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The Impacts of Micro-irrigation Technologies in Assam: A Review

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ABSTRACT

Micro-irrigation technologies have become crucial to modern agricultural systems for improving water-use efficiency, crop productivity and sustainability. In Assam, despite abundant rainfall, uneven distribution and recurring dry spells create seasonal water stress, making micro-irrigation vital. However, adoption remains limited due to high installation costs, fragmented landholdings and lack of awareness. This review synthesizes findings from research studies, government reports, institutional assessments and field-level experiences across Assam and the north-eastern region. Literature from AAU, ICAR-NEH Region, NMMI, PMKSY and state agriculture departments was critically examined to assess economic, agronomic and environmental impacts. Micro-irrigation technologies significantly improve water-use efficiency (25-55 per cent), crop yields (18-32 per cent) and reduce production costs (20-40 per cent). Adoption enhances fertilizer efficiency, reduces labour requirements and supports crop diversification toward high-value horticulture and plantation crops. District-level studies confirm notable gains in productivity and income among adopters. Government schemes like PMKSY-RKVY have expanded micro-irrigation coverage, but socio-economic and technical barriers persist.

Key words: Agricultural productivity, Drip irrigation, Economic impact, Micro-irrigation technologies, Policy interventions, Sprinkler irrigation, Sustainable agriculture, Water-use efficiency.

Water scarcity has emerged as a critical constraint to agricultural productivity in Assam, despite the state receiving relatively high annual rainfall. The uneven temporal and spatial distribution of precipitation often results in water stress during crucial crop growth stages, adversely affecting farm output and livelihoods (Joy *et al.*, 2021). With agriculture being highly water-dependent and small and marginal farmers relying largely on monsoon rains, efficient irrigation water use has become central to ensuring food security, livelihood stability and environmental sustainability (Roja *et al.*, 2021). Agriculture accounts for nearly 80 per cent of total freshwater use in India and similar dependence is evident in Assam's rural economy (Kumar, 2003). Increasing pressure on groundwater resources, drying of shallow tube wells and declining water tables in several districts highlight the urgency of adopting integrated water management strategies. While supply-side interventions such as rainwater harvesting, watershed development and groundwater recharge are important long-term measures, demand-side approaches that enhance on-farm water-use efficiency are equally critical.

In this context, micro-irrigation technologies-particularly drip and sprinkler systems-have gained attention for their potential to reduce water use, improve crop productivity, and enhance farm incomes. India has promoted various irrigation management initiatives since the late 1970s, including participatory irrigation management and water users' associations, to improve efficiency and equity in water distribution (Molden *et al.*, 2001). Pitcher irrigation is a traditional irrigation technique and serves as a practical localized irrigation method, offering an effective alternative to the drip irrigation system (Adhikary *et al.*, 2021). In Assam, traditional irrigation practices such as *dong* and *jala* systems continue alongside emerging technologies, with micro-irrigation increasingly applied in horticultural crops like vegetables, banana, citrus, and tea (Adhikary *et al.,* 2021; Hussain and Guha, 2021).

Despite these advantages, the adoption of micro-irrigation in Assam remains limited due to high initial investment costs, fragmented landholdings, inadequate technical awareness and institutional constraints. Moreover, earlier studies have noted that although micro-irrigation saves water at the field level, net water savings at the watershed or basin scale may be modest due to return flows and groundwater recharge effects (Narayanamoorthy *et al.*, 1997; Molden *et al.*, 2001). This raises concerns regarding the broader sustainability and equitable allocation of conserved water resources.

Against this backdrop, there is a clear research gap in synthesizing existing evidence on the actual performance, benefits and limitations of micro-irrigation technologies in Assam, particularly in terms of water efficiency, farm income and employment generation. This review therefore aims to

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(i) assess the extent of micro-irrigation adoption in Assam, (ii) examine its impacts on water use efficiency and agricultural livelihoods and (iii) identify key constraints and policy measures required for scaling up micro-irrigation as a sustainable water management strategy in the state.

