammam District. Such localized analyses are crucial for understanding how state-level investments in micro-irrigation translate into tangible outcomes for small land marginal farmers.

MAIN FINDINGS OF THE STUDY

Socio- Economic Conditions of Farmers Adopted Drip Irrigation Systems:

This section interprets the socio-economic conditions of the farmers who adopted drip irrigation systems in Penuballi and Sathupally Mandal of Khammam Districts, Telangana State, based on the data collected from 20 sample farmers across seven villages. The analysis provides insights into demographic, social, educational and economic characteristics that influence adoption behaviour.

1. Demographic Composition

A total of 20 farmers were studied in which 17 are male and 3 are female spread across seven villages in Penuballi and Sathupally Mandal. In Penuballi, 12 respondents were selected (10 Male, 2 female), while in Sathupally, 8 respondents (7 male, 1 female) participated. This indicates that male farmers dominate the adoption of drip irrigation technology, with women playing a relatively minor role in its direct implementation. This can be observed in the table 2.

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Table. 2.
Mandal Wise and Village Wise farmers interviewed who adopted the Drip Irrigation System

Mandal Name	Villages	Male	Female	Total
Penuballi	Gangadevipadu	07	02	09
	Bayanna Gudem	02	00	02
	V.M. Banjar	01	00	01
	Village Total	**10**	**02**	**12**
Sathupally	Kakarlapalli	04	00	04
	Sathupally	01	01	02
	Satyam Peta	01	00	01
	Rangapuram	01	00	01
	Village Total	**07**	**01**	**08**
Total		**17**	**03**	**20**

Source: Field Survey 2024.

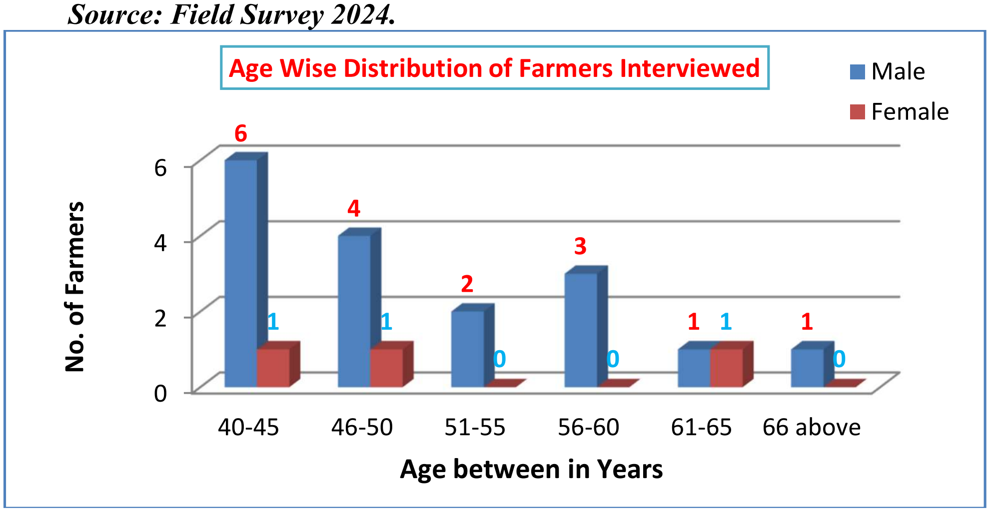
2. Age Distribution

The age profile of respondents shows that drip irrigation adopters are largely middle-aged farmers. About 35% fall within 40-45 years, 25% between 46-50 years, 15% between 51-55 years, and only 10% are above 60 years. This suggests that farmers in their productive age group (40-55 years) are more inclined toward adopting modern irrigation technologies like drip systems, possibly due to greater risk-taking ability, ability, awareness, and adaptability. This can be observed in the table 3.

Table. 3.
Age Wise Distribution of Farmers Interviewed

Age Between in Years	Male	Female	Total
40-45	06	01	07
46-50	04	01	05
51-55	02	00	02
56-60	03	00	03
61-65	01	01	02
66 and above	01	00	02
Total	**17**	**03**	**20**

Source: Field Survey 2024.



