TOWARDS PROSPERITY THROUGH MODERN MICRO IRRIGATION TECHNOLOGY

Chandrakant Bhupal Patil

Asst. prof
Department of Economics
Padmabhushan Vasantravdada Patil Mahavidyalaya
KavatheMahankal, Sangli,(MS), India,

***Abstract*- Micro irrigation technology has occupied a predominant place in recent policy discourse on addressing water management issues in India. Irrigation is the process through which controlled amount of water can be supplied through artificial means such as pipes, ditches, sprinklers etc. The main objective of irrigation systems is to help agricultural crop growth, landscape maintenance and reduce the effect of inadequate rainfall Therefore, the importance of irrigation systems is very high. However, many farmers are finding it hard to choose an irrigation system that can best serve them in this article we are going to cover two of the most popular irrigation systems that save both water in their own way and are highly efficient. The paper has analyzed potential, adoption pattern, impact and institutional arrangements for disseminating micro irrigation technology in the country. micro irrigation technology as a tool to improve water use efficiency and farmers' welfare has occupied a prominent place in policy discourse in India.**

***Key words*: Micro Irrigation Scheme in India, Architecture of PMKSY, Evidences from Previous Studies, Benefits of micro irrigation, Evidences from Previous Studies.**

Introduction

Water is fundamental for sustaining a quality life, as well as economic and social development of human society. The Earth's hydrosphere contains a huge amount of water, but 97.5% of total water is saline and remaining 2.5% is fresh water. Out of total available fresh water, 68.7% is in the form of ice and permanent snow cover in polar and high mountainous regions and 29.9% is present as groundwater. The rest 0.3% is available in lakes, rivers and 0.9% in soil moisture, swamp water and permafrost atmosphere (Gol, 2015). India is blessed with vast network of 20 river basins with utilizable water resources of 1123 billion cubic meter (BCM) including both surface and groundwater. There is a large spatial and seasonal variation in the endowment of water resources (Srivastava et al., 2012). With the rising population, the per capita availability of water in India has declined from 5178 m3 /year in 1951 to 1441 m3 /year in 2015, which is lower than the water-stressed norm of 1700 m3 /year. About 60% of Indian population have per capita water availability close to or lower than the water scarcity threshold of 1000 m3 /year. By the year 2050, India's population is projected to reach 1.64 billion and consequently, the per capita water availability will further decline to 1139 m3 /year. On the demand side, the gross water requirement for all users in India was 813 BCM in 2010 and is expected to grow up to 1447 BCM in 2050 (CWC, 2010). Due to rising inter-sectoral competition, the share of agriculture in total water use is expected to decline to 74% in 2050 from its present level of 85% (Gol, 2015). These estimates clearly suggest that agriculture has to produce more food from less water to feed the burgeoning population with changing food habits. This implies the need for adoption of efficient irrigation methods to make agriculture sustainable in the long-run. In India, agriculture is the predominant user of water resources. Irrigation has played a catalytic role in agricultural growth and development of the country due to its positive, direct and indirect impacts. With the massive financial investment by the governments and the farmers, net irrigated area in the country increased from 20.85 million 2 hectare (Mha) in 1950-51 to 68.38 Mha in 2014-15 (DES, 2019). Although India is a world leader in irrigation infrastructure, still half of the total cropped area (51%) remains rainfed and depends on monsoon rainfall. Further, many studies have flagged sustainability and equity concerns in irrigation development in the country (Selvarajan and Roy, 2004; Narayanamoorthy, 2011; Srivastava et al., 2014). It has been observed that positive impact of irrigation development could not be achieved equally across different geographical regions, and unsustainable water resource development in north-western region co-exists with its under-utilization in eastern region of the country (Srivastava et al., 2014). A structural shift in the sources for irrigation has also been observed during the course of irrigation development. While the area under both surface and groundwater sources has increased, the share of surface water sources has declined from 41% in 1970-71 to 23% in 2015-16. On the other hand, the share of groundwater in net irrigated area increased from 38% to 62% during the same period. The over-dependence on groundwater sources has raised several sustainability issues and its socio-economic and ecological manifestations in many pockets of the