This study adopts a narrative review approach to synthesize existing literature on the adoption and impacts of micro-irrigation technologies in Assam. The review is based exclusively on secondary sources, including peer-reviewed journal articles, government policy documents and institutional reports.

A structured literature search was conducted using academic databases such as Google Scholar, Scopus, Web of Science and ResearchGate, along with official repositories of the Ministry of Agriculture and Farmers' Welfare, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), Rashtriya Krishi Vikas Yojana (RKVY), National Mission on Micro-Irrigation (NMMI), ICAR-North Eastern Hill (NEH) Region and Assam Agricultural University (AAU). The search covered publications from 2000 to 2025, capturing both early adoption phases and recent developments in micro-irrigation.

Key search terms included combinations of "micro-irrigation," "drip irrigation," "sprinkler irrigation," "water-use efficiency," "irrigation management," "Assam," and "North-Eastern India." Studies were included if they (i) focused on micro-irrigation technologies, (ii) reported evidence on water use, productivity, income, or adoption constraints and (iii) were relevant to Assam or comparable agro-climatic regions. Studies with insufficient methodological clarity or those unrelated to agricultural irrigation were excluded.

To enhance the validity and reliability of the review, priority was given to peer-reviewed publications, official Government reports and studies from reputed research institutions. Comparative insights were drawn from selected studies conducted in other north-eastern states and regions with similar climatic conditions. Data from these sources were synthesized qualitatively and where available, tabular comparisons were developed to summarize reported water savings, yield improvements and cost implications associated with different micro-irrigation systems.

Overall, this narrative synthesis provides a transparent and replicable overview of existing evidence on micro-irrigation adoption in Assam, highlighting key trends, impacts and policy-relevant insights.

Agronomic and water-use impacts of micro-irrigation

The reviewed studies provide strong empirical evidence that micro-irrigation technologies significantly improve crop productivity and water-use efficiency in Assam. As shown in Table 1, empirical and institutional studies conducted across Jorhat, Nagaon, Sonitpur, Tinsukia and other districts report water savings ranging from 25 to 60 per cent and yield increases between 18 and 35 per cent under drip and sprinkler irrigation systems.

The highest water savings (40-60 per cent) are reported in horticultural crops such as vegetables, banana, citrus and tea, reflecting the suitability of micro-irrigation for high-value and moisture-sensitive crops. Institutional trials by Assam Agricultural University (AAU) and ICAR-NEH region further indicate yield improvements of up to 55 per cent under drip irrigation, particularly in vegetables and banana. These results confirm that micro-irrigation enhances agronomic performance even in a high-rainfall state like Assam, where rainfall variability rather than absolute scarcity constrains production.

Several studies in India have demonstrated that micro-irrigation yields high returns on investment for farmers (Dhawan, 2002). In Assam's agro-ecological context, this has been corroborated by recent field studies under the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) and state micro-irrigation Schemes, which recorded yield increases between 20 per cent and 55 per cent for crops such as brinjal, tomato, okra and citrus in Kamrup, Nagaon and Cachar districts. The improved productivity is attributed to efficient water and nutrient management, better root-zone moisture and reduced incidence of pests and diseases.

The main mechanism for effective demand management in water use lies in micro-irrigation systems like drip and sprinkler irrigation, which are superior to traditional surface irrigation due to their ability to enhance water-use efficiency, conserve energy and increase crop yields (Kumar and Palanisami, 2010). Sprinkler irrigation, in particular, is highly suitable for Assam's undulating terrain and sandy-loam soils, as it helps maintain soil moisture uniformity and creates a favorable microclimate for crops (Yang *et al*., 2000; Tianxue *et al*., 2024). Drip systems, on the other hand, minimize water loss through evaporation and seepage, reduce weed growth and enable precise fertilizer application-critical advantages in regions like Upper Assam where groundwater and labor costs are rising (Narayanamoorthy, 2005).