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3. Social Composition

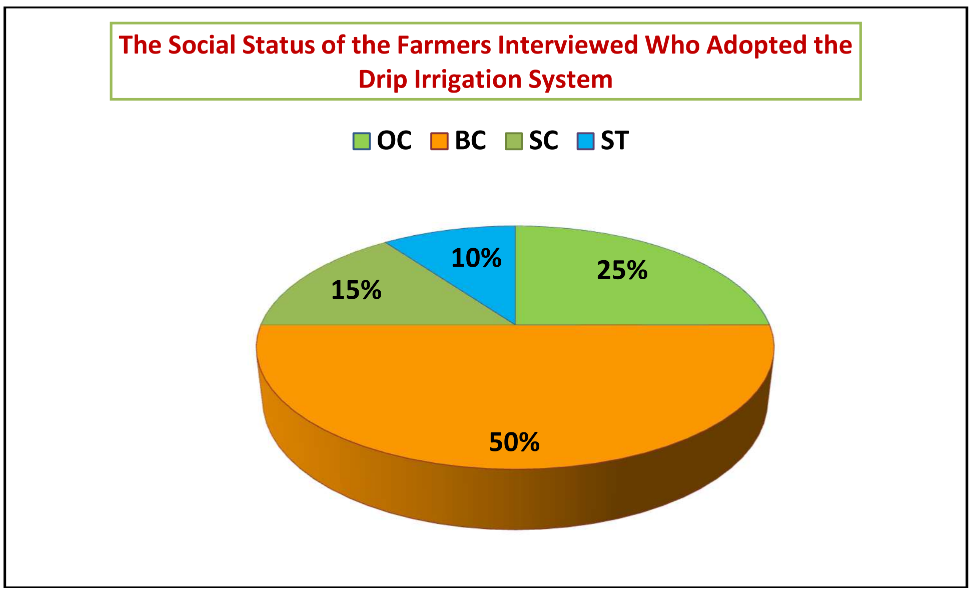
Caste-wise distribution shows that 50% of adopters belong to Backward Classes (BC), 25% to Other Castes (OC), 15% to Scheduled Caste (SC) and 10% to Scheduled Tribes (ST). This reveals that middle and lower socio-economic groups, particularly BCs, are leading in adopting drip irrigation, likely due to government outreach and subsidy support. However, the representation of SCs and STs remains comparatively low. This can be observed in the table 4.

Table. 4.

The Social Status of the Farmers Interviewed Who Adopted the Drip Irrigation System

Mandal Name	OC	BC	SC	ST	Total
Penuballi	00	08	03	01	12
Sathupally	05	02	00	01	08
Total	**05 (25%)**	**10 (50%)**	**03 (15%)**	**02 (10%)**	**20 (100%)**

Source: Field Survey 2024.



4. Educational Background

The literacy levels indicate a moderate educational base among adopters. Around 30% studied up to 6^{th}-10^{th} class, 30% completed Intermediate, 10% hold Degree or above, 20% are illiterate, and 10% have only primary education. This shows that education positively correlates with the adoption of new technologies like drip irrigation. Farmers with secondary or higher education appear more open to modern agricultural practices. This can be observed in the table 5.

