

Economic Analysis of Micro Irrigation Technology Adoption in India: A State Level Analysis

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Abstract

An attempt has made to explore the area under Micro Irrigation Technology across States using secondary data in India. Sustainable Development of Agriculture sector can be achieved by three strategies: a) Micro Irrigation Technologies (MIT) b) Integrated Nutrient Management (INM) and c) Integrated Pest Management (IPM). This study is focused on Micro Irrigation Technology only. The study has found that area under micro irrigation system is evaluated to be 100% in Ukraine and Finland when compared to total irrigated area, followed by Israel and Slovak Rep 99% during 2020-21 respectively. In India, Adoption of Drip Method of Irrigation (DMI) accounts for 5.96 percent of total irrigated area in 2020-21. The result of the study stated that adoption of drip irrigation is found to be high in Karnataka which is followed by Tamil Nadu, Andhra Pradesh and Gujarat during 2020-21, whereas the adoption of drip irrigation method is very low in the states namely Goa, Kerala and Punjab. On the whole, the study revealed that adoption of Sprinkler Method of Irrigation (SMI) is found to be high overall the world as compared to DMI during 2020-21. Specifically, the study has also proved that adoption of drip irrigation method is found to start declining in India during 2020-21. Finally, the study suggest that there is an urgent need to spread the benefits of micro irrigation methods among the small, marginal and large farmers which in turn paves a way for the sustainable development of agriculture sector all over the world.

Keywords: Micro Irrigation, Drip Irrigation, Agriculture Sector and Sprinkler Irrigation.

1.1 Introduction

Agriculture sector is the backbone of Indian Economy. At present, totally labour force engaged on agricultural and allied activities is estimated about 54.6 percent (Census, 2011). The New Irrigation Policy (NIP) has pointed out that the existing water use efficiency increased by using water saving technologies namely drip and sprinkler method of irrigation. Some studies mentioned irrigated areas' cropping pattern totally varies from unirrigated areas in India (Dhawan, 1988). Consequently, it becomes significant to encourage the adoption micro irrigation technology namely drip method of irrigation (DMI) which is possible by providing sufficient incentives through the State and Central government sponsored schemes. Central Government of India has been providing subsidy for drip method of irrigation since early 1990's (Moin and Kamil, 2018). Hence, all the states of India have adopted the centrally sponsored subsidy scheme of Government probably. This study presents adoption of area under drip and sprinkler method of irrigation all over the world. And then, the study mainly analyzed in depth about the adoption of Drip Irrigation Method across States in India.

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1.2 Area under Sprinkler and Micro Irrigation Methods of the World

The micro-irrigated area under total irrigated area has grown slowly. And it was 0.41 mha and 1.1 mha in 1981 and 1986 respectively. This study has mainly used secondary data for the analysis. Though fast urban agglomeration, 44% of the population depends upon state agriculture and allied activities for the survival. However, there has been a decrease in agricultural growth which is due to water scarcity in the recent years (GoTN, 2012), it reached about 57 mha during 2021 (ICID, 2021 and Sivanappan, 1994). The ICID on Micro Irrigation Method (MIM) in 2021 has reported that it is being totally applied in 47 countries. For this study, there are only fourteen countries of major countries adopting Micro Irrigation systems have shown in the Table 1. The study has analyzed that adoption of micro irrigation is found to be high about 68% of the total irrigated area which is followed by China (65 mha) and India (62 mha), which in turn total irrigated area in percentage terms, it seems to be low about 14 and 8 % accordingly.

Table 1: Adoption of Sprinkler and Micro-Irrigation System of the World, 2020-21

(in mha)

Country	Total Irrigated Area (mha)	Sprinkler Irrigation (mha)	Micro Irrigation (mha)	Total Irrigated Area (%)
USA	23.48	14.12	01.97	68.60
China	65.87	03.73	05.27	13.70
India	62.00	03.04	01.89	08.00
Brazil	05.70	03.85	0.62	77.30
Spain	03.63	0.88	01.79	73.70
South Africa	01.67	0.92	0.36	77.00
Germany	00.54	0.52	0.01	98.10
Japan	02.89	0.43	0.06	87.60
Ukraine	0.51	0.44	0.07	100.00
Slovak Rep.	0.31	0.31	0.01	99.90
Israel	0.23	0.06	0.17	99.60
Hungary	0.22	0.18	0.01	87.30
UK	0.15	0.10	0.01	74.00
Malawi	0.05	0.04	0.01	88.40

Source: ICID (2021).