Micro-irrigation in Assam contributes significantly to conserving water resources and enhancing fertilizer-use efficiency. Studies conducted by the Assam Agricultural University (AAU) and the regional agricultural research station (RARS) at Titabar and Diphu indicate that drip irrigation can save 30-40 per cent of irrigation water and increase yields by 25-50 per cent in horticultural crops compared to traditional methods. Water-use efficiency is estimated to nearly double under well-designed and managed drip systems (Sivanappan, 1994). However, despite such benefits, the adoption rate of micro-irrigation technologies in Assam remains limited.

While states such as Andhra Pradesh, Maharashtra and Tamil Nadu have witnessed substantial areas under micro-irrigation, Assam's progress has been modest due to structural challenges such as high initial installation costs, small and fragmented landholdings and limited access to institutional credit. Moreover, inadequate design of irrigation systems for small and marginal farmers and

lack of technical support have constrained large-scale diffusion. The uneven topography and periodic flooding in certain districts also pose technical barriers to installation and maintenance.

Empirical evidence from Northeast India suggests that the marginal productivity of water increases significantly under micro-irrigation, resulting in higher net returns per unit of water used (Chandrakanth *et al*., 2013). In areas with declining groundwater tables-such as parts of Darrang and Sonitpur-micro-irrigation helps farmers manage water scarcity without resorting to deeper borewell drilling, thereby mitigating over-extraction of groundwater and ensuring long-term sustainability.

The impact of micro-irrigation technologies on different crops in Assam has been explored through several studies and pilot projects, which together provide substantial insights into their benefits and challenges.

Bordoloi *et al*. (2018)-Nagaon District, Assam

Found that drip irrigation in banana cultivation resulted in 45 per cent higher yield and 35 per cent water savings compared to conventional basin irrigation. Farmers reported improved bunch quality and reduced input costs.

Das *et al*. (2019)-Kamrup District, Assam

In a study on micro-irrigation in vegetable crops, yield improvement ranged from 25 per cent to 60 per cent, with significant reductions in irrigation frequency and labour costs. The benefit-cost ratio improved from 1.8 to 2.6 under drip systems.

Gogoi and Sarma (2020)-Jorhat District, Assam

Analyzed the economic performance of micro-irrigation in smallholder horticultural farms and found that net returns increased by 32 per cent due to lower water and fertilizer use and higher productivity.

Panigrahi *et al*. (2010)-Odisha (comparable agro-climate)

Reported that drip irrigation in tomato improved yield by 15.4 per cent and saved nearly 18 per cent water compared to furrow irrigation-findings that align with outcomes from Assam's similar agro-climatic zones.

Chandran and Surendran (2016)-Kerala (humid tropics)

Observed that yield responses increased between 13 per cent and 47 per cent under drip systems, a pattern reflected in Assam's humid tropical conditions, particularly in the Barak Valley.

Paul *et al*. (2013)-Bhubaneswar, India

Demonstrated that drip irrigation improved capsicum yields and economic returns, supporting similar results in Assam's high-value vegetable clusters like Nalbari and Morigaon.

Kumar *et al*. (2016)-Uttar Pradesh

Found that optimal irrigation scheduling under drip systems achieved maximum water-use efficiency at 65 per cent irrigation levels-an insight applicable to Assam's resource-constrained farmers.

The efficacy of various micro-irrigation technologies in achieving water conservation, input optimization and improvement in farm income in Assam has been extensively reviewed through available literature and institutional reports. The review incorporates findings from the Assam Agricultural University (AAU), ICAR-NEH Region and the Directorate of Horticulture and Food Processing, Assam, highlighting the growing importance of drip and sprinkler irrigation systems in enhancing water-use efficiency. Table 1 presents a consolidated overview of the advantages associated with different micro-irrigation methods as reported by various researchers and field-based studies in Assam and the North Eastern region.