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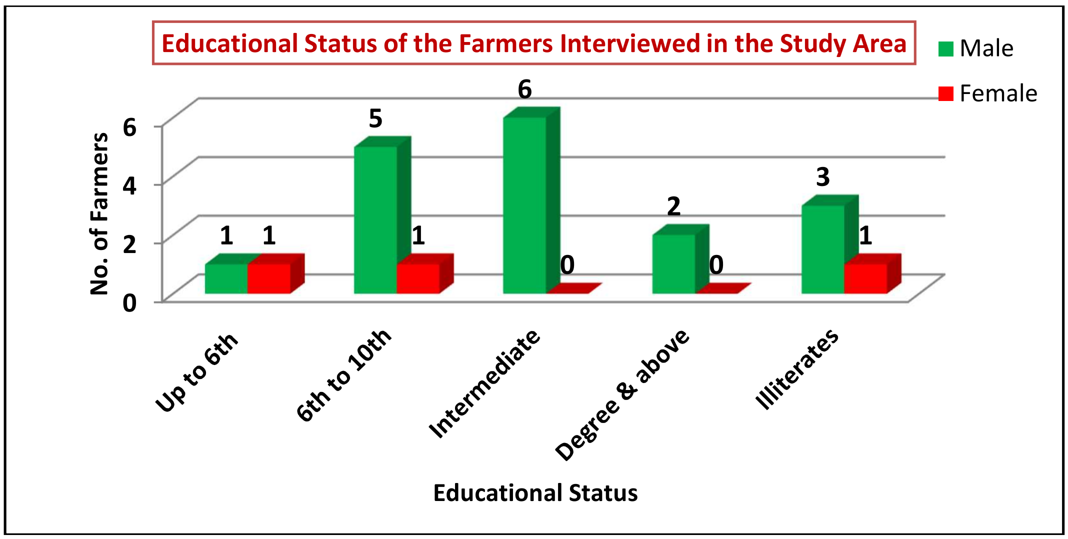
Table. 5.
Educational Status of the Farmers Interviewed in the Study Area

Mandal Name	Gender	Up to 6th class	6th to 10th	Intermediate	Degree & above	Illiterates	Total
Penuballi	Male	0	02	05	01	02	10
	Female	0	01	00	00	01	02
	Total	**0**	**03**	**05**	**01**	**03**	**12**
Sathupally	Male	01	03	01	01	01	06
	Female	01	00	00	00	00	01
	Total	**02**	**03**	**01**	**01**	**01**	**08**
Total	Male	01	05	06	02	03	17
	Female	01	01	00	00	01	03
	Total	**02**	**06**	**06**	**02**	**04**	**20**

Source: Field Survey 2024.



5. Landholding Pattern

Land distribution data (Table 5) reveal that 65% of farmers own less than 5 acres, 15% own 5-10 acres, 10% own 10-15 acres, and only 10% own 15 acres or more. This indicates that small and marginal farmers are the major adopters of drip irrigation systems. The technology has become accessible beyond large-scale farmer, suggesting the effectiveness of subsidies and awareness efforts. This can be observed in the table 6.

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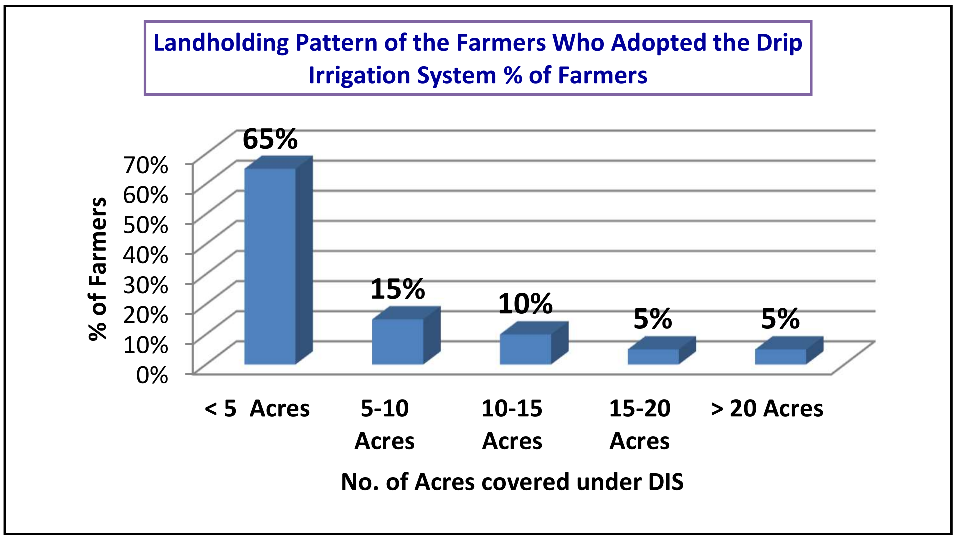
Table. 6.
Landholding Pattern of the Farmers Who Adopted the Drip Irrigation System

Sl. No	No of Acres covered under Drip Irrigation System	No of Farmers	Percentage of Farmers
1	Less than 5 Acres	13	65%
2	5 to 10 Acres	03	15%
3	10 to 15 Acres	02	10%
4	15 to 20 Acres	01	5%
5	20 Acres and above	01	5%
	Total	**20**	**100%**

Source: Field Survey 2024.