Note: TIA – Total Irrigated Area; SI - Sprinkler Irrigation and MI – Micro Irrigation.

While micro-irrigation technologies are considered as a leading water saving/conserving technologies in irrigated agriculture sector, its adoption is still very low as compared to total irrigated area. The area under micro irrigation systems are 100% in Finland and Ukraine in total irrigated area, followed by Israel, Slovak Rep, Germany, Malawi, Hungary and Japan are about 99, 99, 98, 88, 87 and 87 % respectively. Most of the irrigated area under micro irrigation is about 77, 77, 74 and 70 % in Brazil, South Africa, UK, and Moldova accordingly. While micro-irrigation adoption is very low in the following countries Mexico (9.7%), India (8%), Iraq (5%), Bulgaria (4%), Chile (3%), Malaysia (2%), Sudan

(2%), Philippines (0.9%) and Uzbekistan (0.2%) respectively of the total irrigated area of the world. DMI accounts for 5.96 percent of the total irrigated area in India during 2020-21. Finally, adoption of sprinkler and micro irrigation technologies in 47 countries' total area of the world has found to be 40.88 and 16.56 mha of the total irrigated area (228.84 mha) accordingly. Area under micro irrigation technology was evaluated to be about 57.23 mha out of 228.84 total irrigated area. In terms of percentage, sprinkler and micro irrigation adoption is found to be about 18.97 percent in total irrigated area during 2020-21.

Micro-irrigation systems are highly suitable to all agricultural crops except few crops. Recently, it has more significance in the situation where: a) labour and water are become scarcity and costly b) quality of the water is more saline c) soils are rocky, sandy or difficult to the level and d) high value crops are produced namely sugarcane crop. The cash crops under micro-irrigation are commercial field crops viz., sugarcane, cotton and tobacco and so on. Drip irrigation system is continued to be significant in the protected agriculture like greenhouses shade nets, walking tunnels, shallow, etc., for the production of horticulture crops like vegetables and flowers. Some of the studies proved that drip irrigation method is highly beneficial in the cultivation of crops namely chilli, banana, grapes and cotton (Narayanamoorthy, 2003 and 2008, Narayanamoorthy and Deshpande, 2005,)