country (Janakaranjan and Moneach, 2006; Shah, 2007; Kumar et al., 2013). Low level of water use efficiency (WUE) in agriculture is another serious challenge for sustainable development of water resources. At present the WUE in Indian agriculture is estimated between 35% and 40% for canal irrigation and about 60% for groundwater irrigation. The main reasons attributed to this is the dominant use of conventional flood method of irrigation, causing huge conveyance losses due to poor irrigation supply system. Amidst rising demand for water, inter-sectoral competition, declining per capita availability and depleting water resources, several demandside management and supply-side augmentation measures have often suggested for holistic management of water resources (Rosegrant, 1997; Kumar, 2003; Briscoe and Malik, 2006). In this context, improving WUE in irrigation is accorded high priority. Under the National Water Mission, the Government aims to achieve at least 20% improvement in WUE from the existing level. It is estimated that with 10% increase in present level of WUE in irrigation projects, an additional 14 Mha area could be brought under micro irrigation from the existing irrigation capacities which would involve a very modest investment as compared to the investment that would be required for creating equivalent potential through new schemes (Swaminathan, 2006). Concerted efforts are being made to promote the use of drip and sprinkler irrigation technologies for enhancing WUE in agriculture and save water resources. 3 There are two lines of arguments regarding the water-saving potential of micro irrigation technologies. The first line of argument is that the adoption of micro irrigation technologies results in net water savings thereby eases the prevailing water-scarcity problems. The water saving is attained through substantial reduction in losses due to evaporation and inefficient field conveyance and distribution systems. This is the declared motive of the government to embark on the promotion of these technologies. However, the farmers' rationale for adopting these technologies may be different from the policy objectives of the government. Farmers may give more weightage to the other attributes of micro irrigation technologies such as improvement in yield, reduction in labor requirement, improvement in output quality, etc. in their adoption decisions. The second line of thought is that even though micro irrigation technologies can result in water savings at the plot or field level, it may not translate into net water savings at aggregation level such as the watershed or the basin (Molden et al., 2001; Narayanmoorthy et al., 1997). According to this line of thought, the net water savings could be only modest if the phenomenon of return flows, much of which goes to recharge the underground water source, is considered as useful. Thus, the adoption of micro irrigation technologies may not automatically lead to water saving at the basin level, unless enabling institutional and economic policy instruments are put in place that allow the equitable distribution or allocation of the saved water. In the backdrop of this observation, the paper analyzes potential, adoption, and impact of micro irrigation technology.

The specific objectives of the study are ;

(1) The study of examine institutional arrangements and government schemes to promote adoption of micro irrigation technology.

(2) The study of assess impact in micro irrigation technology.

Speech of Theory

The study has used both secondary data to examine potential, adoption and impact of micro irrigation technology. The time-series data was compiled from various published sources for estimating potential area under micro irrigation and analyzing its adoption pattern across the states. Appropriate analytical techniques like descriptive statistics, logit model, two-stage Heckman procedure and fixed effects regression models have been used to analyze data.

What is Micro-Irrigation?

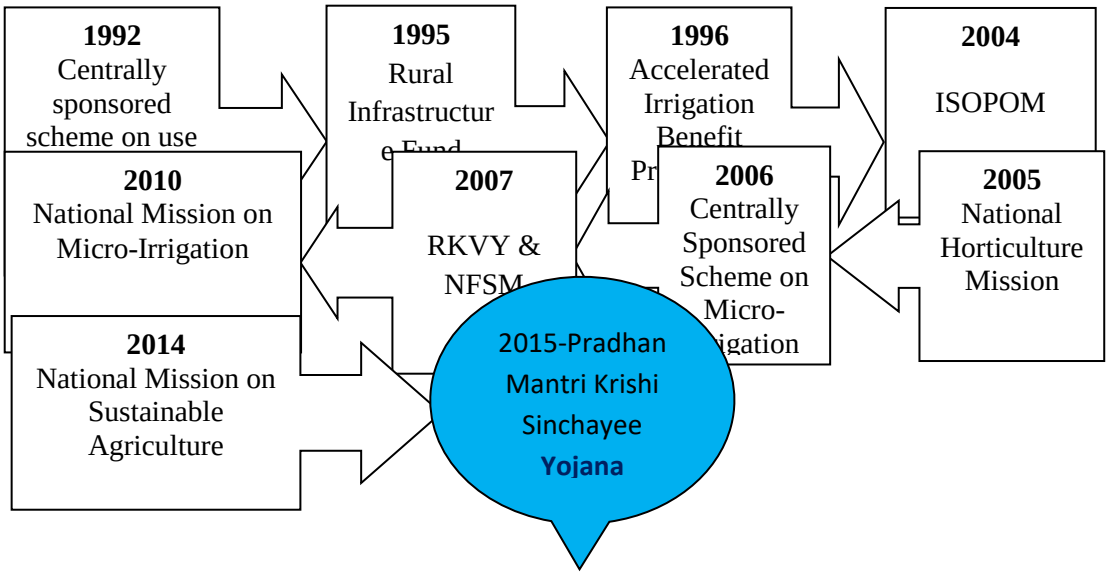
Micro irrigation is the modern method of irrigation which helps to save water and increases the water use efficiency. It makes use of dippers, sprinklers and foggers. Micro irrigation can increase yields and decrease water, fertilizers and labour requirements. It can also help to bring the degraded uncultivable land under cultivation.

