POLICY BRIEF 51

Potential of Micro-Irrigation for Sustainable Intensification of Agriculture

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Irrigation is key to the sustainable development of agriculture, agriculture-based livelihoods, and national food security. Irrigation, besides contributing to productivity enhancement also provides a cushion to crops against extreme climatic shocks such as droughts and heat waves. In India, agriculture uses about 80% of the available water. Currently, about 50% of the total cropped area is irrigated, and two-thirds of it relies on groundwater. Groundwater, however, has been depleting fast because of its over-extraction and lower water use efficiency of dominant flood method of irrigation. Between 2007 and 2016, the groundwater level in more than 62% of wells dropped by 0-5 meters below ground level[1].

Micro-irrigation using the drip and sprinkler methods has the potential to enhance efficiency and optimal use of water. It also entails several other benefits — multiple cropping, higher crop yields and input use efficiency, and lower cost of production, among others[2].

Progress of micro-irrigation

The Government of India has been implementing *Centrally Sponsored Schemes on micro-irrigation* with the objective to enhance water use efficiency (WUE) in agriculture by promoting water-efficient irrigation technologies and encourage farmers to use water-saving and conservation technologies. The scheme was launched by the Department of Agriculture and Farmers Welfare in 2006 to enhance WUE through drip and sprinkler systems. In 2010, it was upgraded to a '*National Mission on Micro-Irrigation* (NMMI)' and in 2014 it was subsumed in the *National Mission on Sustainable Agriculture* (NMSA). In 2015, all such schemes were merged to form a mega scheme the '*Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY)'. The PMKSY aims at providing irrigation to every field (*har khet ko pani*), and improving water use efficiency and water productivity through precision irrigation (*per drop more crop*).

The area under micro-irrigation (MI) has increased steadily, from 3.1 million hectares (Mha) in 2005-06 to 14.12 Mha in 2021-22 (Figure 1), equalling about 14% of the gross irrigated area (GIA). Currently, about one-fifth of the estimated potential for micro-irrigation (69.5 Mha) has been exploited — 53% brought under sprinkler and 47% under the drip systems.

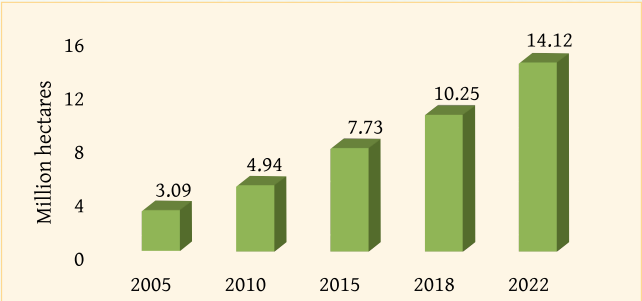

Fig. 1. Status of micro-irrigation in India

However, there is a significant inter-state variation in the adoption of micro-irrigation. Karnataka has the highest penetration of micro-irrigation, followed by Rajasthan, Maharashtra, Andhra Pradesh, Gujarat, Tamil Nadu, Haryana, Madhya Pradesh, and Chhattisgarh (Table 1). Sprinkler irrigation is more pronounced in areas not much suitable for the flood irrigation, and drip irrigation in areas cultivating horticulture crops. In the past one decade, the area under micro-irrigation has increased in most states.

Micro-irrigation is advocated for water-intensive (i.e., rice and sugarcane), and widely-spaced horticultural crops. During 2015-16 to 2021-22, about 5.9 Mha additional area was brought under micro-irrigation–2.94 Mha under sprinklers and 3 Mha under drips. Of the total sprinkler-irrigated area, cereals occupied 53%, followed by oilseeds, horticulture and pulses (Table 2); and of the total drip-irrigated area, horticultural crops accounted for 44.8%, followed by cereals, and commercial crops, including sugarcane and cotton.

[1] CGWB. (2021). Annual Report 2020-21. *Department of Water Resources, River Development & Ganga Rejuvenation*, Central Ground Water Board, Government of India, New Delhi. P.44-45

[2] Gandhi, V.P., Johnson N. and Singh G. (2021). Improving water use efficiency in India's agriculture - The performance and impact of micro-irrigation: Report of Centre for Management in Agriculture (CMA) *Indian Institute of Management*, Ahmedabad.

