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# Recent Trends in Minor Irrigation in Indian Agriculture: Emerging Patterns, Policy Initiatives and Sustainability Challenges

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***Abstract-* *Minor irrigation has emerged as a critical component of agricultural development in India, particularly because of its decentralized nature and strong dependence on groundwater resources. This study examines the recent trends, structural transformation, policy developments and sustainability challenges in India's minor irrigation sector. The study is descriptive and analytical in nature and is based exclusively on secondary data obtained from the Sixth Minor Irrigation Census, Central Ground Water Board, Department of Agriculture and Farmers Welfare, Ministry of Jal Shakti, NABARD and related government reports. The findings indicate that India had 23.14 million minor irrigation schemes, of which 94.8 per cent were groundwater-based, demonstrating the dominant role of decentralized groundwater irrigation. Wells and tube wells together accounted for approximately 62.8 per cent of the country's net irrigated area in 2022–23. At the same time, irrigation development is increasingly shifting towards efficient water-use technologies, particularly drip and sprinkler irrigation. The coverage under the Per Drop More Crop programme reached 114.60 lakh hectares by May 2026, reflecting growing policy emphasis on water-use efficiency. However, increasing groundwater dependence presents significant sustainability concerns. Agriculture accounted for 87 per cent of total groundwater extraction in 2024, while 751 groundwater assessment units were classified as over-exploited. The study also highlights the growing importance of groundwater recharge, restoration of traditional water bodies, renewable-energy-based irrigation and participatory groundwater governance. It concludes that the future development of minor irrigation requires a shift from merely expanding irrigation infrastructure towards improving water productivity, strengthening aquifer management, promoting micro-irrigation, encouraging water-saving cropping patterns and ensuring equitable access to irrigation technologies. Such an integrated approach is essential for maintaining agricultural productivity while addressing the long-term ecological and hydrological challenges associated with irrigation development in India.***

***Keywords:* *minor irrigation, groundwater, micro-irrigation, water-use efficiency, groundwater management, agricultural development***

## I. INTRODUCTION

Irrigation is one of the strategic inputs for agricultural transformation. A good irrigation system is vital for agricultural development and rural development. Agricultural production and productivity respond favorably to the timely irrigation facilities. This in turn increases the relative share of the agricultural sector in the State Domestic Product. It also generates gainful employment opportunities and confidence among the farming community. It stabilizes agricultural base and contributes immensely for the economic development of the country. In this context, minor irrigation has assumed particular significance because it allows irrigation facilities to be developed at relatively smaller spatial scales and is closely associated with individual farmers, farmer groups and local water resources.

The Government of India classifies minor irrigation schemes broadly into groundwater schemes—such as dug wells, shallow tube wells, medium tube wells and deep tube wells—and surface-water schemes, including surface-flow and surface-lift schemes. The Sixth Minor Irrigation Census, with reference year 2017–18, provides the latest completed comprehensive census of the sector. It identified 23.14 million minor irrigation schemes, of which 21.93 million (94.8%) were groundwater schemes and 1.21 million (5.2%) were surface-water schemes. Compared with the Fifth Minor Irrigation Census, the number of schemes increased by approximately 1.42 million; groundwater schemes increased by 6.9 per

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cent while surface-water schemes increased by 1.2 per cent.

The importance of minor irrigation has become even more pronounced because India's agricultural irrigation system is increasingly dependent on groundwater. According to the Department of Agriculture and Farmers Welfare, 49.34 per cent of India's net irrigated area in 2022–23 was irrigated through tube wells and another 13.46 per cent through other wells. Thus, wells and tube wells together accounted for approximately 62.8 per cent of net irrigated area. However, increasing groundwater dependence has created a major sustainability challenge. The Central Ground Water Board's 2024 assessment estimated total annual groundwater recharge at 446.90 billion cubic metres (bcm), annual extractable groundwater resources at 406.19 bcm, and annual groundwater extraction at 245.64 bcm. Agriculture alone accounted for 87 per cent, or 213.29 bcm, of total groundwater extraction.

Against this background, the present study examines the recent trends, structural transformation, policy developments and sustainability challenges in India's minor irrigation sector.

Objectives of the Study

The study has the following objectives:

1. To examine the structural pattern of minor irrigation in India.
2. To analyse the increasing importance of groundwater-based minor irrigation.
3. To examine the recent expansion of micro-irrigation technologies.
4. To suggest policy measures for sustainable and efficient minor irrigation development.

## II. METHODOLOGY

The study is descriptive and analytical and is based exclusively on secondary information. Major sources include: Sixth Minor Irrigation Census, Ministry of Jal Shakti, Irrigation Census publications of the Department of Water Resources, River Development and Ganga Rejuvenation, National Compilation on Dynamic Ground Water Resources of India, 2024, Central Ground Water Board, Annual Report 2024–25, Department of Agriculture and Farmers Welfare,NABARD reports on the Micro Irrigation Fund.