6. Access to Subsidy

According to Table 6, 55% of farmers received subsidies for installing drip systems, while 45% did not. This demonstrates that government subsidy schemes significantly influence adoption. However, nearly half of the adopters installed drip systems without subsidy, indicating that farmers recognize the economic and water-use benefits of drip irrigation, even without financial assistance. This can be observed in the table 7.

Table. 7.
Distribution of Farmers According To the Subsidy Received For the Adoption of the Drip Irrigation System.

Sl. No.	Subsidy	No of Farmers	Percent of Farmers received the subsidy
1	Subsidy Received	11	55%
2	Subsidy Not received	09	45%
	Total	20	100%

Source: Field Survey 2024.

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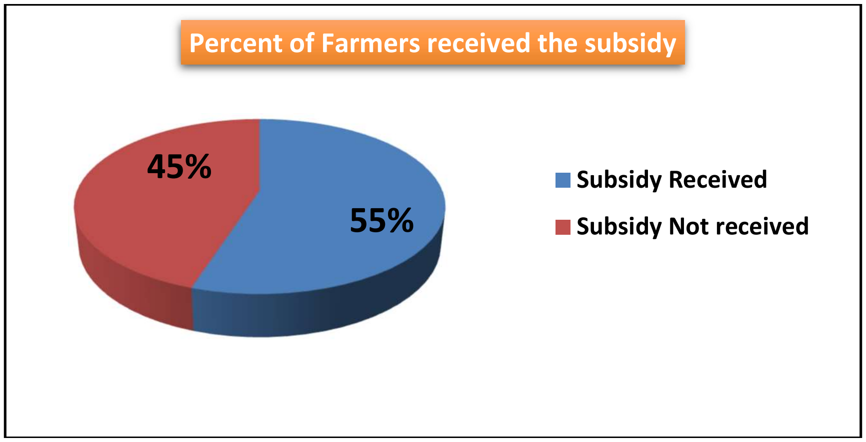


7. Summary of Socio-Economic Insights

The adoption of drip irrigation in the study area is male-dominated and concentrated among middle-aged BC farmers. Education and small landholdings are key characteristics of adopters, showing that awareness and farm size are not major barriers. Government subsidy programs play a vital role in technology adoption, while increasing independent uptake indicates growing awareness of the system's benefits.

The socio-economic profile of farmers adopting drip irrigation in Khammam District suggests that the technology has reached a diverse cross-section of the rural community. It is no longer confined to wealthy or large-scale cultivators. The results indicate that education, moderate income levels, and institutional support through subsidies are critical determinants of adoption. Strengthening awareness programs, training and timely subsidy disbursement could further enhance adoption and sustainability of drip irrigation systems in Telangana.

Impact Assessment of Drip Irrigation

The present study assesses the impact of drip irrigation on agricultural productivity, input use efficiency, and farm economics in the Penuballi and Sathupally Mandals of Khammam District, Telangana. The data collected from 20 farmers provide valuable insights into the benefits of drip irrigation on cropping intensity, cost efficiency, yield improvement, and resource conservation.