Table 1. Trend in micro-irrigtion across major states of India, 2010 and 2022

State	Area under MI[3] (000 ha)		Share of states (%), 2022		Share of MI in GIA (%), 2022
	2010	2022	Sprinkler	Drip	
Karnataka	595.1	2124.0 (15.0)	61.4	38.6	44.8
Rajasthan	896.6	2063.7 (14.6)	85.3	14.7	18.7
Maharashtra	899.8	2009.2 (14.2)	30.7	69.3	44.5
Andhra Pradesh	762.1	1921.9 (13.6)	27.1	72.9	52.9
Gujarat	407.5	1709.7 (12.1)	46.1	53.9	29.3
Tamil Nadu	181.3	1255.6 (8.9)	30.9	69.1	39.4
Haryana	545.1	683.5 (4.8)	93.5	6.5	11.3
Madhya Pradesh	194.9	659.5 (4.7)	45.8	54.2	5.2
Chhattisgarh	102.1	380.4 (2.7)	90.6	9.4	24.3
Other states	357.7	1315.8 (9.3)	62.4	37.6	2.7
All-India	4942.2	14123.3 (100.0)	53.0	47.0	13.8

Note: Data on gross irrigated area pertain to 2018-19. Figures in parentheses are per cent to total MI area.

Table 2. Crop group-wise area under micro-irrigation

Crop group	Additional area brought under MI ('000 ha) during 2015-16 to 2021-22			
	Drip	Sprinkler	Total	% share
1. Horticulture	1342.0	366.3	1708.3	28.8
Fruits	446.5	13.2	459.7	26.9
Vegetables	439.1	169.5	608.5	35.6
Spices	437.9	178.1	616.0	36.1
Medicinal & aromatic plants	9.3	4.9	14.1	0.8
Flowers	9.3	0.6	9.9	0.6
2. Pulses	6.1	284.5	290.6	4.9
3. Oilseeds	59.9	653.6	713.5	12.0
4. Commercial crops (cotton and sugarcane)	410.2	63.5	473.7	8.0
5. Cereals	1133.5	1547.6	2681.0	45.2
6. Other crops	40.3	20.2	60.5	1.0
Total	2991.9	2935.7	5927.7	100.0

Source: https://pmksy.gov.in.

Benefits of micro-irrigation

The evidence indicates considerable potential of micro-irrigation to save water, fertilizer and energy, and enhance crop yields, farm incomes and labour use. A study on the evaluation of the '*National Mission on Micro-Irrigation*' has shown that micro-irrigation could save 27-32% costs towards irrigation, electricity and fertilizer, and enhance yields of horticultural crops by 40%, besides improving the cropping intensity (Table 3). On the whole, adoption of micro-irrigation could enhance farm income by 42%. Besides, it also helped farmers to diversify their crop portfolio towards high-value horticultural crops.

Potential of micro-irrigation

The estimates of the potential area suitable for micro-irrigation differ. The INCID[4] has estimated a potential of 42.5 Mha for sprinkler irrigation, while the TFMI[5] has put it at 69.5 Mha. Narayanmoorthy[6] and Chand *et al.*[7] have estimated 72.0 Mha suitable for bringing under micro-irrigation, both sprinkler and drip irrigation.

Figures 2 and 3 show the potential for micro-irrigation in different states. Uttar Pradesh, Gujarat, Punjab, Tamil Nadu, Rajasthan, Telangana, Bihar, Haryana, West Bengal, and Madhya Pradesh have considerable potential for the adoption of micro-irrigation. But, it remains grossly under-exploited in Uttar Pradesh, Punjab, Bihar, Haryana and West Bengal. In other states, the unexploited micro-irrigation potential ranges between 40 to 80%.