The analysis combines trend interpretation with selected indicators relating to the number and type of irrigation schemes, sources of irrigation, groundwater extraction, micro-irrigation coverage and government financial interventions.

Limitations

A limitation of the study is that the Seventh Minor Irrigation Census was launched in April 2025 and is still under implementation. Therefore, the Sixth Minor Irrigation Census remains the latest completed nationwide census and is used as the principal structural benchmark.

Recent Trends in Minor Irrigation

1 Continued expansion of minor irrigation schemes

The Sixth Minor Irrigation Census recorded 23.14 million minor irrigation schemes across India. This represented an increase of about 1.42 million schemes over the Fifth Census. The increase demonstrates the continuing importance of decentralized irrigation in Indian agriculture.

The growth, however, has not been uniform across irrigation sources. Groundwater schemes increased substantially faster than surface-water schemes. This indicates that the recent expansion of minor irrigation has primarily occurred through privately or locally managed groundwater infrastructure rather than through traditional surface-water systems.

Table 1. Structure of Minor Irrigation Schemes in India

| Indicator | Sixth MI Census |
|---|---|
| Total minor irrigation schemes | 23.14 million |
| Groundwater schemes | 21.93 million |
| Share of groundwater schemes | 94.8% |
| Surface-water schemes | 1.21 million |
| Share of surface-water schemes | 5.2% |
| Increase over Fifth Census | About 1.42 million |
| Increase in groundwater schemes | 6.9% |

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| | |
|---|---|
| Increase in surface-water schemes | 1.2% |
| Schemes in use | 97.0% |
| Private ownership | 96.6% |

Source: Ministry of Jal Shakti, Sixth Minor Irrigation Census.

The data indicate that minor irrigation in India is fundamentally a decentralized and privately dominated system. The fact that 96.6 per cent of schemes were under private ownership is particularly significant for understanding India's irrigation economy.

2 Dominance of groundwater-based irrigation

The most important structural trend is the overwhelming dominance of groundwater.

Of the 23.14 million minor irrigation schemes recorded by the Sixth Census, 94.8 per cent were groundwater schemes. Dug wells had the largest share among minor irrigation schemes, followed by shallow tube wells, medium tube wells and deep tube wells.

This pattern is also visible in agricultural irrigation statistics. In 2022–23, India's net irrigated area was 79.312 million hectares. Tube wells accounted for 39.134 million hectares and other wells for 10.672 million hectares. Together, these two sources accounted for approximately 49.8 million hectares, or about 62.8 per cent of net irrigated area.

This represents a major transformation from an irrigation system historically associated with canals and tanks towards one increasingly dominated by decentralized groundwater infrastructure.

Table 2. Source-wise Net Irrigated Area in India, 2022–23

| Source | Area (million ha) | Share (%) |
|---|---|---|
| Canals | 18.124 | 22.85 |
| Tanks | 2.235 | 2.82 |
| Tube wells | 39.134 | 49.34 |
| Other wells | 10.672 | 13.46 |
| Other sources | 9.147 | 11.53 |
| Total | 79.312 | 100.00 |

Source: Department of Agriculture & Farmers Welfare, Annual Report 2024–25.

The figures demonstrate that groundwater-based irrigation is not merely one component of minor irrigation; it has become a major pillar of India's agricultural production system.

3 Shift from Traditional Wells towards Deeper Groundwater Structures

The Sixth Minor Irrigation Census suggests an important technological transformation within groundwater irrigation itself. While dug wells and shallow tube wells remain numerically important, medium and deep tube wells have gained importance.

This change reflects several factors:

- increasing demand for assured irrigation;
- declining water levels in some regions;
- technological improvements in drilling and pumping;
- expansion of electrification;
- farmers' attempts to secure irrigation during uncertain rainfall; and
- the commercialisation and intensification of agriculture.

The development has increased the reliability of irrigation in many areas but has also introduced a significant sustainability dilemma: technological capacity to extract groundwater has expanded faster than mechanisms for regulating groundwater use.

Consequently, the future of minor irrigation cannot be assessed solely through the number of wells constructed. It must increasingly be assessed through indicators such as groundwater balance, aquifer health, irrigation efficiency and crop-water productivity.

4. Rapid Growth of Micro-Irrigation

A major contemporary trend is the transition from conventional flood irrigation towards drip and sprinkler irrigation.

The Government of India's Per Drop More Crop (PDMC) programme was introduced in 2015–16 to improve water-use efficiency through micro-irrigation. From 2022–23, PDMC has been implemented under the Rashtriya Krishi Vikas Yojana framework rather than as a component of PMKSY.

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Government support provides financial assistance of 55 per cent for small and marginal farmers and 45 per cent for other farmers, with some states providing additional assistance.

