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POLICY BRIEF - 32

Whether Micro-Irrigation is a Panacea for Ground water Scarcity and Sustainable Use in Indian Agriculture? Policy Imperatives

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Backdrop:

Currently, water scarcity led crisis is apparent in the semiarid regions of India impairing agriculture development as well as performance of other sectors in the economy. Relatively, water is scarcer than land in agriculture in many states of India. Out of the total net irrigated area of 68 million ha, the share of groundwater irrigation is around 65 % (GOI, 2017) reflecting the overdependence of agriculture on the fragile and fast depleting resource an indicator of unsustainable use. NASA indicated rampant fall in groundwater levels at the rate of one foot per year in India (Mathew et al 2009). Due to drastic fall in groundwater levels especially in semi-arid regions of India, many bore-wells have become defunct exacerbating the agrarian distress among farmers jeopardising agriculture. Hence appropriate irrigation technologies and the supporting institutions are needed for sustainable use of the scarce resource.

The critical constraints groundwater farmers are facing to sustain their income are relatively heavy dependence on bore-well irrigation that has led to groundwater over exploitation; uncertainty in the supply of surface water for irrigation and low adoption rate of micro irrigation technologies in agriculture.

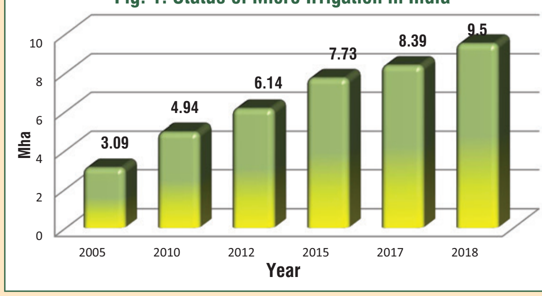
Focus

The focus of this brief is to analyse the current status and gap between the potential and actual coverage of micro-irrigation along with identifying bottlenecks in the adoption of micro irrigation. Impact of micro irrigation is decisive for stakeholders to prioritize and promote micro irrigation (MI) to cope with water scarcity. This policy brief is based on analysis of relevant data including intensive reviews.

Current Scenario of Micro Irrigation trend in India

The world's largest area irrigated is in India with 68 mha, of which groundwater irrigation accounts for 65 %. The area under micro irrigation is increasing slowly despite savings in water, labour, reliability, relative ease to operate and control and with the policy support (Fig 1).According to the Taskforce on Micro Irrigation (2004), the estimated potential of MI is about 69.5 Ml ha, while the actual area under micro irrigation is around 9.5 ml ha constituting about 14 % of net irrigated area (68.38 mha). However, there are no compelling reasons to accept that almost the entire area under irrigation in India can potentially be under micro irrigation. This assumes that micro irrigation is an appropriate technology for both surface and groundwater irrigation. Hence the gap between potential and actual is sizable and hence questionable.

Fig: 1. Status of Micro Irrigation in India



Source: Data compiled from - Pocket Book of Agricultural Statistics, Directorate of Econ & Statistics, GOI, 2018

For instance, most crops under canal and tank irrigation, micro irrigation technology is not the preferred choice of farmers.It is crucial to note that MI is specific to crops, topography, source of irrigation, water quality, awareness among farmers and the relative economics. Even in advanced countries, the entire area irrigated is not under micro irrigation due to associated constraints.

Coverage among states in India

Given monsoon, market and groundwater uncertainty, any technological innovation that entail heavy capital takes time to adopt and MI is no exception. The slow coverage is due to lack of favourable, physical, socio-economic, institutional and policy environments. Also, adoption is skewed in relation to geographical spread, crops and source of irrigation. Currently, the MI is largely confined to groundwater irrigated areas due to its control and relative ease in management. The MI forms over 22 % of the total groundwater irrigation. It has increased sharply from 2.3 m ha to 9.5 mha in a decade with a growth rate of 12.5 % per annum. With respect to geographical distribution (Table-1), Rajasthan has the highest share of micro-irrigation with 19.4 % followed by Maharashtra (15 %), undivided AP (15 %) Gujarat (12 %) and Karnataka (11 %). Due to frequent droughts, failure of monsoon and labour shortage farmers are responding to MI in these states. Again, in the hard rock areas forming 65 percent of India, there has been increasing costs of groundwater extraction. The cost of groundwater irrigation forms 15 to 30 percent of the total cost of cultivation of crops which is not accounted by farmers (Chandrakanth, 2015). Thus, due to the relative economic scarcity of groundwater farmers are responding to MI.