The Evolution of Micro Irrigation Scheme in India

The journey of micro irrigation (MI) in India was started in 1981 when the National Committee on Plasticulture in Agriculture (NCPA) approved the use of plastics in agriculture on a pilot basis. The NCPA, in its four successive report (1982, 1983, 1984, and 1985), emphasized upon promoting use of plastics for drip irrigation, mulching and green houses to boost horticulture production. Based on the recommendations of NCPA, the Government of India launched a centrally-sponsored scheme on the use of plastics in agriculture in 1992. Under the scheme, farmers were eligible for financial assistance or subsidy for installing MI system depending on land size, cost and economic condition of farmers. Besides installing drip system, the Government also extended subsidy for drip demonstration farms. To accelerate spread of MI technologies, the Government created the Rural Infrastructure Development Fund (RIDF) under the purview of National Bank for Agriculture and Rural Development (NABARD) in 1995-96 with an initial corpus of Rs. 2000 crore. A total of 36 eligible activities including micro, major and medium irrigation projects were provided the financial assistance through RIDF. In 1996-97, Accelerated Irrigation Benefit Programme (AIBP) was launched for giving financial assistance to states with an objective of expediting completion of ongoing irrigation projects. The Extension, Renovation and Modernization (ERM) of irrigation projects, with the provision of implementation of MI in at least 10% of command area, were given priority in extending financial support. Similarly, in the centrally sponsored Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) launched in 2004 in 14 major oilseeds growing

states, financial assistance was provided for creating efficient irrigation infrastructure through distribution of sprinkler sets or drip system. All types of farmers, including small and marginal categories, were eligible to participate in this scheme. The launching of National Horticulture Mission (NHM) in 2005 strengthened the MI activities and accelerated its spread on a large scale. The mission aimed at creation of water sources, protected 6 cultivation, and precision farming, which promote MI technology. With broad objectives for the holistic growth of horticulture sector, NHM was restructured into a Mission for Integrated Development of Horticulture (MIDH) in 2014-15. In MIDH, adoption of MI is being fostered through the activities of protected cultivation and creation of water sources. Having realized the potential benefits of MI technology in conserving water resources and sustaining crop yield, the Government of India launched a dedicated scheme named Centrally-Sponsored Scheme (CSS) on MI on January 20, 2006. The main objective of the scheme was to enhance WUE in agriculture sector by encouraging farmers to adopt appropriate technological interventions like drip and sprinkler irrigation. At the time of launch, about 2.24 Mha area was covered under MI. In the flagship scheme, Rashtriya Krishi Vikas Yojana (2007), MI was included as one of the components for ensuring an aggregate growth rate of 4% in agriculture and allied sector. To bring all states, including north eastern and Himalayan states, under the ambit of MI scheme, the Government upgraded the CSS on MI into National Mission on Micro irrigation (NMMI) in June 2010 and further to National Mission on Sustainable Agriculture (NMSA) in April 2014 and implemented On Farm Water Management (OFWM) programme from year 2014-15. The objective of the scheme was to create additional irrigation facilities through installing MI structures at the command of the farmers. From the year 2015-16, the Government has subsumed all existing schemes of irrigation into Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). The main motive of PMKSY is to provide water to every field (har khet ko pani), improve on-farm water use efficiency, enhance adoption of precision irrigation and water-saving technologies (per drop more crop). The scheme also aims to augment recharge of aquifers and introduce sustainable water conservation practices by reusing treated water for peri-urban agriculture and attract greater private investment. An outlay of Rs. 50,000 crore over a period of five years (2015-16 to 2019-20) was allocated for PMKSY. The scheme provides a comprehensive and holistic view of the entire 'water cycle' and proper water budgeting is done for all sectors namely, household, agriculture and industries. Presently, 11.4 Mha area has been brought under MI, 53.1% of which is covered under sprinkler system (6.06 Mha) and 46.9% under drip system (5.35 Mha) (MoA&FW, 2019). A time line of development of schemes promoting MI in the country is presented in Figure 1

Figure 1. Evolution of Micro Irrigation Scheme In India



Architecture of PMKSY

A Mission Directorate has been established in the Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India, for implementing PMKSY in mission mode. The mission is responsible for overall coordination and outcome-focused monitoring of all components of PMKSY for achieving its target. Micro irrigation is an integral component of the PMKSY (per drop more crop) to amplify WUE at farm level. This component (per drop more crop) is being implemented by the Ministry of Agriculture and Farmers' Welfare (MoA&FW), Government of India. Table 1 presents the committees and their responsibilities to implement the PMKSY at various levels. District irrigation plan (DIP) provides a holistic irrigation development perspective of the district, outlining medium-to long-term development plans integrating three components viz. water sources, distribution network, and water use applications.