The expansion has been substantial. Official government information indicates that 114.60 lakh hectares had been brought under micro-irrigation under PDMC since 2015–16 by May 2026.

An earlier official assessment reported 83.06 lakh hectares under PDMC up to 2023–24, demonstrating the rapid expansion during the subsequent period.

Table 3. Expansion of Micro-Irrigation under PDMC

| Period | Cumulative area covered |
|---|---|
| Up to 2021–22 | About 69.55 lakh ha |
| Up to 2023–24 | 83.06 lakh ha |
| By May 2026 | 114.60 lakh ha |

Source: Government of India, Ministry of Agriculture & Farmers Welfare/PIB.

The trend represents an important qualitative change in irrigation policy—from expanding the quantity of water supplied to improving the efficiency with which water is applied to crops.

5 Increasing Institutional Support for Micro-Irrigation

The expansion of micro-irrigation has also been supported by the Micro Irrigation Fund (MIF) administered through NABARD.

The Fund was originally established with a corpus of ₹5,000 crore. The Government subsequently approved an additional ₹5,000 crore, taking the overall corpus to ₹10,000 crore. NABARD reports that, as of 31 May 2025, cumulative loans sanctioned under MIF amounted to ₹4,719.10 crore, with ₹3,750.57 crore released. The sanctioned projects envisaged micro-irrigation coverage of about 22.22 lakh hectares, of which 21.69 lakh hectares had been covered by 31 March 2024.

6 Groundwater Sustainability as the Major Emerging Challenge

The expansion of groundwater-based minor irrigation has simultaneously created serious sustainability concerns.

The Dynamic Ground Water Resources of India, 2024 assessment estimated:

- Annual groundwater recharge: 446.90 bcm
- Annual extractable groundwater resource: 406.19 bcm
- Annual groundwater extraction: 245.64 bcm
- Overall stage of groundwater extraction: 60.47%

Agriculture accounted for 87 per cent of total groundwater extraction, equivalent to 213.29 bcm.
The national average, however, conceals substantial regional differences. Of 6,746 assessment units, 751 (11.13%) were classified as over-exploited, 206 as critical, 711 as semi-critical and 4,951 as safe.

This creates a central policy contradiction:
Minor irrigation has improved agricultural reliability and productivity, but excessive dependence on groundwater can undermine the long-term sustainability of the very agricultural system it supports.

Therefore, future minor irrigation policy must shift from groundwater development alone towards groundwater management.

7. Increasing Emphasis on Groundwater Recharge

The policy approach is increasingly moving towards balancing groundwater extraction with recharge. The Central Ground Water Board's 2024 assessment found that rainfall recharge contributed approximately 61 per cent of India's total annual groundwater recharge, while other sources—including canal seepage, irrigation return flows, tanks, ponds and water-conservation structures—contributed the remaining 39 per cent.

This highlights the importance of integrating minor irrigation with:farm ponds, check dams, recharge structures, restoration of tanks, rainwater harvesting, watershed development, groundwater recharge structures, and improved soil-moisture conservation.
The policy emphasis is therefore gradually shifting from "more wells" to "more water productivity and better aquifer management."

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8. Revival and Restoration of Surface-Water Minor Irrigation

Although groundwater dominates minor irrigation, surface-water systems continue to have an important role, particularly in regions where tanks, ponds and local streams are significant sources of irrigation.

Under the Surface Minor Irrigation (SMI) and Repair, Renovation and Restoration (RRR) of Water Bodies components of Har Khet Ko Pani, thousands of schemes have been supported. Government documentation indicates that, from the Twelfth Plan onwards, 6,213 SMI schemes and 2,333 RRR water-body schemes were ongoing, with a target of creating or restoring minor irrigation through surface water.
This represents a significant policy correction to excessive reliance on groundwater.

Traditional water bodies have multiple benefits like irrigation, groundwater recharge, drought resilience, livestock water supply and local ecological benefits.
Hence, restoration of tanks and ponds should be considered an integral component of contemporary minor irrigation policy rather than merely a conservation activity.

9. Emergence of Solar and Renewable-Energy-Based Irrigation

Another important trend is the growing integration of renewable energy into irrigation.

The Sixth Minor Irrigation Census itself collected information on energy sources and energy-conserving devices, including non-conventional energy sources such as solar pumps and windmills. Solar irrigation has potential advantages because it can:

- reduce dependence on diesel;
- reduce farmers' exposure to fluctuating fuel costs;
- provide irrigation in areas with unreliable electricity;
- reduce operating costs; and
- contribute to agricultural decarbonisation.

However, solar irrigation also presents a groundwater-management challenge. When pumping costs decline substantially, farmers may have greater incentives to extract groundwater. Consequently, solarisation of irrigation should be accompanied by groundwater budgeting, efficient irrigation and appropriate incentives for conserving surplus electricity/water.