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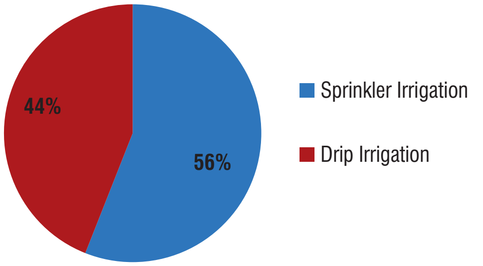
Fig: 2. Share of Drip and Sprinkler irrigation out of total microirrigation in India



Source: Data compiled from - Pocket Book of Agricultural Statistics, 2018, GOI

It is to be noted that out of the total MI, the sprinkler share (56 %) is higher than drip irrigation (44 %) share (Fig-2),as the sprinkler irrigation is gaining prominence in areas where the topography and soil condition is not suitable for conventional irrigation. Sprinklers are preferred for field crops like wheat, sorghum, pearl millet, groundnut and mustard where these crops occupied a significant proportion of area in northern and north western states like Gujarat, Rajasthan and Haryana. In addition, sprinklers are widely used in plantation crops like coffee, tea, areca, coconuts and fruit crops in Kerala, Karnataka and Tamil Nadu. Of late, mini sprinklers have emerged for crops like potato, groundnut and other vegetables. While drip irrigation is concentrated in the Deccan Plateau comprising, Maharashtra, undivided AP and Karnataka. Again, this is due to regional diversity of crops as well as increased scarcity of groundwater, increasing probability of well failure, increased reciprocal externalities, reduced life of wells and reduced groundwater recharge.

In terms of growth rate in the MI, AP and Haryana recorded an impressive growth rate of 42 % per annum followed by Karnataka and Maharashtra (Table-1). The IT based initiatives in these states enabled real time monitoring of transactions that facilitate the efficiency of the process from application, installation till subsidy payment for micro irrigation equipment (Likhi 2019).

Table-1. Trends in Micro Irrigation across states between 2005 and 2016

Sl No	State	Area under MI in 2005-06 (000 ha)	Area under MI in 2017 (000 ha)	State share in 2017 (%)	CGR (%/year)	Share of Drip (%)
1	Rajasthan	1629.90	1788.5	19.40	0.30	11.58
2	Maharashtra	120.20	1412.5	15.30	26.6	70.58
3	Andhra Pradesh	33.10	1398.5	15.20	43.1	72.00
4	Gujarat	38.3	1138.0	12.40	20.40	50.00
5	Karnataka	131.80	1050.5	11.40	36	51.10
6	Haryana	11.50	584.1	6.40	42	4.23
7	UP	44.50	70.7	0.75	-1.7	39.4
8	Other States	371.0	1762.0	19.20	13.24	33.34
	All India	2380	9205.4	100	12.50	45.43

Source: Department of Agriculture, Cooperation & Farmers Welfare

The front runner states in adopting MI in India are Rajasthan, Andhra Pradesh, Haryana, Karnataka, Maharashtra and Gujarat as these states account for more than 75 % of the total micro irrigation in India. By and large, MI is more visible in drought prone states of Rajasthan, Maharashtra, erstwhile AP, Karnataka and Gujarat where water scarcity is apparent on a large scale. Here, MI facilitated to mitigate water scarcity as well as labour scarcity together increasing economic efficiency in water use. It is crucial to note that it is the farmers of Easter Dry Zone especially Kolar and Chikkaballapur districts, Karnataka who ventured upon using drip irrigation for narrow spaced crops such as vegetables and flowers, as drip irrigation technology largely developed for broad spaced crops in Israel. Accordingly, these districts cumulatively top the area under drip irrigation for vegetables and flowers respectively in India. The entrepreneurship and innovations by farmers in these districts have been largely responsible in expanding MI area (Centre for Budget and Policy Studies 2013).

