MICRO-IRRIGATION AND APPROACHES FOR IMPROVING WATER USE EFFICIENCY IN AGRICULTURE

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With half the cultivable land in the country still being rain-fed, there is mammoth potential for promoting micro-irrigation in India. To change this situation, there is need of strong political will, a dedicated team of extension personnel to create awareness among farmers about the importance of micro-irrigation and available Govt. Schemes along with a better and efficient administration delivering the inputs.

Indian population is expected to reach 1.6 billion by 2050, which along with a large number of livestock needs to be supported from the available resources. To achieve food security of this large population, increase in productivity is the only option as the land devoted for agriculture sector is limited. This agrarian sector is the principal source of livelihood for over 60 per cent of rural households. As per United Nations Food and Agriculture Organization (UNFAO, 2011), irrigation and livestock segments use 91 per cent of water withdrawal in India. About a third of the water withdrawal comes from groundwater. Ground water level is depleting very fast due to its use in irrigation along with rural and urban water supplies. Presently, about 54 per cent of India suffers from water stress. As recharging most of this withdrawn groundwater takes a long time and the groundwater exploited from greater depth cannot be recharged by rainfall, there is an urgent need of sustainable and judicious use of water resources.

Introduction:

Water is applied to crops externally through irrigation, in order to sustain crop production and productivity. The tropical climate of India leads to a high evapo-transpiration and prevalent uneven distribution of rainfall across regions, necessitates increasing the area under irrigation. India has a net irrigated area of 65.3 million hectares out of 142 million hectares under agriculture. Most common method of irrigation under Indian agriculture is Surface irrigation, but its water use efficiency is low (Table 1). The irrigation methods having greater irrigation efficiency are different methods of micro-irrigation like drip and sprinkler irrigation. Drip irrigation and Sprinkler irrigation are the usual micro-irrigation systems followed.