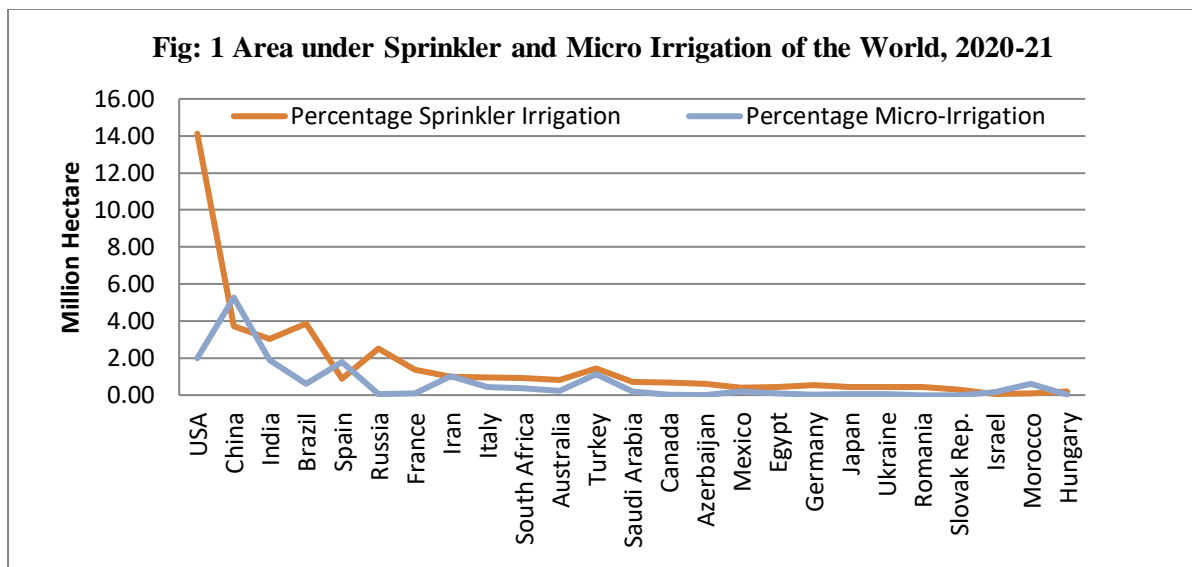


Fig. 1 depicts pictorial representation of the total irrigated area, area under sprinkler and micro irrigation of the world during 2020-21. It has also shown sprinkler irrigation method (SIM) is highly applied in USA as compared to other countries of the world. The study revealed that sprinkler irrigation is found to be high over micro irrigation system. But, adoption of micro irrigation is high in Spain when compared to sprinkler irrigation method. Finally, it clearly shows that adoption of sprinkler and micro irrigation system are very low when compared to the total irrigated area of the world during the study period.

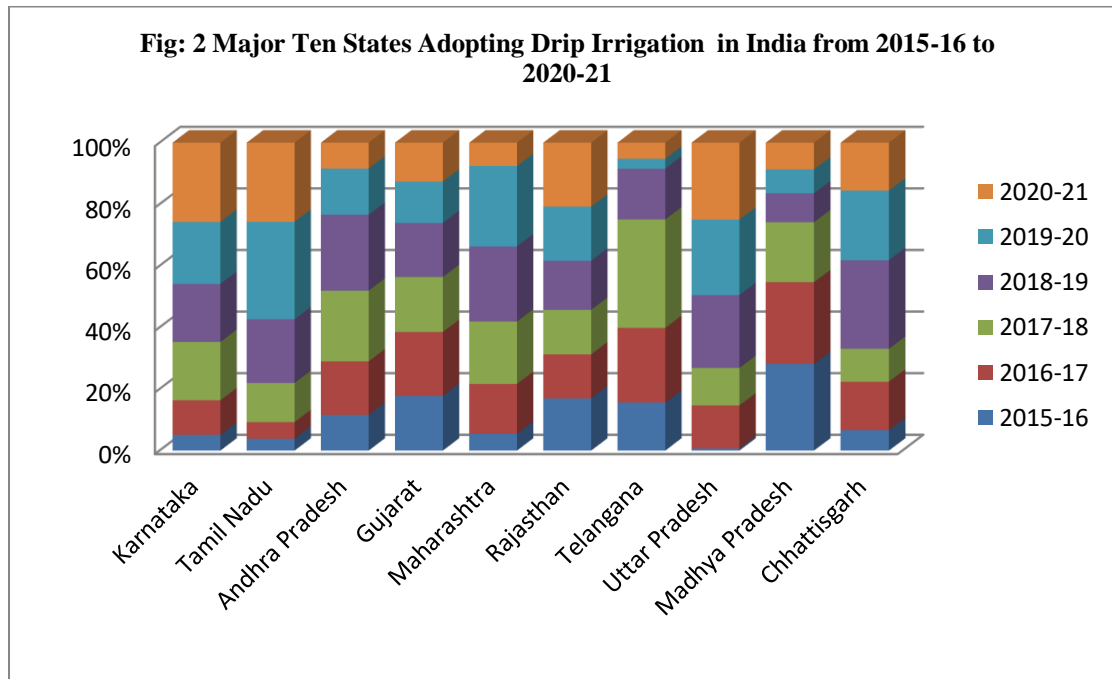
1.3: Major Ten States Adopting Drip Method of Irrigation

Table:1 Major Ten States Adopting Drip Irrigation Method in India from 2015-16 to 2020-21
(in ha)

S. No	States	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total	Average
1	Karnataka	64220	139406	236108	234853	250590	321178	1246355	207725.79
2	Tamil Nadu	32287	44778	105696	172445	263494	214147	832847	138807.88
3	Andhra Pradesh	94104	141098	186441	200257	121712	68183	811795	135299.18
4	Gujarat	142681	165948	143129	140778	107649	101329	801514	133585.73
5	Maharashtra	35671	106172	132829	159959	171098	49878	655607	109267.84
6	Rajasthan	56346	47651	48207	53074	58573	69191	333041	55506.88
7	Telangana	39864	61980	90018	42186	8195	13441	255684	42614.05
8	Uttar Pradesh	1597	32512	28235	55074	56953	58104	232475	38745.85
9	Madhya Pradesh	57397	54324	39759	19212	15882	17717	204291	34048.52
10	Chhattisgarh	8068	19287	13088	35195	27688	19033	122359	20393.17
Total		190611	325281	528245	607555	635797	603508	2890997	481832.85