Table 1. Committees involved in implementation of PMKSY

Committee		Chairperson and Member	Work
National level	National Steering Committee (NSC)	PM as Chairperson and Union Ministers from concerned ministries and Vice Chairman, NITI Aayog as members	To provide general policy strategic directions for programme implementation and overall supervision addressing national priorities, etc.
State level	National Executive Committee (NEC)	Vice Chairman, NITI Aayog as Chairperson and Secretaries of concerned ministries/ departments and Chief Secretaries of selected States as members	To oversee programme implementation, allocation of resources, inter-ministerial coordination, monitoring & performance assessment, addressing administrative issues
	State Level Sanctioning Committee (SLSC)	Chief Secretary of the State as Chairperson	To sanction projects and activities as recommended by Inter-Departmental Working Group
District level	Inter Departmental Working Group (IDWG)	Agriculture Production Commissioner/ Development Commissioner as Chairperson and Secretaries of line departments as members.	Recommend project and activities to SLSC
	District Level Implementation Committee (DLIC)	District Magistrate Collector / CEO of Zila Parishad/ PD DRDA as Chairperson, and JD/ DD of line departments and progressive farmers, representative of MI industry, and leading NGO as members	To oversee PMKSY implementation and interdepartmental coordination

The DIP identifies gap in the existing irrigation plan after assessing available resources, which could be added from ongoing schemes. So, DIP is considered as foundation for planning and implementation of all components of PMKSY. All communications between the MoA&FW and State Governments are made through the nodal department. The state agriculture department may be the nodal department for implementation of PMKSY (Table 1). The main motive of PMKSY is to ensure efficient delivery and use of water at every farm for enhancing agricultural production and productivity. However, a state government is free to identify the nodal department based on the established institutional set up and mandate of the department.

Assistance Pattern for Micro Irrigation

The subsidy scheme of MI (borne by the Centre and the states) aims to encourage farmers to adopt innovative irrigation system on a large scale with faster speed. However, with a view to broadening the scope and coverage of MI, many states have supplemented the specific subsidy structure with funds from their own resources and prioritized its allocation towards specific regions and beneficiary groups. For instance, while the SC/ST and general categories of farmers in Andhra Pradesh were provided subsidy up to 100% and 90%, respectively, all categories of farmers in Bihar were offered subsidies of 50%, irrespective of their landholdings on micro irrigation methods. 0Further, subsidy on drip irrigation is significantly higher than sprinkler irrigation in Andhra Pradesh which implies that the state is encouraging drip system over the sprinkler irrigation. In Gujarat, subsidy on MIS was higher for dark zone than non-dark zone, while Rajasthan provides higher subsidy to DPAP/DDP area as compared to their counterparts. Also, Maharashtra is offering higher subsidy to farmers of Vidarbha region than other regions. The unit-cost of drip irrigation system varies with plant spaci0ng and location of water resources. The Central Government issues guidelines on the cost structure for installing MI system with different plant spacing. As per the guideline, subsidy is given to farmers under various categories. Small and marginal beneficiary farmers installing MI systems receive 55% and other beneficiary farmers receive 45% as subsidy on total cost. Subsidy amount is shared by the Centre and State Government in the ratio of 60:40 for all states, except North Eastern and Himalayan states, wherein the ratio is 90:10. The Central Government grants total fund to the Union Territories. In the present scheme, subsidy is limited to five ha per beneficiary for installation of MI system. Based on MI coverage, states are classified into following three categories:

Category A states: States with comparatively better penetration of drip technology have been brought under category "A". These include Andhra Pradesh, Delhi, Gujarat, Goa, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, and Telangana.

Category B states: All the states except covered under the category "A" and those falling in the Himalayan belt come under category "B". These include Bihar, Chhattisgarh, Jharkhand, Odisha, Uttar Pradesh, West Bengal and Union Territories. Considering lesser availability of companies and after sale service, the unit cost of MI is considered 15% higher for these states.

Category C states: States with very low penetration of drip technology due to poor infrastructure and difficult terrain have been grouped under "C". These states include north eastern and hilly regions, namely, Assam,

Pre-Installation Activities

The implementing agency identified by the state government advertises scheme at block and village levels through its existing networks. At the district level, it appoints a nodal officer who is responsible for coordination with scheme implementation. It disseminates the suppliers list and unit price approved by SLSC to the farmers. At least one district level seminar/ workshop is conducted for creating awareness about MIS. The implementing agency will compile and scrutinize the application submitted by the farmers and forward the same to the company's or manufacturer's local office as indicated by the farmers. The beneficiary share may be deposited with manufacturer or their representative or the state nodal agency as per the practice to be adopted by the state with the approval of SLSC. The beneficiary is free to purchase MI equipment from any manufacturer from the approved list of registered manufacturers. The manufacturers need to follow certain processes indicated in Table 2.