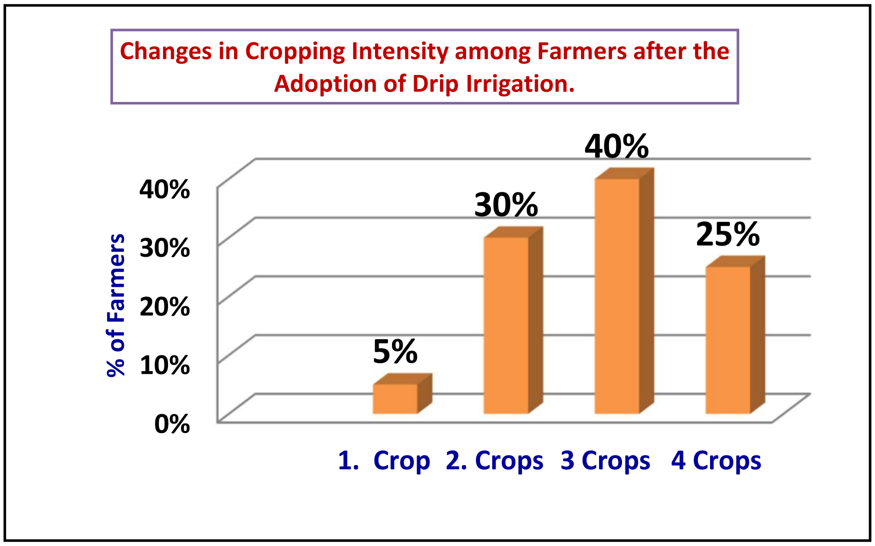
1. Cropping Intensity and Number of Crops per Year

The introduction of drip irrigation has enabled farmers to cultivate multiple crops within a year, reflecting improved water availability and soil moisture management. About 40% of farmers' cultivated three crops annually, 30% grew two crops and 25% managed four crops per year, while only 5% saw no change. This demonstrates a clear increase in cropping intensity due to the assured and efficient water supply provided by drip systems. Drip irrigation helps extend the growing season and supports diversification toward high-value crops, particularly vegetables, leading to improved farm income stability.

Table. 8.
Changes in Cropping Intensity among Farmers after the Adoption of Drip Irrigation.

Sl. No	Number of crops cultivated in Year	Number of Farmer	Percent of Farmers
1	1. Crop	01	5%
2	2. Crops	06	30%
3	3 Crops	08	40%
4	4 Crops	05	25%
	Total	**20**	**100%**

Source: Field Survey 2024.



2. Reduction in Cultivation Expenditure

Drip irrigation significantly reduced the cost of cultivation. Around 35% of farmers reported a decrease of Rs.5,000 per acre per crop, 25% reduced costs by Rs.15,000-Rs.20,000 and 10% achieved reduction beyond Rs.20,000 per acre. The decline is mainly due to lower consumption of water and fertilizers, reduced labor for irrigation and weeding, and decreased power consumption land maintenance costs. Consequently, cost economies have become a key driver behind the sustained adoption of drip systems.

Table 9.
Reduction in Cultivation Expenditure per Acre per Crop after the Adoption of Drip Irrigation.

Sl. No.	Range of Cultivation Cost Decreased per crop per acre	No. of Farmers	% of Farmers
1	Up to 5000	02	10%
2	5001 to 10000	07	35%
3	10001 to 15000	04	20%
4	15001 to 20000	05	25%
5	20001 and above.	02	10%
Total		**20**	**100%**

Source: Field Survey 2024.

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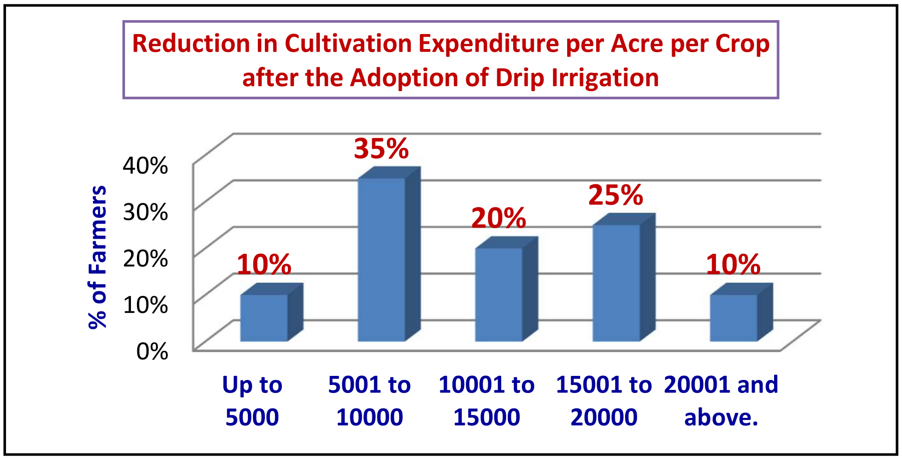