Potential Vs Actual

Out of the estimated potential for drip irrigation, the actual coverage of area in AP, Maharashtra, Karnataka and Tamil Nadu is closer to the potential when compared with other States (Table-2). This is because, in the Indo-Gangetic states, bulk of the area is in rice wheat cropping system using flood irrigation and not so friendly to micro irrigation. On the contrary, in hard rock areas, the yield of the bore wells is extremely low and cannot irrigate continuously with conventional flow irrigation, while in low pressurised drip and sprinkler, it is possible, and more area could be irrigated. In comparison with surface water, groundwater is relatively expensive and thus farmers are motivated to invest on micro irrigation since 75 percent of capital formation in agriculture is private investment and more than 60 per cent of this investment is on groundwater (Diwakara and Chandrakanth,2007). In addition, adoption share is higher for commercial crops such as vegetables, flowers and fruits as these crops are grown under groundwater.

Table - 2. Potential and actual area under Micro Irrigation in the leading states of India

Sl No	State	Potential area (000 ha) Drip	Actual area,2017 Drip (000 ha)	Actual as % to the potential	Potential area Sprinkler	Actual area, 2017 sprinkler (000ha)	Actual as % to the potential
1	Rajasthan	727	212.4	29.2	4931.0	1576.1	31.9
2	Maharashtra	1116	1004.1	89.9	1598.0	408.3	25.5
3	Andhra Pradesh	730	1012.0	138.6	387.0	386.4	99.8
4	Gujarat	1599	557.6	34.8	1679.0	580.1	34.5
5	Karnataka	745	514.0	68.9	697.0	536.4	76.9
6	Tamil Nadu	544	352.3	64.7	158.0	45.1	28.5
6	Haryana	398	28.0	7.0	1992.0	556.0	27.9
7	UP	2207	20.11	0.91	8582.0	50.6	0.6
8	Other States	3593	537.80	14.9	10554.0	828.0	7.8
	All India	**11659**	**4238.40**	**36.3**	**30578.0**	**4967.0**	**16.2**

Source: Department of Agriculture, Cooperation & Farmers Welfare, 2017
Raman 2010; www.indiastat.com, for estimating potential for drip, sprinkler and total MI area

Sprinkler Vs Drip irrigation growth

Out of total micro irrigation in the country, the area under drip exhibited an impressive growth of 15 % than sprinkler irrigation growth of 9 % per annum between 2005 and 2018(Table-3).The states with higher growth in drip irrigation include Gujarat Rajasthan, AP and Haryana. Similarly, the high growth in sprinkler irrigation include Gujarat, AP, Karnataka, Maharashtra and Rajasthan. This difference in growth rate is because MI is not suitable for all crops as well as for all the irrigated situations due to differences in natural endowments, diversity in crop pattern and policies. For instance, in the Indo-Gangetic states rice wheat cropping system is dominated except Rajasthan, where MI is not widely practiced. In hard rock areas owing to physical and economic scarcity of groundwater coupled with labour shortage, farmers are adopting drip irrigation.

Table-3. Growth rate in Drip and Sprinkler irrigation

States/year	CAGR (%) Drip irrigated area (2001-2018)	CAGR (%) Sprinkler irrigated area (2005-2018)
Rajasthan	23.3	10.1
Maharashtra	11.4	11.0
Andhra Pradesh	21.6	13.4
Gujarat	28.7	24.7
Karnataka	12.8	12.2
Tamil Nadu	11.4	9.9
Haryana	16.7	0.8
UP	13.0	17.0
Other States	18.5	8.7
All India	**15.4**	**9.4**

Source: Computed by Author from the data- Pocket Book of Agricultural Statistics, 2018

Plate 1: Cabbage and Tomato narrow spaced crops grown under drip irrigation in Eastern Dry Zone of Karnataka

Economic Benefits and impacts of Micro Irrigation

In order to evaluate the investment on drip irrigation a case study was conducted in the eastern dry zone of Karnataka, a typical hard-rock area in the year 2019. The study area is in Malur Taluk, Kolar district of Karnataka. The farmer owns 8 acres of farm with three bore-wells, of which one is functional yielding 1500 gallons/hr. Without drip irrigation, only 1.5 acre was irrigated. With introduction of drip, another 0.5 acre is added under irrigation. The Particulars of investment on drip is shown in the table 4. In order to install drip for one acre of tomato entail an investment of Rs 50,500 without subsidy. Generally, the cost of drip depends on the lateral spacing followed and the quality of material purchased. In case of non ISI, the initial cost will be lower and maintenance cost will be higher, as life span is very low (2-3 years) while in case of ISI, initial cost will be higher and maintenance will be lower due to long life span (7-10 years).In order to find out the additional cost and additional returns due to drip irrigation partial budgeting analysis is done.