Source: GoI, (2021)

The major ten states which are adopting drip irrigation method in India are shown in the table 1. Now let us start to analyze the states one by one. Firstly, Karnataka is ranked first among the states in India. During the study period, Karnataka state adopted drip method of irrigation have shown an increasing trend when compared to other states, it is found to be high about 321178 ha in the year of 2020-21. Secondly, Tamil Nadu is ranked second in the adoption of drip irrigation over other states which is increasing at a decreasing rate from 32287 ha to 263494 ha during 2015-16 and 2019-20 and then it starts to decrease about 214147 ha particularly in the year of 2020-21. Thirdly, Andhra Pradesh has shown a drastic increase in the adoption of drip irrigation method, it is high about 94104 ha and 200257 ha from 2015-16 to 2018-19. But, it starts decrease continuously from 121712 ha to 68183 ha during 2019-20 and 2020-21. Fourthly, Gujarat is also in the same situation which means that it is in the beginning shown an increasing but at a decreasing rate. The remaining states namely Maharashtra, Telangana, Madhya Pradesh and Chhattisgarh are increasing at a decreasing rate during the study period except two states such as Rajasthan and Uttar Pradesh. The study revealed that adoption of drip irrigation method is found to be high in 2019-20 which is followed by the year of 2018-19 and 2020-21. Likewise, the study has proved that adoption of drip irrigation method is high in Karnataka, followed by Tamil Nadu, Andhra Pradesh and Gujarat during the study period.



The above figure presents that the major ten states adopting drip irrigation method in India from 2015-16 to 2020-21. This pictorial representation clearly shows the adoption of drip irrigation and how it fluctuates during the study period of time. In Karnataka, adoption of drip irrigation is very low in 2015-16 but it is shown a massive increase from 2018-19 to 2020-21. Likewise, Tamil Nadu has shown an drastic increase in 2019-20 and then 2020-21. Whereas adoption of drip irrigation in Andhra Pradesh is found to be high in 2018-19, in this state, there is no much fluctuation in the adoption.

However, it is starting decreasing in 2020-21. The same fluctuation is shown in Gujarat state too. But, the adoption of drip irrigation is high in Maharashtra state in three periods of time from 2017-18 to 2019-20. In 2020-21, it starts to decrease in a fast manner. Although adoption of drip irrigation in Rajasthan is increasing in an increase rate, there is no much fluctuations shown during the study period. Whereas adoption of drip irrigation in Telangana state is found to be high during 2016-17 and 2017-18, at the meantime, drip irrigation adoption is very less during 2019-20 and 2020-21. In Uttar Pradesh, adoption of drip irrigation is high from 2018-19 to 2021. Whereas the same in Madhya Pradesh state, it is increasing at a drastic decreasing rate during 2018-19 and 2020-21. Lastly, Chhattisgarh has shown an improvement in the adoption of drip irrigation method. Kumar and Palanisami (2010) studied the impact of drip irrigation on resources use, cropping pattern and productivity of the farming. The study has found that drip irrigation had significant impact on resource saving, cost of cultivation, farm yield and profitability.

1.4: Lower Ten States Adopting Drip Method of Irrigation in India

Table:2 Lower Ten States Adopting Drip Irrigation Method in India from 2015-16 to 2020-21
(in ha)

S. No	States	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Total	Average
1	Haryana	3116	5701	10752	10469	22652	12446	77583	12930.54
2	West Bengal	399	799	1598	11404	19917	15240	64598	10766.26
3	Odisha	2895	4551	3037	9797	8498	13193	41971	6995.17
4	Jharkhand	4528	5810	1544	3977	5989	1909	23757	3959.55
5	Uttarkhand	904	3199	2186	4256	6796	4128	21469	3578.20
6	Bihar	134	4228	3143	925	3967	1275	13672	2278.66
7	Himachal Pradesh	3306	937	1198	421	2574	2051	10488	1747.93
8	Punjab	1799	1951	600	507	942	742	6540	1089.96
9	Kerala	1407	309	359	965	623	389	4053	675.46
10	Goa	92	122	107	196	285	132	934	155.72
Total		18580	27607	24525	42918	72242	51505	265065	44177.45