Table 2. Processes to be followed by the material supplying firms

Approval
Assessment of the crop water requirement and design the system accordingly Prepare cost estimate and submit it to the implementing agency duly indicating the time frame for installation The implementing agency will approve the estimate, issue work order and ensure installation.
Installation
Quality components with BIS marking are installed at farmer's field The installed system should match the water requirement of the crop earlier estimated Necessary orientation and training given to the beneficiary farmers for system maintenance and irrigating the crop Proper warranty and a user's manual for running and maintenance of system are provided to farmers A certificate towards successful installation/commissioning of system is obtained from the beneficiary.

Source: Gol(2017a)

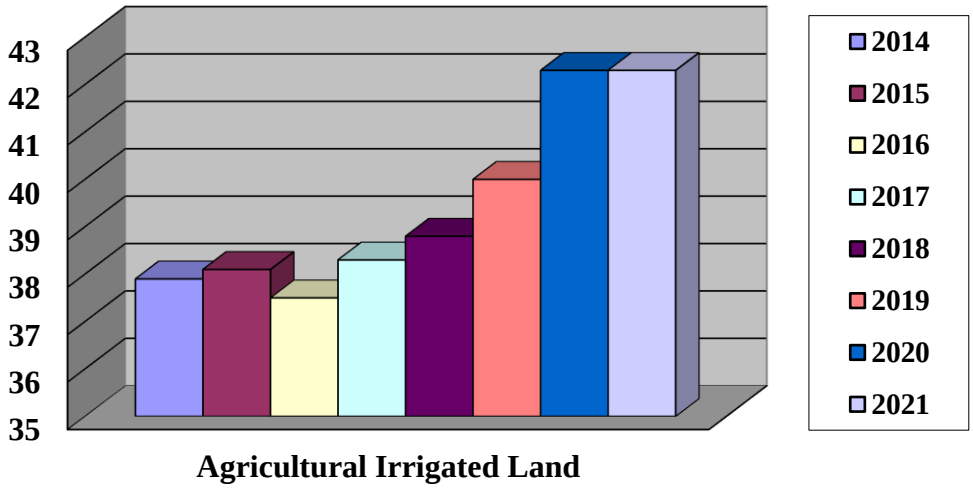
Post Installation Disbursement of Subsidy

The manufacturer will install the MI system as per the agreement with the state nodal agency and the procedure for payment is decided by the SLSC. After physical verification of MI system with satisfactory certificate from beneficiary, the implementing agency will disburse recommended subsidy amount to the beneficiary bank account electronically. In case the amount is placed with the manufacturers or companies or financial institutions on behalf of the beneficiary, the consent of beneficiary is required and the transaction details are conveyed to him or her over SMS immediately and subsequently in writing.

Trends in Public Spending and Area under Micro Irrigation

At the time of launch of Central Sector Scheme on MI in 2005-06, the area covered under micro irrigation was 2.24 Mha. The public investment and area covered with micro irrigation has shown a consistent increase, except in few year. The public spending witnessed over 10 times increase between 2005-06 and 2018-19. Consequently, coverage under MI increased from 2.24 Mha in 2005-06 to 11.41 Mha in 2018-19. Of the total coverage (11.41 Mha), sprinkler system constituted 53.1% share and remaining 46.9% of area was covered under the drip system in 2018-19. Source: DES (2019). Future the figure 2. trend in area under micro irrigation during 2014 -15 to 2021-22. Agricultural irrigated land (% of total agricultural land) in India was reported at 42.27 % in 2021, according to the World Bank collection of development indicators, compiled from officially recognized sources. India - Agricultural irrigated land (% of total agricultural land) - actual values, historical data, forecasts and projections were sourced from the World Bank on December of 2023.

Figure 2. trend in area under micro irrigation during 2014 -15 to 2021-22.