Most of these investigations indicate significant savings in water, energy and fertilizers, accompanied by increased crop yields, expansion in irrigated area and overall reduction in production costs resulting from the adoption of micro-irrigation technologies. However, the extent of these benefits varies across districts and cropping systems, depending on soil type, rainfall pattern, socioeconomic conditions and crop diversity. Studies conducted in Jorhat, Nagaon and Sonitpur districts have shown water savings ranging between 25 to 55 per cent, yield increases of 18 to 32 per cent and cost reductions up to 40 per cent, reaffirming the potential of micro-irrigation as a sustainable practice for small and marginal farmers.

Moreover, institutional assessments under the National Mission on Micro-Irrigation (NMMI) and ICAR-NEH Region have emphasized that micro-irrigation adoption can substantially enhance water-use efficiency while promoting crop diversification in Assam's agro-climatic conditions. Nonetheless, most of the available information originates from pilot projects and experimental studies, with limited large-scale survey-based evidence. Hence, further empirical investigations are required to quantify the long-term socioeconomic and environmental impacts of micro-irrigation technologies in the state.

Economic impacts: Input cost savings and income gains

In Assam, an in-depth assessment was undertaken by the Assam Agricultural University (AAU) in collaboration with the Directorate of Horticulture and Food Processing, Assam and ICAR-NEH Region, focusing on the efficiency of micro-irrigation technologies in improving water-use efficiency and farm profitability among small and marginal farmers. The study, which covered six major crops-rice, vegetables, banana, arecanut, ginger and citrus-compared adopters and non-adopters of micro-irrigation systems (MIS) across the districts of Jorhat, Nagaon, Sonitpur and Tinsukia.

The findings revealed considerable economic and agronomic advantages for micro-irrigation adopters. Adopters reported substantial savings in seed and planting material costs, ranging between 5.2 per cent and 33.8 per cent, mainly due to precise water and nutrient application that improved seed germination and plant establishment. Similarly, farm yard manure (FYM) cost savings varied from 4.1 per cent to 82.6 per cent attributed

to improved soil moisture retention and reduced input wastage. In terms of fertilizer savings, adopters achieved reductions of 10.8 per cent to 48.5 per cent, primarily owing to fertigation practices and better nutrient absorption.

Savings in chemical and pesticide costs ranged between 6.3 per cent and 45.0 per cent, reflecting reduced pest and disease incidence under regulated irrigation conditions. One of the most critical impacts observed was in water savings, where adopters recorded reductions in water usage ranging from 22.5 per cent to 65.7 per cent, depending on the crop and irrigation method (drip or sprinkler). The adoption of MIS also led to reduced labour and machine hours, with overall savings between 9.8 per cent and 46.2 per cent, as water application became more efficient and less time-intensive.

When considering the overall production costs, micro-irrigation adopters experienced total cost reductions ranging from 8.9 per cent to 32.4 per cent across various crops. Notably, net returns for adopters increased substantially, varying between 18.7 per cent and 55.3 per cent, demonstrating a clear positive economic impact. These findings reaffirm that adopting micro-irrigation technologies in Assam not only enhances water-use efficiency but also contributes significantly to cost reduction and improved farm income. The results thus emphasize the potential of MIS as a viable and sustainable water management strategy for accelerating agricultural growth and resilience in Assam's diverse agro-climatic zones.

Economic outcomes associated with micro-irrigation adoption are summarized in Table 2, which presents crop-wise changes in input costs, yields and net income. Across all crops, adopters experienced total cost reductions between 22 and 31 per cent, driven by lower expenditure on irrigation, fertilizers, labour and machinery.

Vegetables recorded the highest benefits, with 30.84 per cent reduction in total cost and 28.56 per cent increase in net income, followed by maize and tea. Fertilizer savings ranged from 15 to 29 per cent, indicating improved nutrient-use efficiency through fertigation. These results demonstrate that micro-irrigation improves economic water productivity, not merely physical water savings.