[3] GoI. (2022). Agricultural Statistics at a Glance 2021. Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

[4] GAPL (2014). National Mission on Micro Irrigation-Impact Evaluation Study. Report submitted to Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

Table 3. Benefits from micro-irrigation adoption (drip system)[4]

S. No.	Particulars	Unit	Before MI	After MI	Change (%)
1	Change in input use/ cost				
	Reduction in irrigation cost	Rs/ha	7929.6	5376.9	-32.2
	Reduction in electricity use	Hr/day	5.4	3.7	-30.5
	Reduction in fertilizer use	Kg/ha	222.0	162.4	-26.8
	Increase in labour use	Day/ha	100.4	103.5	3.1
2.	Increase in irrigated area	Ha	2.3	2.5	7.5
3	Area diversified towards horticultural crops	Ha	0.8	1.3	65.8
4.	Productivity change				
	Horticultural crops	Qtl/ha	157.0	220.5	40.4
	Fruits	Qtl/ha	164.1	217.8	32.8
	Vegetable crops	Qtl/ha	149.9	223.2	48.9
5.	Increase in farm income	Rs /ha	75,106	1,06,615	42.0

Source: GAPL (2014)

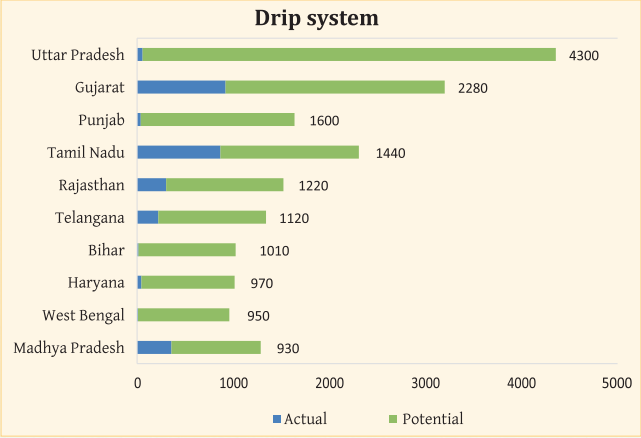

Fig. 2. Drip irrigation potential (thousand ha)

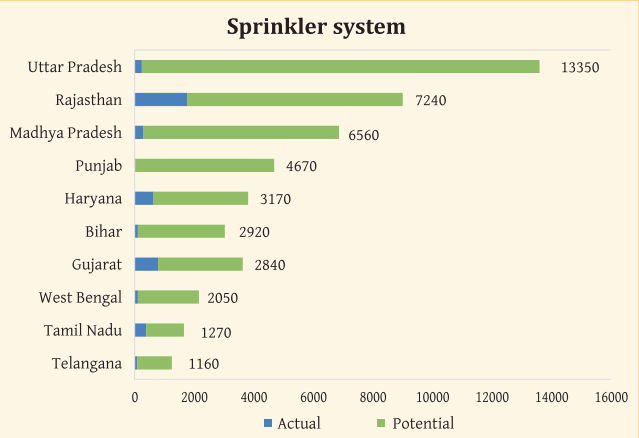

Fig. 3. Sprinkler irrigation potential (thousand ha)

Challenges and way forward

High initial investment: Indian agriculture is dominated by smallholders. The farm households owning less than or equal to one hectare of land comprise over two-thirds of the total farm households, and they lack resources to invest in micro-irrigation systems because of their substantial initial cost of installation, despite the subsidy ranging from 40-90% of the total cost of the systems. For example, in Rajasthan the unit cost of close spaced drip system is fixed at Rs 1,12,237 per hectare. The small farmers are entitled for a 70% subsidy, shared in the ratio of 33:37 between the Centre and State government[9]. To avail the subsidy, the farmer must have his her own source of irrigation, i.e., tube-well. The digging a bore-well also involves substantial initial cost. As a result, it is mostly the large farmers who adopt micro-irrigation systems[10].

The cost of irrigation infrastructure including digging well and installation of micro-irrigation systems can be reduced following a community approach. The farmers

5 INCID (1998). Sprinkler irrigation in India. Indian National Committee on Irrigation and Drainage, New Delhi.

6 TFMI (2004). Report of the Task Force on Micro-Irrigation, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi.

7. Narayanmoorthy, A. (2006). Potential for drip and sprinkler irrigation in India. *Gokhale Institute for Politics and Economics*, Pune.

8. Chand, S., Kishore P., Kumar S. and Srivastava S.K. (2020). Potential, adoption and impact of micro-irrigation in Indian agriculture. *Policy Paper 36*. ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi.