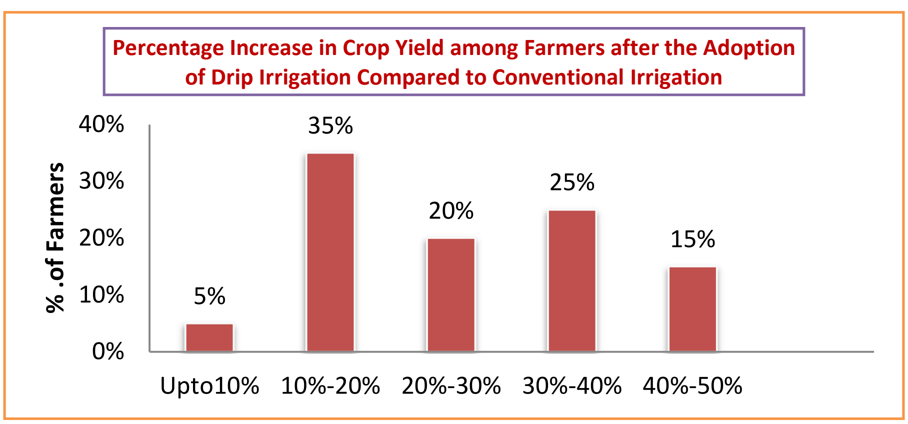
3. Increase in Crop Yield

A major benefit observed is the significant rise in crop yield following the adoption of drip irrigation, 35% of farmers experienced yield increases of 10-20%, 25% between 30-40%, and 15% between 40-50%. Overall, yield gains ranged between 10% and 50% across crops, particularly in vegetables and fruit crops. The increase is attributed to uniform and optimal soil moisture conditions, controlled nutrient delivery through fertigation, and reduced crop stress. Thus, drip irrigation enhances both productivity and crop quality.

Table 10.
Percentage Increase in Crop Yield among Farmers after the Adoption of Drip Irrigation Compared to Conventional Irrigation

Sl. No.	Percent of out put increased after aadoption of drip irrigation system	No of farmers	Percnage of Farmers
1	Up tp 10%	1	5%
2	10% to 20%	7	35%
3	20% to 30%	4	20%
4	30% to 40%	5	25%
5	40% to 50%	3	15%
	Total	20	100%

Source: Field Survey 2024.



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4. Fertilizer Efficiency and Cost Reduction

Farmers observed a 20-50% reduction in fertilizer use with drip irrigation. The precise fertigation process delivers nutrients directly to the crop's root zone, reducing losses through leaching and volatilization. This efficiency results in higher nutrient uptake, reduced wastage land environmental pollution, and lower overall input costs. On average, fertilizer use efficiency improved by 440-70%, depending on the crop type.

Table. 11.
Percentage Reduction in Fertilizer Use under Drip Irrigation Compared to Conventional Irrigation.

Sl. No.	Percentage Reduction in Fertilizer Use Under Drip Irrigation Compared to Conventional Irrigation	No Of Farmers	Percnage of Farmers
1	Up tp 10%	1	5%
2	10% to 20%	2	10%
3	20% to 30%	6	30%
4	30% to 40%	7	35%
5	40% to 50%	4	20%
	Total	**20**	**100%**

Source: Field Survey 2024.

5. Water Savings and Improved Water Use Efficiency

Drip irrigation provides precise and controlled water delivery to the root zone, minimizing deep percolation and runoff losses. Farmers reported 40-50% water savings compared to traditional irrigation. This system allows expansion of irrigated areas, cultivation of water-intensive crops, and reduction in weed growth due to localized watering. Hence, drip irrigation substantially improves water productivity, producing more output per unit of water, which is vital for water-scare regions like Telangana.

6. Energy (Electricity) Savings

Due to reduced water usage and automation, electricity consumption decreased significantly. Farmers noted shorter pumping hours and longer motor lifespan. Automation systems such as timers and sensors minimized energy waste and optimized irrigation timing. Overall, drip irrigation provides dual savings in water and energy, improving total resource-use efficiency.