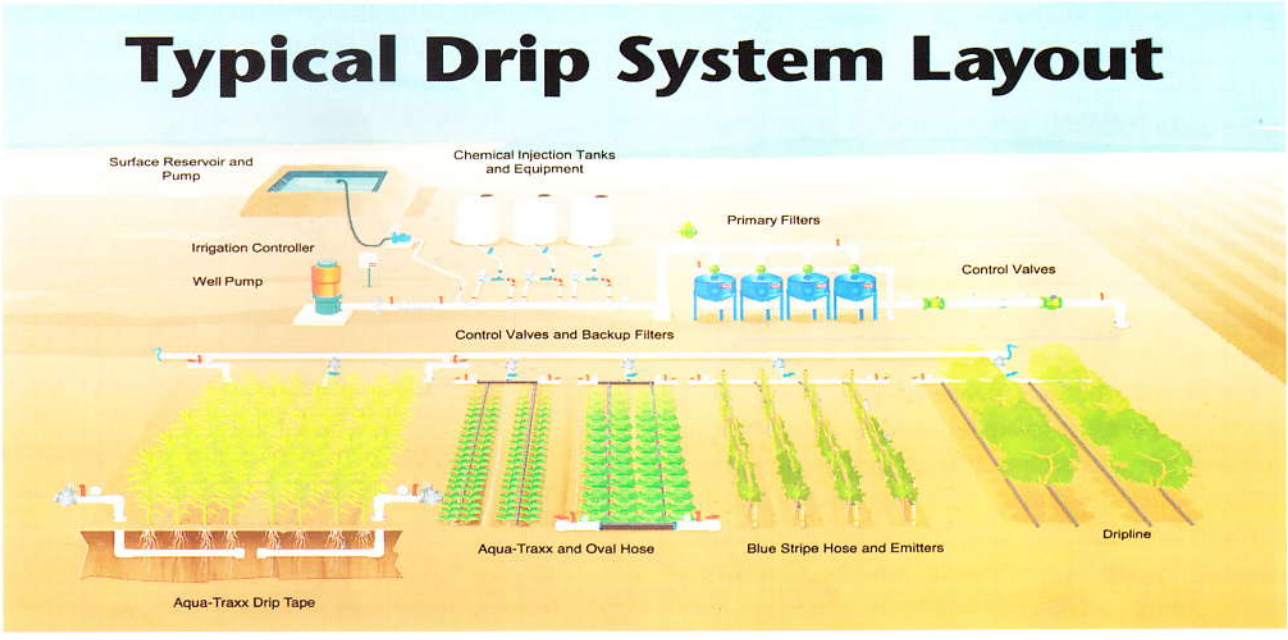


Table 1: Water Use Efficiency (%) Under Different Irrigation Systems

	Surface irrigation	Sprinkler irrigation	Drip irrigation
Conveyance efficiency (%)	50-70	Not applicable	Not applicable
Application efficiency (%)	40-70	60-80	90
Surface water moisture evaporation (%)	30-40	30-40	20-25
Overall efficiency (%)	30-35	50-70	80-90

Drip irrigation system irrigates the root zone of the crop, not the whole surface. It provides a continuous supply of water throughout the day by releasing frequent, but small quantities of water continuously unlike surface irrigation where feast and famine cycles affect growth and yield parameters. In sprinkler irrigation, water is distributed through a system of pipes, is sprayed on the crops and falls as smaller water drops.

Micro-irrigation: Way to 'More Crop Per Drop'

Micro-irrigation helps in reduction of input consumption and increases the productivity of the crop by various means. Judicious use of water in micro-irrigation systems helps to improve the water use efficiency by saving water and brings down the overall irrigation costs by saving water, electricity and labour, e.g. In general, an average cost reduction of 31.9 per cent was achieved by farmers which were almost 50 per cent farmers from Gujarat. In micro-irrigation systems, the evaporation, runoff and deep percolation losses are reduced. Water is also saved as limited quantity of water is applied at root zones or selected places which actually need water and thus, small water sources can also be used for micro-irrigation. As a result of reduction in input cost, farmers have more choice to introduce new crops on their farms which is evident from the data that about 30 per cent of micro-irrigation adopting farmers have adopted new crops.

Electricity consumption in agriculture is about 20-25 per cent and the use of micro-irrigation techniques help in improving power use efficiency by 30-50 per cent as lower power and fewer hours are involved in irrigation. Judicious use of fertilizer and direct fertilizer application to the root through fertigation can improve fertilizer consumption efficiency by 20-30 per cent. From these two commodities, a lot of electricity and fertilizer can be saved along with the subsidy amount provided to the farmers for this purpose amounting to thousands of crores.

As water is applied in a controlled manner at the targeted places, the soil moisture remains at optimal levels and in turn, increases the crop productivity, of fruit (42.3 per cent) as well as vegetable crops (52.8 per cent). This helps in increasing the income of the farmers. The economic viability analysis of micro-irrigation tilts in favour of farmers. Though, the farmer has to pay the installation cost at first, the benefits to the farmer is really promising and sustainable.

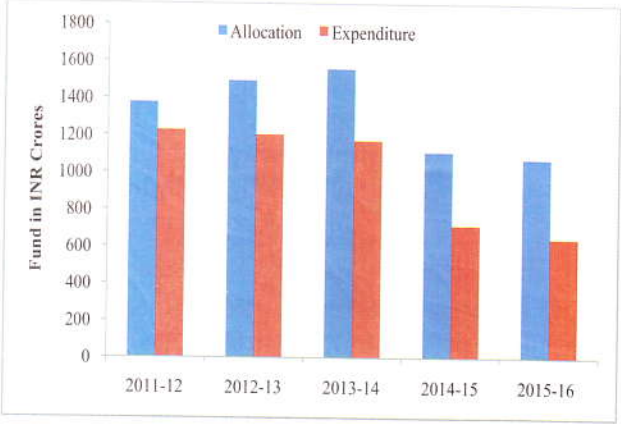
Current Status and Growth in India:

India now has close to 8 million hectare out of 140 million hectare of total area under cultivation through micro-irrigation, i.e. about 5.5 per cent average penetration at the all India level, much less than developed countries and even China. The real scenario is even worse as only some of the western, southern and northern Indian states particularly Rajasthan, Maharashtra and Andhra Pradesh have adopted this technology to some extent, but the performance of eastern and North-eastern states are the worst. Majority of the area covered under micro irrigation systems comes under sprinkler irrigation with 56.4 per cent, while 43.6 per cent comes under drip irrigation. However, area under drip irrigation has shown a stronger growth in recent years than sprinkler irrigation.