9. GoR (2022). PMKSY programme implementation directory. Directorate of Horticulture, Government of Rajasthan, Jaipur.

10. Namara, R.E., Nagar R.K. and Upadhyay B. (2007). Economics, adoption determinants, and impacts of micro-irrigation technologies: Empirical results from India. *Irrigation Science*, 25: 283-297, DOI 10.1007/s 00271-007-0065-0.

in a contiguous area can share the community–owned micro-irrigation system. This also reduces the subsidy burden. This model has been tested by PRADAN- an NGO in Bastar district of Chhattisgarh by installing micro-irrigation system at the level of self-help groups. This community sharing of water promotes rationality in water and in a fiscally prudent manner[11].

Poor quality equipment and post-installation services: Another major reason for the poor adoption of the micro-irrigation system is the supply of poor quality equipment and other materials (e.g. filter, emitter, flush valve, etc.) by the manufacturers or dealers[12]. Besides, the post-installation services for their repair and maintenance are also poor. These tendencies discourage farmers from adopting the micro-irrigation.

To ensure good quality equipment and materials and post installation services, the nodal agency designated by the state governments must keep a strict watch on the companies/agencies supplying micro-irrigation equipment, facilitating its installation, and providing post-installation repair and maintenance services. Besides, there is need to promote local entrepreneurship for the repair and maintenance of irrigation systems.

Lack of transparency: The nodal agencies responsible for the installation of the micro-irrigation systems and releasing the subsidy often transfer the liability of installation to the suppliers of micro-irrigation systems[13]. The procedures for getting subsidy are complex. Farmers often rely on equipment suppliers for installation, and in goodwill they provide no objection certificate to the suppliers for release of the subsidy amount to them.

The use of information technology enabled operation systems can enhance the monitoring, showcasing of best practices and improving transparency. The details about scheme and assets created under PMKSY can be geo-tagged and mapped on using Bhuvan application developed by Indian Space Research Organization. The regular update of scheme and assets being completed can be uploaded using global positioning system enabled smart phone to bring transparency.

Erratic electricity supply: Irregular and untimely supply of electricity also limits the adoption of micro-irrigation systems. The Reserve Bank of India in a recent study has suggested promoting minor-irrigation infrastructure and electricity supply in Uttar Pradesh, Madhya Pradesh, Bihar and West Bengal, where exists a large potential for micro-irrigation[14].

To address the issue of erratic and untimely power supply, the community-owned solar pump can be encouraged. Though the government is providing subsidy to buy solar pump upto 90% of total cost, the margin money to be paid by farmers is still unaffordable in most cases by marginal and small farmers. In community based project in Bastar district of Chhattisgarh, each member of the self-help group paid an upfront contribution of Rs 1,500 and a monthly charge of Rs 50. The findings of a field survey have shown that about 70% of the members joined the project due to its affordability. The model is scalable, especially for marginalised communities and farmers who do not have access to irrigation and working well since 2019[15].

Lack of convergence among different schemes: Government of India operates two schemes, one for promoting micro-irrigation and another energy conservation. These are the *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY) and the *Pradhan Mantri Kisan Urja Suraksha Evam Utthan Mahabhiyan* (PM-KUSUM), but these are implemented by two different Ministries. The PMKSY is implemented by the Ministry of Agriculture and Farmers Welfare, the PM-KUSUM is implemented by the Ministry of New and Renewable Energy, which aims at promoting the use of solar energy. For availing benefits of these schemes, farmers have to approach two different agencies. A convergence between the two will ease farmers' access to both, and may also generate significant economic gains at micro and macro levels.

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11. Rahman A. and Jain A. (2021). Deploying community-owned solar pumps in Chhattisgarh: 5 key takeaways. CEEW, Delhi.
12. SPACE (2021). Study on efficacy of micro-irrigation system in drought prone parts of Haryana. *NABARD Research Study 15*,completed by Society for Promotion and Conservation of Environment (SPACE), Chandigarh.
13. (ibid, 12)
14. RBI (2022). Irrigation management for sustainable agriculture. Reserve Bank of India Bulletin, May.
15. (ibid, 11)

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