7. Labour Cost Savings

Labour requirements declined because of the simultaneous application of water and fertilizers, reduced weed growth, and decreased need for manual irrigation. Farmers reported nearly 45% labor savings compared to traditional flood irrigation. Technologies such as mulching, automation, and soil moisture sensors further reduced manual work, allowing efficient management of larger farm areas.

8. Economic Viability and Cost Recovery

Despite the initial installation cost, drip irrigation has proven economically viable. Reduced costs of cultivation (by 7-28%), increased yields, and resource efficiency enable cost recovery within 3-5 years, even without subsides. This demonstrates that drip irrigation is a profitable long-term investment for small and medium-scale farmer.

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9. Soil Health and salinity Control

Drip irrigation improves soil conditions and nutrient balance by reducing nitrate leaching and controlling salinity. Better root-zone aeration and reduced waterlogging enhance soil fertility and sustain productivity in the long term. Thus, the system promotes sustainable soil management and environmental conservation.

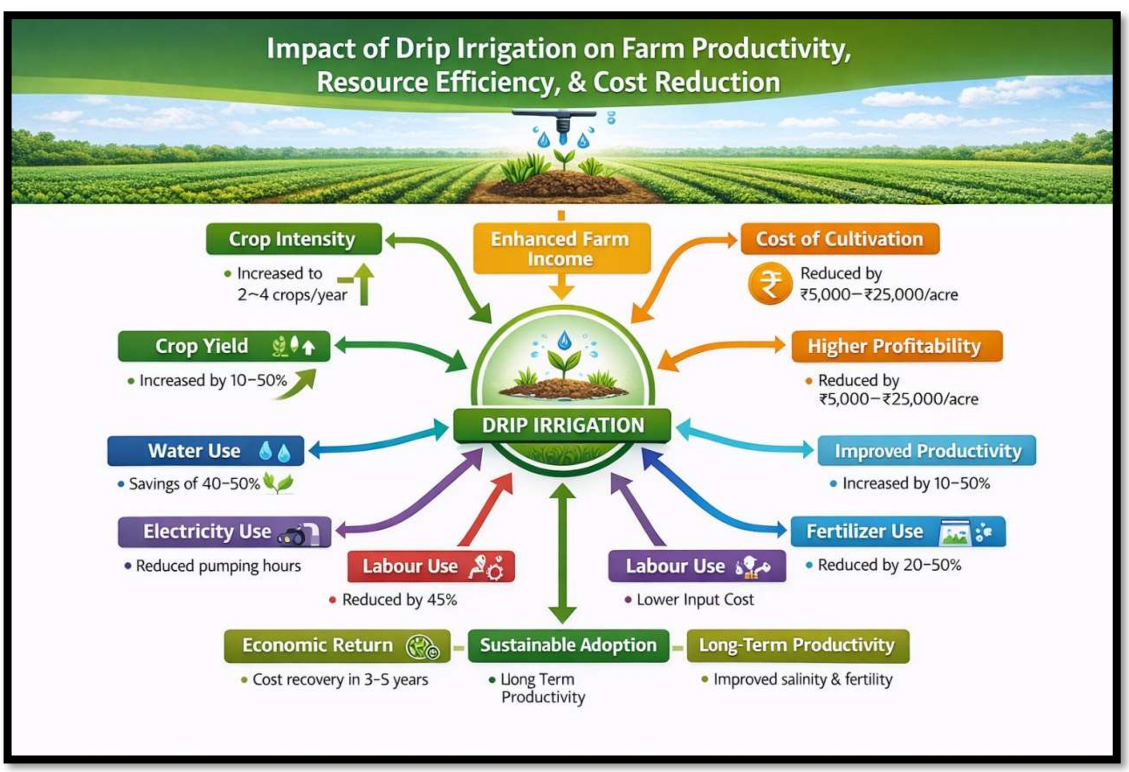
10. Overall Impact Summary

Table. 12.
Impact of Drip Irrigation on Farm Productivity, Resource Efficiency, &Cost Reduction