With half the cultivable land in the country still being rain-fed, there is mammoth potential for promoting micro-irrigation in India. To change this situation, there is need of strong political will, a dedicated team of extension personnel to create awareness among farmers about the importance of micro-irrigation and available Govt. Schemes along with a better and efficient administration delivering the inputs.

Future Potential:

Task-force on micro irrigation (2004) estimated a potential of 27 million hectares for drip irrigation and 42.5 million hectares for sprinkler irrigation with



a total potential of 69.5 million hectares out of arable land of 140 million hectares.

Table 2: Potential Area (million hectares) under Crops Suitable for Micro-Irrigation

Crop	Potential Area
Cereals	27.5
Pulses	7.5
Oil seeds	4.9
Cotton	8.8
Vegetables	6.0
Spices and condiments	2.4
Flowers, medicinal and aromatic plants	1.0
Sugarcane	4.3
Fruits	3.9
Coconut, plantation crops and oil palm	3.0
Total	69.5

(Source: Task-force on micro-irrigations, 2004)

Government Initiatives on Micro-irrigation :

The financial allocation by Government of India to micro-irrigation in different financial years and their utilization have been presented below:

The situation as targeted and achieved is alarming as about 40 per ent of the funds in the last two years have not been utilized. Previously, the Government targeted a growth rate of 0.5 million ha/per year coverage under micro-irrigation, which needs to be enhanced to achieve a sustainable growth in agriculture and achieve the potential. Realizing the grave problem, in 2017, Indian

Government has allocated a corpus fund of Rs. 5000 crore on micro-irrigation to NABARD for achieving the goal of 'Per Drop More Crop', in addition to Rs. 50,000 crore to Pradhan Mantri Krishi Sinchayee Yojna for 2015-19 five year period.

Some of the Government efforts via various micro-irrigation focus schemes/projects are as follows:-

i) **National Mission on Micro-irrigation: NMMI (2010-2014):** The NMMI is regarded as a strong and well visioned programme. Under this programme, the area under micro-irrigation almost doubled, growing from 3.09 million ha in 2005 to 6.14 million ha in 2012. Overall, many states achieved more than 90 per cent of set physical and financial targets.

ii) **National Mission for Sustainable Agriculture: NMSA (2014-15):** Under the head 'On Farm Water Management' component of NMSA, micro-irrigation issue is addressed. It emphasizes on enhancing water use efficiency by promoting efficient on-farm water management technologies and equipments. It also focuses on effective harvesting and management of rain water.

iii) **Pradhan Mantri Krishi Sinchayee Yojana: PMKSY (2015-2019):** It was launched in July 2015 for the period 2015-16 to 2019-20 with a financial outlay of Rs. 50,000 crores for 2015-19. The objective of the scheme is "to achieve convergence of investment in irrigation at the field level, expand cultivable area under assured irrigation." In short, there is a need to converge all ongoing efforts and to bridge gaps through location specific interventions.

Government is hoping to encash the many gaps through this scheme. It is realized that only about 20 per cent of rainfall is actually utilized by agriculture, only marginal increase in irrigation can bring an additional thousands of hectares under assured irrigation. It also emphasizes utilizing the potential groundwater reserve of 202 billion cubic meters. Micro-irrigation fits into the *'Per Drop More Crop'* component, which advocates improving water use efficiency by use of precision water application devices like drips, sprinklers, pivots, rain-guns etc. on the farms. It also aims to construct micro-irrigation structures like tube wells and dug wells, along with water lifting devices like diesel/electric/solar powered pump sets including water carriage pipes, underground piping system. Thus, this aims to create infrastructures on micro-irrigation within certain months, not years as in Watershed Development Scheme. This vision is welcomed from every sector involved in micro-irrigation, but the success rate is needed to be seen, as financial hurdles, administrative lags and awareness among farmers is still lacking. The vision is optimistic and can have far reaching consequences. A whole hearted approach from political, bureaucrats, extension workers and farmers is needed to achieve its objective.