Source : World Bank Development Indicators

India's Agricultural Irrigated Land (% Of Total Agricultural Land) Agricultural irrigated land refers to agricultural areas purposely provided with water, including land irrigated. Besides following observation Table : 3. State-wise Area Covered under Micro Irrigation

Table 3. State-wise Area Covered under Micro Irrigation (as on 31.03.2022)(Hectare)

Name of State	Drip	Sprinkler	Total	Name of State	Drip	Sprinkler	Total
Andhra Pradesh	1400780	521165	1921945	Maharashtra	1414185	625598	2039783
Arunachal Pradesh	6245	4275	10520	Manipur	358	9933	10291
Assam	7603	25671	33274	Meghalaya	308	207	615
Bihar	15834	106995	122829	Mizoram	5914	1808	7722
Chattisgarh	35600	345634	381234	Nagaland	8040	7277	15317
Goa	1386	1346	2732	Odisha	32354	142798	175152
Gujarat	921010	788672	1709682	Punjab	37682	16508	54190
Haryana	43868	639656	683524	Rajasthan	318742	1777985	2096727
Himachal Pradesh	7934	6403	14337	Sikkim	7006	10518	17524
Jammu & Kashmir	1780	293	2073	Tamil Nadu	867898	387723	1255621
Jharkhand	30056	18211	48267	Telangana	222603	91085	313688
Karnataka	824916	1604399	2429315	Tripura	2304	3204	5508
Kerala	24360	9289	33649	Uttar Pradesh	57963	245138	303101
Madhya Pradesh	357328	301497	658825	Uttrakhand	14941	11796	26737
West Bengal	10437	107259	117696	**Total**	**6679434**	**7812443**	**14491877**

Source : Department of Agriculture & Farmers Welfare

Present Scenario of Micro Irrigation in India

Further data provided by the Ministry of Agriculture and Farmers Welfare to the Lok Sabha show that the net irrigated area in the country is 68,649 thousand ha In detail table 4. Area covered under micro irrigation technology.

Table 4. Area Covered Under Micro Irrigation

Less Than One-Fifth of Irrigated Area Under Micro Irrigation	
	Area under micro irrigation

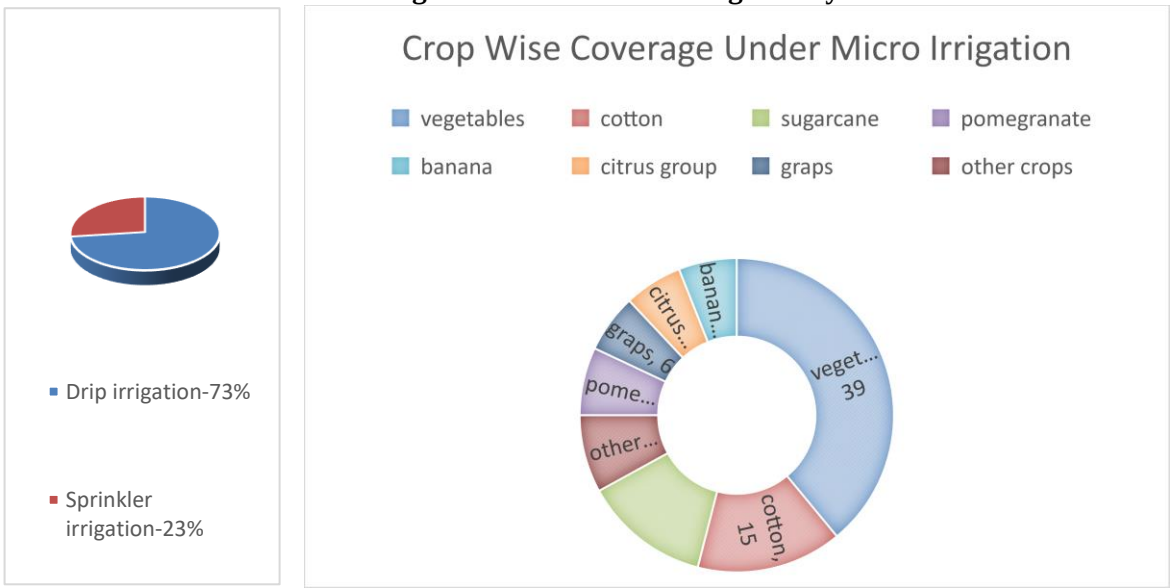
Total net irrigated area	Drip irrigation	Sprinkler irrigation	% Covered
68649	6112.05	6796.39	19
State with more than 30 % of irrigation area under micro irrigation			
State	Net irrigated area	Area under micro irrigation	
		Drip irrigation	Sprinkler irrigation	% Covered
Sikkim	16	6.35	5.26	73
Andhra Pradesh	2.719	1388.13	519.17	70
Karnataka	3104	752.82	1148.70	61
Maharashtra	3163	1314.81	561.65	59
Mizoram	16	5.09	2.45	47
Tamil Nadu	2385	735.81	311.06	44
Gujarat	4233	852.02	747.75	38
Large State are Lagging				
State	Net irrigated area	Area under micro irrigation		
		Drip irrigation	Sprinkler irrigation	% Covered
Uttar Pradesh	14337	33.52	179.64	1
Madhya Pradesh	9876	322.27	249.24	6
Punjab	4128	36.03	13.7	1
West Bengal	3106	10.32	78.12	3
Bihar	3101	12.49	106.98	4

Source : DAC &FW: Lok Sabha Fub-2021.