Table 4: Capital requirement for drip irrigation in case of tomato crop (in Rs)

Particulars	Cost incurred/ acre	Remarks
Head unit components	8500	Filters, inlet and outlet, pressure gauze, control valve, butterfly valve, air release valve, bypass tea and GI fittings
Field Unit components including transport plus GST @ 9 %	42,000	Main line, sub-main and laterals -PVC pipes, PVC ball valve, PVC flush valve, LLDPE plain lateral, emitters and PVC fittings and accessories
Total investment	**50500**	
Apportioned/Amortized cost /year considering life span of 5 years for drip system@ interest rate of 5 %/annum	11584	
Operational & M expenses	3000	
Annual amortized cost of drip	11664	

Source: Based on Primary data collected from the farmer, Hulidenahalli village,Malur Tk, Kolar District

Table 5: Partial budgeting analysis of investment on Drip irrigation (in Rs)

Sl No	Debit	Amount	Credit	Amount
1.	a) **Added cost due to drip** (Apportioned cost of drip)	11664	**Reduction in cost due to drip:** • Reduction in labour cost on irrigation and weeding (30 man days/Ac @ 500/md)	15000
	b) **O and M cost**	3000		
	c) Increased cost of harvesting (Due to improved yield on account of drip)	5000		
2	**Decrease in returns**	**Nil**	• **Increase in returns due to drip:** (ie.increase in productivity of15 Qtls/Ac @ 1500/Qtl • Additional income from increased area under cultivation due to savings in water: (Finger millet 0.5 acre with a yield of 7 quintals @ 3500/Qtl)	22500 24500
	Total: A	**19664**	**B**	**62000**
	Net change B-A = 42336			
	Incremental cost benefit ratio	**1:3.15**		

Source: Based on Primary data collected from the farmer, Hulidenahalli village,Malur Tk, Kolar District

The capital on drip is amortized to arrive at the annual cost of drip irrigation considering 5 years as life span of drip system with 5 % interest rate as the opportunity cost of capital. The productivity difference before and after drip is considered for calculations. The debit side reflects the added cost due to drip and decrease in return if any, while the credit side reflects the reduction in cost due to drip irrigation and incremental returns due to drip. As evident from the table 5, the additional benefits of Rs. 42,000/acre/ crop on account of drip irrigation outweigh the additional cost of 19,664 as reflected in the net change (B-A). The incremental cost benefit ratio indicates that for every rupee invested on drip irrigation, it has generated an incremental return of Rs. 3. This unequivocally proves that the capital invested on drip irrigation can be recovered within a season or at the most within a year considering two crops. With subsidy, farmers can recover their investment on drip within a season.

Contribution of Micro Irrigation

Studies quantifying the contribution of mirco irrigation need to quantify precisely the gain due to irrigation in general and due to irrigation technologies used either drip or sprinkler. Using slope and intercept dummy variables the study has attempted to discern the benefits due to groundwater irrigation, and due to drip irrigation technology (Chandrakanth et al.,2013). The marginal productivity of groundwater was Rs. 1960 for each acre inch of groundwater applied through drip irrigation. The marginal productivity of groundwater was Rs. 465 per acre inch of groundwater applied through conventional irrigation method. Thus, marginal productivity in drip irrigation (Rs. 1960) is around three times higher than that in conventional irrigation (Rs. 465). In another study (Namara et al 2007) pertaining to Gujarat and Maharashtra, the technical and economic efficiency parameters (i.e.,MPP and VMP) for different micro-irrigation technologies derived from the fitted transcendental response functions. Even under the conservative scenario of comparing the VMP with the actual investment cost, except for micro-tube drip and conventional sprinklers, all of the micro-irrigation technologies are economically efficient and the farmers can recuperate their initial investment capital within 1–3 years without subsidy.