Sl.No.	Impact Area	Observation	Benefit
1	**Crop Intensity**	Increased to 2–4 crops/year	Enhanced farm income
2	**Cost of Cultivation**	Reduced by ₹5,000–₹25,000/acre	Higher profitability
3	**Crop Yield**	Increased by 10–50%	Improved productivity
4	**Fertilizer Use**	Reduced by 20–50%	Lower cost & pollution
5	**Water Use**	Savings of 40–50%	Better water efficiency
6	**Electricity Use**	Reduced pumping hours	Energy savings
7	**Labour Use**	Reduced by 45%	Lower input cost
8	**Economic Return**	Cost recovery in 3–5 years	Sustainable adoption
9	**Soil Health**	Improved salinity & fertility	Long-term productivity

Source: Field Survey 2024.

The impact assessment clearly established that the drip irrigation system significantly enhances agricultural efficiency across multiple dimensions- water, fertilizer, energy and labor. It not only improves crop productivity and profitability but also supports sustainable water management and soil health. In Telangana's semi-arid conditions, drip irrigation stands out as a transformative technology promoting climate-resilient agriculture, improved livelihood security, and environmental sustainability. This can also be observed in the following image.



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Conclusion and Suggestions

Conclusion

The study clearly demonstrates that the adoption of drip irrigation technology has significantly enhanced agricultural productivity, resource efficiency, and profitability among farmers. The system has led to an increase in the net sown and irrigated area, resulting in higher cropping intensity and more efficient utilization of available water resources. There is a noticeable shift in cropping pattern from traditional crops to high-value crops such as fruits, vegetables, sugarcane and other commercial crops. This change is primarily driven by water scarcity, rising labor costs, and the search for higher returns per unit of land and water.

The analysis of economic parameters revealed that drip irrigation considerably reduces the cost of cultivation, fertilizer and water usage and labour expenditure, while increasing crop yield and farm income. Moreover, the energy productivity under drip irrigation is significantly higher compared to conventional flood irrigation systems, making it both economically and environmentally sustainable.

Overall, the findings indicate that drip irrigation is a viable and profitable technology that not only enhances private farm income but also contributes to long-term sustainability by conserving critical natural resources such as water, and energy.

Suggestions

- **Uniform Subsidy Policy:** The current differential subsidy rates for different crops and regions lead to implementation challenges. The government should introduce a uniform subsidy structure across all districts and crop types to ensure fairness and ease of adoption.
- **Inclusive Access to Subsidies:** Many small and marginal farmers are still unable to afford drip lsystems even with partial support. The state government should ensure full or enhanced subsidies for smallholders and tenant farmers to make the technology more inclusive.
- **Awareness and Capacity Building:** A large number of farmers remain unaware of the long-term economic and environmental benefits of drip irrigation. Therefore, intensive awareness campaigns, demonstration farms, and training programs should be organized through agricultural extension departments and NGOs.
- **Maintenance and Aftercare Support:** To sustain the benefits, farmers require guidance on the operation, maintenance, and troubleshooting of drip systems. The establishment of local service centers or community-level technicians can ensure continued systems efficiency and longevity.
- **Integration with Fertigation and Automation:** Farmers should be encouraged to integrate fertigation and automation technologies with drip irrigation to further reduce fertilizer loss and labor requirements. The use of timers, soil moisture sensors, and mobile-based irrigation scheduling apps can make the systems more efficient.
- **Water Resource Management:** Drip irrigation should be promoted as part of a comprehensive water management strategy. Community-level micro-irrigation clusters and water-user associations can help optimize water distribution and maintenance.
- **Financial and Institutional Support:** Banks and rural financial institutions should continuously monitor the field performance of drip systems and develop region-specific designs and crop packages that maximize water-use efficiency and economic returns.

In summary, drip irrigation is not merely a technological innovation but a transformative solution for sustainable agriculture. By combining policy support, farmer education, and technological integration, the adoption of drip irrigation can significantly improve farm-level productivity, income security, and environmental resilience, particularly in water-scarce regions like Telangana.

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