Approaches for Enhancing Water-use Efficiency in Agriculture:

Supplemental irrigation combined with on-farm water-harvesting practices, such as mulching or increasing bund height, reduces susceptibility to drought and helps farmers to get the most out of the scarce resources. Mitigating the effects of short-term drought is therefore a key step in achieving higher yields and water productivity in rainfed areas. Discussed hereunder are various means of enhancing use-efficiency and productivity of water in agricultural production system.

(i) **Avoid Over-irrigation:** Applying too much water to crops wastes soil and fertilizer as well as water. Frequent, light irrigations help keep water and mobile nutrients in the root zone where plants can use them. This practice is helpful in avoiding wastage of irrigation water as well as soil erosion.

(ii) **Select Crops and Cropping Systems Based on Available Water Supplies:** The crop selection for a particular agro ecosystem should be done on the basis of availability of water. As monsoon varies and water scarcity issue persists, aerobic rice varieties are being developed to require less water.

(iii) **Mixed Cropping System:** The water use efficiency in the mixed cropping fields of corn grasses were much higher than those in the fields where only corn or grass was grown. It is true for many mixed cropping systems.

(iv) **Irrigation Scheduling Based on Evapotranspiration (ET), Soil Water Content or Soil Water Tension:** Seasonal demand pattern for water varies from crop to crop. The optimal time to irrigate a particular field depends on the soil water-holding capacity, water extraction by the crops and rate of ET. Knowledge of water-holding capacity of the field soils helps in fixing the time for re irrigation. A sandy loam soil will not hold as much water as a silt loam, thus, it must be irrigated more frequently with less water per irrigation. Extra water is lost to runoff and goes deep into the ground. Moisture meter and tensiometer help in determining the moisture content in the soil. These instruments, when used with ET charts, provide a fairly accurate estimate of irrigation needs.

(v) **Use Full Irrigation at Critical Growth Stages and Deficit Irrigation at Rest of the Stages:** Deficit irrigation is irrigation that applies less water than the crop needs. Under deficit irrigation at non critical stages, the water productivity of the crops increases significantly with minor yield loss due to decrease in irrigation water input. Deficit irrigation particularly works well with deep-rooted crops such as wheat and corn, which minor test weight and yield loss. It is better to know each crop's tolerance of drought stress, and its irrigation should be done accordingly.

vi) **Practice Conservation Tillage:** To conserve soil water, conservation tillage practices like minimum tillage, no till, and strip till are much useful. Under these practices, tillage operation is reduced and crop residue from the previous crop is at least partially retained on the soil surface. The retention of crop residues helps in reducing water loss from the soil to the air and cools the soil. Tillage exposes the soil to drying, conversely, reductions in tillage help conserve

soil water. For strip tillage, cultivate only within the row zone and leave the inter-row zone undisturbed. This usually leaves at least 30 per cent of the previous crop residue on the surface after planting. Soil infiltration capacity of the inter-row zone is increased, allowing water to go where it's needed.

(vii) **Carefully Manage Surface Irrigation:** The irrigation efficiencies of surface irrigation systems are very low. They also bring a heavy flow of water in direct contact with soil, dislodging soil particles. Under surface irrigation, the top of the field often results in over-irrigation and the bottom is under-irrigated. Over-watering the top of the field stresses plants and causes nitrogen deficiency as nitrogen leaches below the root zone. Slightly drought stressing the bottom of the field often causes production losses similar to those caused by over-watering the top of the field. Mulch the bottom of the field with straw so the water that gets there soaks in.

To improve water infiltration in tight soils, polyacrylamide or straw mulch should be used for increasing water holding capacity of the soil. For crops that are less sensitive to moisture stress, use alternate-row irrigation, irrigate one side of a bed on one irrigation and then the other row or side.

Another strategy is to irrigate only compacted rows; since water infiltrates wheel-traffic rows more slowly than soft rows, water is less likely to move below the root zone. Compact the soft, non-traffic rows in furrow-irrigated fields, so their infiltration rate is similar to that of the wheel-traffic rows.