Source: GoI, (2021)

Table 2 represents the lower ten states adopting drip irrigation method from 2015-16 to 2020-21. Let us start to analyze the fluctuations in depth. Haryana is the first state in the adoption of DMI. It is increasing at a decreasing rate about 3116 ha to 22652 ha from 2015-16 to 2019-20. In 2020-21, adoption of drip irrigation is decreased more than about 50%. In West Bengal, adoption of drip irrigation is very low about 399 ha during 2015-16. And then it starts to increase about 19917 ha upto the period of 2019-20 after that it decreases to 15240 ha in 2020-21. In Odisha, adoption of drip irrigation method is shown fluctuations but it is widely adopted when compared to West Bengal state. Likewise, the same fluctuations are seen in Jharkhand state, it is increasing at a decreasing rate. In the beginning of the study period, adoption of drip irrigation is high about 4528 ha and 5810 ha from 2015-16 to 2016-17. And then it decreases about 1544 ha at an increasing rate in 2017-18. Finally, it decreases about 1909 ha in 2020-21. Likewise, the same has shown in Uttarkhand state. In Bihar, adoption of drip irrigation is only high in two period of time in 2017-18 and 2019-20. In Himachal Pradesh, it is only high about 3306 ha in 2015-16 and then it starts to decrease at an increasing rate throughout the period of study. Whereas the adoption of drip irrigation in Punjab and Kerala are high only in 2015-16 and then it decreases throughout the period of study. Finally, adoption of drip irrigation in Goa is very low about 92 ha in 2015-16 and then it starts to increase entire period of analysis. The study revealed that adoption of drip irrigation method among the selected states is very high about 72242 ha in 2019-20.