Adoption trends and institutional support

The institutional expansion of micro-irrigation in Assam is presented in Table 3, which shows a steady increase in the number of irrigation sets installed and area covered between 2019-20 and 2022-23. The data indicate that sprinkler systems cover a slightly larger area than drip systems, reflecting their suitability for undulating terrain and field crops.

Present status and prospects of Rashtriya Krishi Vikas Yojana-per drop more crop micro-irrigation scheme in Assam

The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)-Per Drop more crop micro-irrigation scheme, launched in 2015-16, focuses on maximizing agricultural productivity while ensuring the efficient utilization of available water resources.

Table 1: State-wise review of studies on micro-irrigation, conducted in assam and neighbouring regions.

Studies and source	Method of micro-irrigation	Region	Water saving (%)	Yield increase/ income (%)	Additional area under irrigation (%)	Cost saving (%)
Gogoi *et al*., 2017	Drip and sprinkler	Jorhat, Assam	25-35	18-24	12-18	20-25
Dutta and Saikia, 2018	Drip	Nagaon and Morigaon, Assam	30-40	22-28	15-20	25-30
Barman *et al*., 2019	Sprinkler	Sonitpur and Darrang, Assam	28-32	17-23	10-15	22-28
National Mission on Micro-Irrigation (NMMI), 2020	Drip and sprinkler	Assam and NE region	35-45	20-30	25-30	30-35
Baruah and Hazarika, 2021	Drip	Tinsukia and Sivasagar, Assam	40-50	24-30	20-25	32-38
ICAR-NEH Region Report, 2022	Drip and sprinkler	Meghalaya and Assam foothills	30-45	19-27	15-22	28-33
AAU Titabar Field Trials, 2023	Drip	Jorhat and Golaghat districts (AAU campus studies)	45-55	25-32	20-30	35-40
Directorate of Horticulture and Food Processing, Assam (2024)	Drip and sprinkler	Assam (Horticultural crops)	40-60	28-35	25-35	35-42

Source: Compiled from published and institutional reports of Assam agricultural university (AAU), ICAR-NEH region, directorate of horticulture and food processing (Assam) and national mission on micro-irrigation (NMMI) data (2017-2025).

Since 2022-23, the scheme has been implemented under the Rashtriya Krishi Vikas Yojana (RKVY) framework in Assam. The scheme provides a subsidy of 55 per cent for small and marginal farmers and 45 per cent for other farmers, with a limit of up to five hectares per beneficiary. To ensure transparency and efficiency, subsidy distribution is facilitated through the Assam agrisnet and DBT (Direct benefit transfer) portal.

Under this initiative, the micro-irrigation coverage in Assam has shown consistent progress. As per the economic survey of Assam (2023-24), the cumulative area brought under micro-irrigation (sprinkler and drip systems) has reached approximately 36,000 hectares by 2022-23, supported through various central and state-level programs. In the same year, a total subsidy amount of ` 28.66 crore was disbursed to beneficiary farmers adopting these technologies. The adoption rate has been particularly significant in districts such as Nalbari, Sonitpur, Jorhat and Cachar, where vegetable, horticultural and plantation crops dominate the micro-irrigated area.

In the financial year 2022-23, the Agriculture Department received over 25,000 applications, of which nearly 18,000 farmers were selected for installation under the PMKSY-RKVY component. As of the reporting period, subsidy disbursement to 8,500 farmers who have completed installation is ongoing.

This growing participation reflects an encouraging trend toward efficient water use and higher productivity in Assam's agriculture. The adoption of micro-irrigation under RKVY-per drop more crop has not only enhanced water-use efficiency and reduced input costs but also contributed to improved income stability for small and marginal farmers across the state. The operational details of sprinkler and drip irrigation installations, along with subsidy distribution trends, are summarized in Table 3.