Switching over to micro irrigation methods like sprinkler irrigation or drip irrigation helps to manage water more efficiently and even often increase yields. Micro irrigation can save about 30-50 per cent of water than the amount used for furrow irrigation.

Present Challenges and Their Solution:

Micro-irrigation has penetrated only 5.5 per cent owing to various reasons which are discussed hereafter along with possible solutions.

i) **Finance:**
Micro-irrigation demands an initial investment which is not in the reach of every Indian farmer as most of them belong to small and marginal category. They need financing, but the procedure is not easy and the collateral is also very high. Though public and private sector financial institutions have devised special plans to support the farmers and manufacturers through different schemes, there are several flaws or lacking in their implementation. This needs to be sorted out and implemented effectively to accelerate the credit availability for purchase and installation of the micro-irrigation systems. Thus, easier financing norms will increase both the production and adoption rate of micro-irrigation systems.

ii) **Stable Scheme Guidelines and their Implementation:** It has been observed that schemes are only effective for 5 months of the year and are not available to the farmers during the peak demand months due to their uncertainty in guidelines for implementation. These are often very complex and in the recent years, have changed drastically year over year (NMMI to NMSA to now PMKSY). Thus, after missing the benefit of micro-irrigation in the peak cropping season, they could not realise the true benefits of a micro-irrigation system. This results due to the lack of smoother/ longer-term guidelines, which needs to be smoothened for faster approval and installation. The inefficiencies in the operating process for implementation results in this time lag along with their uncertainty of implementation. Therefore, ensuring availability of micro-irrigation system at the right time is needed to generate interests among the farmers. Delays in subsidy disbursement add to the plight. Thus, a dedicated team with clear and focused operational guidelines needs to be enforced to ensure its delivery at right time.

iii) **Use of Information Technology and Dedicated Team for Process Management:** The entire process, from application to installation and payment, should be backed by IT tools such as geo-tagging and referencing, which allow real-time monitoring of projects and helps to complete the process in time. A skilled and dedicated team focused on micro-irrigation further expedites the process.

iv) **Focusing Strategy for Water Intensive Crops:** Making drip irrigation mandatory for high water-consuming crops like sugarcane and rice etc. not only cuts water use, but also increases their productivity. Taking a crop-specific focus

would yield quicker results with large areas brought under micro-irrigation in shorter periods of time.

v) Other Practical Approaches:

To promote the judicious use of the water, use of water should be charged a nominal amount by the government. The public water bodies should be managed by local bodies for their maintenance and usage. In addition, package of practice should be designed specific for regions and crops, which would describe both the equipments and guidelines for effective use of these systems for the specific region and crop in question.

Conclusion:

Though irrigated area occupies only 37% of the total cultivated land, it contributes 60% to the national food basket. It emphasizes the need of irrigation or on-farm need based water management practices to get optimum production. The 'More Crop Per Drop' principle needs to be followed for sustainable production and enhancing water productivity. This will also help to alleviate water scarcity and help in ensuring food security. Need based irrigation, particularly micro-irrigation is a must for enhancing sustainable food production in this era of water scarcity to meet the national aim of providing food and nutritional security to all.

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National Water Mission

The main objective of the National Water Mission (NWM) is "conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources development and management". For achieving the objectives of the National Water Mission, long-term sustained efforts both in terms of time bound completion of identified activities and ensuring the implementation of identified policies and enactment of necessary legislation through persuasion at different levels with the State Governments have been envisaged. The five identified goals of the Mission are:

(a) Comprehensive water database in public domain and assessment of impact of climate change on water resource;
(b) Promotion of citizen and state action for water conservation, augmentation and preservation;
(c) Focused attention to vulnerable areas including over-exploited areas;
(d) Increasing water use efficiency by 20 per cent and;
(e) Promotion of basin level integrated water resources management.

Various strategies for achieving the goals have been identified which lead to integrated planning for sustainable development and efficient management with active participation of the stakeholders after identifying and evaluating the development scenario and management practices towards better acceptability on the basis of assessment of the impacts of climate change on water resources based on reliable data and information.