Use Of Micro Irrigation system

The micro irrigation usage scenario is shown in figure .3 below From this it can be seen that in micro irrigation, the share of drip irrigation technology 73 percent sprinkler irrigation technology is 23 percent, also if micro irrigation technology is taken from a crop wise perspective, it is seen that micro irrigation is used in various crops.

Figure 3. Use Of Micro Irrigation system



Observing table and figure number three & four abow -

I) The average penetration of micro irrigation in India is 19% (as on February 3, 2021), which is much lesser than many countries.

II) The agriculture land covered under micro irrigation is 12,908.44 thousand ha in which drip irrigation is 6,112.05 thousand ha and sprinkler irrigation is 6,796.39 thousand ha

III) Up to 60% of water used for sugarcane, banana, okra, papaya, bitter gourd and few other crops could be saved if drip irrigation systems employed for cultivation.

IV) Currently only Sikkim, Andhra Pradesh, Karnataka and Maharashtra have more than half of their net cultivable area under micro irrigation whereas 27 states in India have less than 30% micro irrigation system out of which 23 have less than 15%

V) Uttar Pradesh is the largest producer of Sugarcane, which is water intensive crop but has only 15% area under micro irrigation and Punjab has only 12%.

VI) Bihar and West Bengal are among the major Agriculture Dependent States that have less than 5 per cent micro irrigated land. An September 2020, Agriculture minister Mr. Narendra Singh Tomar said that the government has set the target of covering 100 lakh ha land in the next five years under micro irrigation.

Classification of Micro Irrigation

MI system can be broadly classified into two categories I) Drip irrigation system, II) Sprinkler irrigation system.

I). Drip irrigation system

Drip irrigation system also known as tickle irrigation system, is a method of applying the requited amount of water directly to the root zones of plants through dippers or emitters at frequent intervals. In this system water is applied drop by drop or by a micro jet on the soil surface or sub-surface at a rate lower than the infiltration rate of the soil. The emitters dissipate pressure from the distribution system by means of orifices, vortexes and tortuous or long flow paths, thus allowing a limited volume of water to be discharged.

Drip irrigation system reduces water consumption by 50% With drip irrigation water applications are more frequent which provides a more favorable moisture level for the plants to thrive.

II). Sprinkler irrigation system.

Sprinkler irrigation is a method of applying irrigation water which is similar to natural rainfall Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. Sprinkler irrigation is a type of pressurized irrigation that consists of applying water to the soil surface using mechanical and hydraulic devices that simulate natural rainfall.

Impact of Micro-Irrigation

- An impact evaluation study of micro irrigation scheme carried out by the Department of Agriculture Cooperation and Farmers. Wiles found that irrigation cost is reduced by 20-50 per cent with an average of 32.3 per cent in micro-irrigation schemes.
- Electricity consumption is reduced by about 31 percent and the saving of fertilizers is in the range of 7 to 42 percent.
- Most importantly, the overall income enhancement of farmers is in the range of 20 to 68 percent with an average of 40.5 percent

Evidences from Previous Studies

A review of previous studies on the impact of MI technology in terms of water saving, energy and input saving, employment and income enhancement is summarized in table 5. The analysis has revealed significant savings in water, energy, and fertilizer, and increase in cropped area and yield resulted from adoption of MI, thereby overall reduction in production cost. However, the extent of benefits varied depending upon underlying factors such as differences in MIS components, farming system, climatic conditions, socio-economic settings, etc. It is to be noted that most of the studies are based on experiments at research farms, and impact studies based on field survey are limited in numbers. Ten key benefits of MI identified from past studies are presented in figure 4. These benefits are classified into two categories: (1) input saving, and (2) yield increasing/quality enhancing. Water saving and water use efficiency, reduction in labour use, reduced soil loss, and reduction in energy cost are some of the benefits noted under input saving category. The benefits like higher yield, improved quality resulting to higher farm profit are classified under returns from MI technologies.

Table 5. Review of past studies on impact of micro irrigation in India

Studies Study	Area/ Region	Water Saving	Energy Saving	Fertilizer Saving	Cost Saving	Additional Area Under Irrigation	Yield/ Income Increase
Ncpah, 2014	India	25-40	30-40	20	40	30	30
Priyan and panchal, 2017	India	50-90	30.5	28.5			
Kapur et al. 2015	Maharashtra	50-90	30.5	28.5	30-45	31.9	42.4-52.7