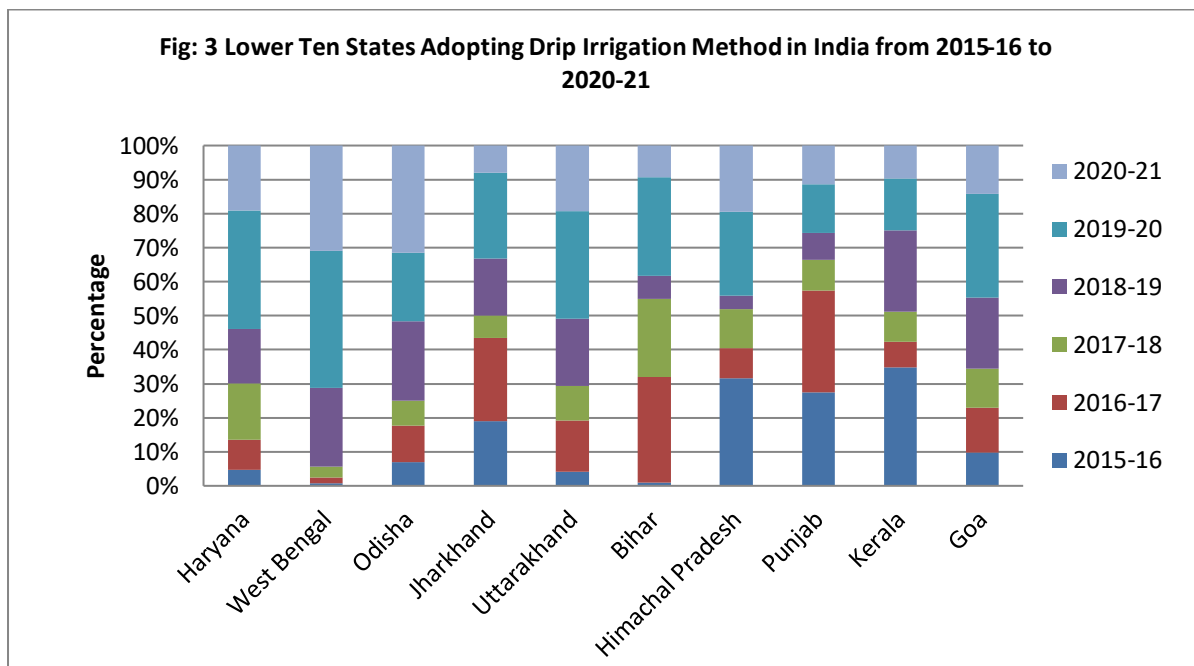


Figure 3 has clearly shown the fluctuations in the lower ten states adopting drip irrigation method during the study period. This pictorial representation explains that drip adoption is found to be high in Himachal Pradesh, Punjab and Kerala in 2015-16. Likewise, in the states namely Jharkhand, Bihar and Punjab, drip irrigation adoption is high during 2016-17. But, the same in Bihar is found to be high in 2017-18. In 2018-19, drip method adoption is high in the following states namely West Bengal, Odisha, Uttarkhand, Kerala and Goa. In Haryana, West Bengal, Jharkhand, Uttarkhand, Bihar, Himachal Pradesh and Goa adoption of drip irrigation is very high in 2019-20. Finally, the same is high in West Bengal and Odisha in 2020-21 when compared to other states.

1.5 Major Findings and Policy Suggestions

An attempt has been made to estimate the development of micro irrigation technology namely drip and sprinkler methods of irrigation in India by using secondary data. In order to increase the adoption of drip and sprinkler methods of irrigation, many policy measures have to be introduced.

Firstly, the area under micro irrigation systems are 100% in Finland and Ukraine in total irrigated area, followed by Israel, Slovak Rep, , Germany, Malawi, Hungary and Japan are about 99, 99, 98, 88, 87 and 87% respectively. But, in the meantime, total area coverage is comparatively very less when compared to USA, China and India. In particular, drip irrigation in India accounts for 5.96% of the total irrigated area during 2020-21. The adoption of sprinkler and micro irrigation system are very low when compared to the total irrigated area of the world during 2020-21. Drip/sprinkler irrigation methods are economically viable for crops cultivation, most of the farmers specifically small and marginal farmers have expressed that it is a capital-intensive technique that is a hurdle for them to adopt

drip/sprinkler irrigation technology. If the availability of those irrigation systems are made by the government at a lesser cost, area and adoption of micro irrigation technology in all crop cultivation agriculture and horticulture which can be enhanced not only agriculture but also in horticulture sector in a sustained manner.

Secondly, the study evaluated that the area under DMI in India has increased from 0.07 mha in 1991-92 to 5.96 mha in 2020-21 (GoI, 2021). The analysis revealed that area coverage under DMI is found to be very low when compared to the area coverage under total irrigated area 2020-21.

Thirdly, the study revealed that Karnataka is high in area under drip irrigation in India when compared to other states which is followed by Tamil Nadu, Andhra Pradesh and Gujarat from 2015-16 to 2020-21. The study also found that adoption of sprinkler irrigation is high in Tamil Nadu when compared to other states in 2019-20.

Fourthly, the study found that Goa is very low in area under drip irrigation method in India when compared to other states which is followed by Kerala, Punjab and Himachal Pradesh from 2015-16 to 2020-21. Thus, effective policy measures have to be taken for the lower ten states more adoption of sprinkler and drip irrigation methods in India.

Fifthly, the analysis of the study has clearly revealed that sprinkler and micro irrigation adoption is very low when compared to the total irrigated area during 2020-21. Therefore, effective policy measures have to be taken for the more adoption of sprinkler and micro irrigation technologies in India. The Government has to provide good subsidies schemes for the small and marginal farmers for the adoption of micro irrigation systems.

Finally, the study has revealed that adoption of drip irrigation is decreased widely in India during 2020-21. Thus, immediate policy measures have to be framed in order to enhance adoption of micro irrigation technologies in India.

1.6 Conclusion

In recent years, adoption of drip method of irrigation continues to grow in a rapid manner but the crops are mainly cultivated under flood irrigation method all over the world. Due to this, more groundwater source is used for irrigation purpose that leads to decline in groundwater table rapidly and more pressure on the available water resources which in turn will affect for future generation definitely. By now, many countries of the world are come across water scarcity problem. To alleviate this problem, protect the available groundwater resource for the upcoming generation and achieve sustainable development in agriculture sector, micro irrigation methods (drip/sprinkler) have to be adopted in a rapid manner. Implementation of suitable policy measures have to be formulated to enhance the adoption of micro irrigation methods in India.

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