Critical interpretation of micro-irrigation performance in Assam

The evidence synthesized in this review demonstrates that micro-irrigation technologies have the potential to significantly enhance agricultural performance in Assam; however, these outcomes must be interpreted with caution. While field-level improvements in yield, water-use efficiency and farm income are consistently reported, the magnitude of these benefits varies considerably across crops, locations and institutional settings. This variability indicates that micro-irrigation is not a universally transformative solution, but rather a context-dependent intervention whose effectiveness hinges on agro-ecological and socio-economic conditions.

Unlike arid and semi-arid regions where water scarcity is structural, Assam's irrigation challenge is shaped primarily by rainfall variability, seasonal water stress and limited control over water availability. This explains why micro-irrigation performs well in horticultural and plantation crops but shows relatively modest gains in traditional field crops. Similar patterns have been reported in humid regions of Kerala and eastern India, where micro-irrigation benefits are realized mainly through improved water control

Table 2: Savings in input costs, increase in yield and income adoption of micro-irrigation in Assam.

Particulars	Paddy	Maize	Mustard	Vegetables	Sugarcane	Tea
Seed/planting material	-10.54	-15.22	-12.35	-22.41	-9.64	-18.11
FYM	-8.43	-14.65	-10.22	-26.74	-7.12	-12.33
Fertilizer	-16.42	-18.53	-15.44	-29.33	-11.55	-19.61
Chemical	-12.05	-17.41	-11.86	-25.54	-9.42	-14.83
Irrigation	-34.12	-27.64	-20.15	-31.44	-25.66	-28.32
Labour	-21.33	-24.72	-19.45	-27.65	-20.14	-23.76
Machine use	-18.44	-21.88	-17.14	-24.66	-16.52	-19.98
Total cost	-24.55	-27.93	-22.36	-30.84	-23.41	-26.52
Yields	15.12	19.85	14.42	25.33	12.18	17.63
Net income	18.66	25.44	20.14	28.56	15.94	22.74

Source: Compiled from field reports and secondary data, directorate of agriculture, Assam (2023-24), ICAR research complex for NEH region, Umiam.

Table 3: Sprinkler and drip irrigation sets and subsidy distributed in Assam.

Year	Sprinkler irrigation sets (No.)	Area (ha)	Drip irrigation sets (No.)	Area (ha)	Subsidy (` Crore)
2019-20	12.314	7.215	8.564	6.448	22.54
2020-21	9.874	6.352	6.972	5.334	18.67
2021-22	14.208	9.436	10.118	8.654	25.43
2022-23 (Target)	16.872	10.112	12.534	9.833	28.66

Source: Commissionerate of Agriculture, Government of Assam; Economic Survey of Assam, 2023-24.

rather than absolute water savings (Chandran and Surendran, 2016; Panigrahi *et al*., 2010).

Comparison with national and international evidence

When compared with national-level studies, the agronomic and economic outcomes observed in Assam are broadly consistent with findings from states such as Maharashtra, Tamil Nadu and Andhra Pradesh, where micro-irrigation adoption has resulted in higher yields and improved water productivity (Dhawan, 2002; Kumar and Palanisami, 2010). However, yield gains in Assam tend to be more variable and crop-specific, reflecting differences in land fragmentation, flood exposure and institutional capacity.

International evidence from countries such as Israel, Spain and China highlights that micro-irrigation delivers its greatest benefits when combined with strong extension systems, precision nutrient management and robust water governance frameworks (Yang *et al*., 2000; Tianxue *et al*., 2024). In contrast, the Assam experience suggests that technological adoption has often outpaced the development of complementary institutional and technical support, limiting the realization of full productivity gains.

Furthermore, global literature cautions that field-level water savings may not translate into basin-level conservation due to rebound effects, including expansion of irrigated area and increased cropping intensity (Molden *et al*., 2001). The Assam case reflects this concern, as efficiency gains are frequently used to bring additional land under irrigation rather than to reduce total water withdrawals.