Wrachienb et al. 2014	Maharashtra	37				19-29
Narayanamoorthi, 2003, 2005, 2006, 2008, 2018	Maharashtra	12-84 & 8-60		50		114
Bhaskar et al. 2005	Maharashtra	40-50				30-100
Panigrahi et al, 201	Odisha			17.9		15.4
Reddy et al., 2017	Guntur, Ap			25-40	55-60	
Raina et al. 2011	Himachal Pradesh	30-35		41.37		
Paul et al. 2013	Bhubaneswar, Odisha				54	57
Biswas et al. 2015	Gazipur, Bangladesh	50				25-27
Kumar et al. 2016	Moradabad, Uttar Pradesh	35				
Chandrakanth et al, 2013	Karnataka					65
Tiwari et al. 2014	Kharagpur					21.05
Chandran and surendran, 2016	Kerala					13-47
Bhamoriya and mathew, 2014	Gujarat		20			20-30
Jha et al. 2017	Punjab	40-42				9.13
Vanitha and mohandass, 2014	Tamil Nadu	50	100			19.05
Rao, et al. 2017	MP	40				11.03

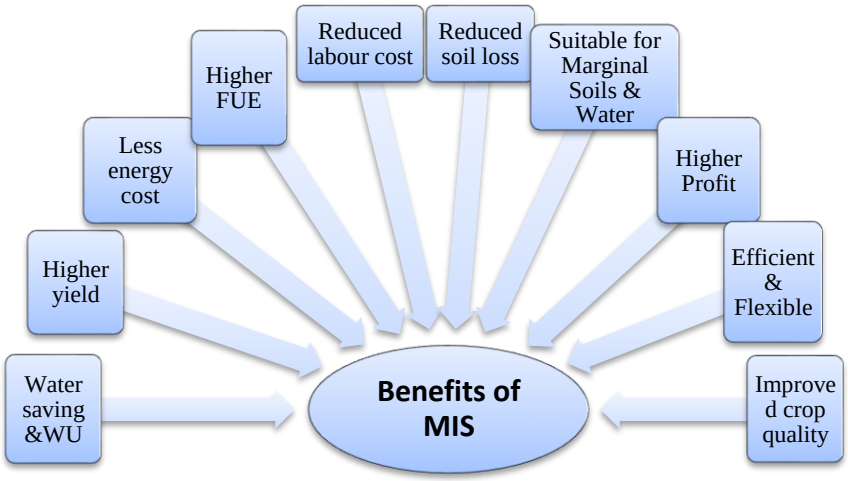
Source: Authors' Compilation

Adoption of MI provides better employment and income generation opportunities to rural youths by attracting them towards agriculture and improving their skills through capacity building program.

Benefits of micro irrigation

Further the observation to Figure 4. discusses the benefits realized by the farm households adopting MI technologies.

Figure 4. Benefits of micro irrigation



The main vehicle of government policies to promote MI systems are product subsidies which range from 50% to 90%. Provision of the government subsidy has been instrumental in promoting adoption of MI technologies. The regression coefficient for government subsidy was positively associated with the area under MI technology. It could be concluded that adoption of MI in major states increased with provision of subsidy for installation of MI technologies. This could be due to the fact that financial support provided by the government reduced the cost of installation that motivated the farmers to go for installating capitalintensive irrigation infrastructure, which otherwise was difficult for individual farmers.

Summary

The main purpose of promoting MI technology (drip and sprinkler) by the governments and other stakeholders is to increase WUE, thereby bringing more area under irrigation (water to every field) and increase water productivity (per drop more crop). With the launch of Central Sector Scheme on MI in 2005-06, there has been a substantial increase in area under micro irrigation. Presently, 11.4 Mha area is covered under MI (comprising 6.06 Mha under sprinkler and 5.35 Mha under drip) in 2018-19. Both central and state governments are promoting this capital-intensive irrigation technology by providing subsidy, creating awareness, organizing fair & camps, and demonstrating benefits. The subsidy provided under National Mission on Micro Irrigation (NMMI) through central government is fixed uniformly for different categories of farmers with a ceiling of five hectare. This needs to be revisited as about 15% of large and medium farmers' hold more than 55.42% of operational landholdings in India. Adoption of MI provides better employment and income generation opportunities to rural youths by attracting them towards agriculture and improving their skills through capacity building program.

There has been a considerable progress in area coverage under MI in India during past one and half-decades. The area coverage increased from 2.24 Mha in 2005-06 to 11.41 Mha in 2018-19. Of the total MI area, sprinkler system accounts for 53.1% share and the remaining (46.9%) area is covered by drip system. Farmers using sprinkler irrigation in wheat crop, saved water by 15% and improved yield by 21% as compared to their counterparts using flood irrigation. Farmers using sprinkler also performed better on technical efficiency and water productivity. Overall, it can be said briefly, there is no denying the undeniable fact that irrigation schemes the use of micro-irrigation in increasing the irrigated area.

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