Relative Irrigation Efficiencies under Different Methods

Water use efficiency in micro irrigation ranged from 80- 90 % compared with the conventional method (30-35 %). There are several studies which indicate that canal irrigation water use efficiency is hardly 30 percent, wherein water is conveyed through open channels resulting loss of water through evaporation, percolation and seepage (Gulati and Banerjee, 2016). Many studies indicate that MI saves water up to 40 to 80 % and improves water use efficiency up to 100 %, savings in energy consumption (30.5%), savings in fertilizer consumption (28.5%),savings in irrigation cost (31.9%), enhancing area under new crops (30.4%)and increase in farmers' income (42%),through appropriately designed and managed micro irrigation system as against the conventional practices (IAI-FICCI Grant Thornton, 2016, Kumar and Palanisami 2010,Suresh Kumar 2008 and Narayanamoorthy,2009). Thus, substantial amount of water can be saved through use of micro Irrigation.

Key bottlenecks for micro irrigation adoption and spread in India

On the one hand the contribution of groundwater to total irrigation is around 70 percent, while the proportion of area under micro irrigation is negligible which is puzzling. This implies lack of extension role in sharing knowledge and technology in adoption of micro irrigation which is lacking and almost left to the hands of vendors. Despite the proven benefits from MI, the adoption rate is limited due to several constraints. MI needs reliable supply of water as well as energy to lift the water which is lacking in many hard-rock regions. Further, in these areas high capital investment is required to develop groundwater and conveyance in the districts like Kolar, in Karnataka. In these hard-rock areas, well interference and well failure is very common leading to negative externalities posing a serious constraint for MI adoption. In canal areas, the water supply and scheduling is not matching for MI and moreover, the price of surface water is not reflected the scarcity value of water. Hence there is no incentive for adoption of water saving technologies. Several studies documented the key constraints towards adoption of MI, these include physical, socio-economic, financial, institutional comprising pricing and subsidies, extension service and policy related. High initial cost, clogging of drippers, lack of adequate technical inputs, high cost of spare components; and insufficient extension education effort and irregular power supply are the major problems in the slow rate of adoption of drips (Narayanamoorthy, 1997; Kumar, 2002 and Suresh et al 2018). Already, there is overcrowding of investments on small holdings towards drilling deeper bore-wells, I-P set, piped network and other components that deter further investment on MI.

Conclusions and Policy Recommendations

Though MI has immense potential to reduce consumptive use of water, labour, enhancing productivity and incomes of the adopters, the coverage has not been impressive despite water scarcity due to relatively high cost, technology intensiveness, lack of access to credit, fragmented landholdings, topography, uncertainty of water and water quality. In order to stimulate the adoption MI technologies in agriculture, sound policies and institutions are vital:

- Provision of quality power supply to the farming sector is vital to encourage adoption. In this regard, viability of the solar pumps needs to be evaluated.
- Extending outreach / extension especially for diffusion of irrigation literacy and irrigation technologies is crucial. Hence investment on extension and capacity building is required to impart irrigation literacy. Further, effective linkage with Agricultural universities/ research institutes for outreach and training need to be strengthened. This facilitates imparting skills to the rural youth so that they act as local service providers.
- In groundwater irrigated areas, targeted approach of making MI a mandatory for high value crops like sugarcane, cotton, maize and fruits and vegetables with precision technologies like sensor networks and tensio meters need to be adopted. Further, differential subsidy for water scarcity regions alone should be introduced.
- Direct disbursement of subsidy to the farmer account instead of through company enables farmer to independently choose the firm and the relatively cost-effective design suitable for his crop.
- For non-subsidy farmers, ensure financial inclusion at nominal interest rate making credit available for small and marginal farmers on soft terms.
- The resourceful farmers who can afford to invest on micro irrigation, technical support and ISI quality material at reasonable price need to be ensured and incentivised.
- Use of plastics in agriculture is evident and it turns out to be big environmental threat. Hence, farmers should be educated for safe disposal after use or recycling the same.
- As water continues to be a crucial constraint, community driven drip irrigation projects like Ramthal in Karnataka should be explored in surface irrigated command area treating MI as part of irrigation infrastructure by the Govt.

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