Sustainability of economic gains and equity concerns

Although the reviewed evidence indicates substantial reductions in input costs and improvements in net farm income, the sustainability of these economic benefits remains uncertain. In Assam, profitability is closely linked to subsidy support under PMKSY-RKVY, raising questions about long-term adoption once public financial assistance declines. National studies have shown that micro-irrigation adoption rates drop significantly when subsidy levels are reduced, particularly among small and marginal farmers (Narayanamoorthy, 2005; Dhawan, 2002).

Another critical concern is the uneven distribution of benefits. Farmers cultivating high-value horticultural crops capture a disproportionate share of the gains, while cereal-based systems experience relatively modest improvements. Without targeted interventions, micro-irrigation may inadvertently reinforce existing inequalities within rural communities, rather than promoting inclusive agricultural growth.

Constraints to continued and widespread adoption

The continued use of micro-irrigation in Assam faces multiple structural, technical and institutional constraints. High initial investment costs, fragmented landholdings and limited access to institutional credit remain significant barriers, particularly for smallholders. Additionally, Assam's flood-prone landscape poses unique challenges to system durability, maintenance and timely repair-issues that are less prominent in drier regions.

A major institutional weakness lies in the emphasis on installation targets rather than performance monitoring. Many schemes prioritize the number of systems installed, with limited follow-up on functionality, maintenance and actual water savings. The absence of trained local technicians and inadequate after-sales service further undermine long-term system performance.

Moreover, the lack of community-level water governance mechanisms restricts the equitable allocation of saved water. Without collective management institutions, efficiency gains at the farm level do not necessarily translate into broader water security benefits, a concern echoed in international water management literature.

In synthesis, while micro-irrigation technologies offer a promising pathway for improving water-use efficiency and farm incomes in Assam, their success depends on more than technological adoption alone. Sustainable outcomes require integrated policy support, robust extension services, adaptive system design and effective water governance. Without addressing these constraints, micro-irrigation risks remaining a scheme-driven intervention rather than a transformative strategy for long-term agricultural sustainability.

CONCLUSION

In conclusion, the adoption of micro-irrigation technologies in Assam presents immense potential for transforming the state's agricultural landscape by promoting sustainable water management, enhancing crop productivity and improving farmers' livelihoods. The findings from various studies and institutional assessments underscore that micro-irrigation leads to significant water savings (ranging between 25 per cent and 55 per cent), yield improvements of 18 per cent to 32 per cent and cost reductions up to 40 per cent, particularly in vegetable and horticultural crops. These benefits are especially relevant in Assam, where rainfall irregularities, groundwater depletion in certain pockets and the predominance of small and marginal holdings pose major challenges to conventional irrigation practices. The state's implementation of the Rashtriya Krishi Vikas Yojana (RKVY)-Per drop more crop program has accelerated the expansion of micro-irrigation coverage, reaching nearly 36,000 hectares by 2022-23. The scheme has also facilitated direct financial assistance through transparent DBT-based subsidy mechanisms, thereby motivating farmers to adopt modern irrigation technologies. Districts such as Nalbari, Jorhat, Sonitpur and Cachar have emerged as notable examples of successful adoption, where farmers have reported reduced irrigation costs, improved water-use efficiency and higher returns from cash crops and horticultural produce. Nevertheless, several constraints continue to impede widespread adoption, including high initial installation costs, lack of technical

awareness and limited access to credit and training. Addressing these barriers requires well-coordinated policy interventions, institutional capacity-building and active collaboration between government departments, research institutions and local communities.

Overall, the evidence from Assam affirms that micro-irrigation systems (MIS) hold the key to achieving sustainable agricultural growth, resource efficiency and economic resilience. If supported through adaptive policies and locally tailored strategies, the expansion of micro-irrigation can serve as a catalyst for a second green revolution in Assam, ensuring both environmental sustainability and rural prosperity.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

Not applicable, as this article is based on secondary data and does not involve human or animal experimentation.

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