10. Regional Concentration and Unequal Adoption

Minor irrigation is not evenly distributed across India.The Sixth Census identified Uttar Pradesh as the state with the largest number of minor irrigation schemes, followed by Maharashtra, Madhya Pradesh and Tamil Nadu. Maharashtra, Karnataka, Telangana, Odisha and Jharkhand had particularly important shares of surface-water schemes.

Similarly, micro-irrigation adoption is concentrated in particular states. Official data up to 2023–24 show substantial cumulative coverage in Karnataka, Gujarat, Tamil Nadu, Andhra Pradesh and Maharashtra. Karnataka alone accounted for approximately 21.59 per cent of the national PDMC coverage in the cited period. This regional variation reflects differences in:

- cropping patterns;
- groundwater availability;
- farm size;
- horticultural development;
- state subsidies;
- institutional capacity;
- electricity availability; and
- farmer awareness.

Hence, a uniform national irrigation strategy may not produce optimal results. State- and agro-climatic-region-specific strategies are necessary.

Major Challenges

Despite considerable progress, several challenges remain.

- Groundwater depletion

The dominance of groundwater creates risks of declining water tables and aquifer stress, particularly in intensively cultivated regions.

- Energy-water nexus

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Cheap or subsidised electricity and expanding pumping capacity can encourage excessive groundwater extraction.

- Small and fragmented holdings

Small farmers may find the initial investment in drip and sprinkler systems difficult without subsidies or institutional credit.

- Unequal adoption of technology

Micro-irrigation adoption remains geographically uneven, with substantial differences between states and agricultural regions.

- Operation and maintenance

The creation of irrigation infrastructure does not automatically ensure effective utilisation. Poor maintenance, damaged pipelines, malfunctioning pumps and silted tanks can reduce irrigation efficiency.

- Crop-water mismatch

Irrigation expansion can sometimes support water-intensive crops in regions where water resources are already stressed. Irrigation policy therefore needs to be coordinated with crop planning.

- Institutional fragmentation

Water management involves multiple institutions and levels of government. Better coordination among agriculture, groundwater, irrigation, rural development and energy departments is required.

## III. POLICY RECOMMENDATIONS

Based on the analysis, the following policy measures are suggested.

- Move from irrigation expansion to irrigation efficiency

The policy objective should gradually move from simply increasing the number of irrigation structures towards increasing crop output per unit of water.

- Promote micro-irrigation in groundwater-stressed regions

Drip and sprinkler systems should receive greater priority in over-exploited and critical groundwater blocks, particularly for horticultural and high-value crops.

- Integrate irrigation with aquifer management

Minor irrigation schemes should be planned using aquifer-level groundwater budgets rather than administrative boundaries alone.

- Strengthen recharge infrastructure

Farm ponds, tanks, check dams and recharge structures should be integrated with minor irrigation programmes.

- Encourage water-saving cropping patterns

Irrigation policy should be coordinated with agricultural diversification towards crops that generate greater economic returns per unit of water.

- Improve access for small and marginal farmers

Credit, subsidy, community irrigation systems and farmer-producer organisations can help smaller farmers overcome the capital constraints associated with modern irrigation technology.

- Link solar irrigation with water conservation

Solar pumps should be promoted alongside mechanisms that encourage farmers to conserve groundwater rather than simply increase pumping.

- Strengthen participatory groundwater governance

Water-user associations, Gram Panchayats and farmer groups should participate in local groundwater planning and monitoring.

- Use digital irrigation databases

The Seventh Minor Irrigation Census and related water-resource censuses should be used to develop regularly updated district-level irrigation and groundwater dashboards.

## IV. CONCLUSION

Minor irrigation has become indispensable to Indian agriculture. The Sixth Minor Irrigation Census demonstrates the enormous scale of the sector, with 23.14 million schemes, 94.8 per cent of which were groundwater-based. At the same time, agricultural statistics show the central role of wells and tube wells in India's net irrigated area.

Recent developments show a gradual transition from conventional irrigation expansion towards micro-irrigation, groundwater recharge, restoration of water bodies, renewable-energy-based pumping and data-driven water management. The expansion of PDMC to 114.60 lakh hectares by May 2026 represents a particularly important shift towards improving water-use efficiency.

Nevertheless, the sustainability challenge is substantial. Agriculture accounted for 87 per cent of India's groundwater extraction in 2024, while 751 groundwater assessment units were classified as over-exploited.

The future of minor irrigation in India therefore depends not simply on how much irrigation infrastructure is created, but on how efficiently, equitably and sustainably water is used. A new generation of minor irrigation policy should integrate groundwater management, micro-irrigation, recharge, renewable energy, crop diversification and participatory institutions. Such an approach can enable minor irrigation to remain a foundation of agricultural productivity while reducing its environmental and hydrological costs.

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