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Microirrigation: The water saving technology

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Abstract
Agriculture is both a contributor to and a victim of water scarcity and the issue is only going to get worse as agricultural demand increase in the future. Sustainable agricultural technologies are the only way to address this issue. Micro irrigation is a modern technique for irrigation that provides water to the crops with low pressure and flow. Using drippers, sprinklers, foggers and other emitters on the surface and subsurface of the ground. This system is effective in saving water and increase water use efficiency as they use pipes or underground tubes according to the crop need and surface runoff and deep percolation is totally avoided ensuring uniform water application. When compared to conventional irrigation system micro irrigation can lower usage by 70-80%. More engineering solutions will be used to increase the economic return, keeping water productivity more adaptable to new technology. The current approach assists with proper water usage by offsetting the drawbacks of conventional approaches with mostly involve drip irrigation and sprinkler systems. Micro irrigation systems can be used to increase crop quality and yield while conserving a significant amount of water. All of these highlight the necessity of water conservation and increased water usage effectiveness in order to increase agricultural production.

Keywords: Drip irrigation, sprinkler irrigation, challenges, efficient technology

Introduction
The improvements in irrigation over the past few decades have been astonishing. Given that India is a predominantly agrarian nation, technology advancements in sustainable agriculture can help to meet the challenges of an expanding agricultural demand in both the present and the future. The largest user of water is agriculture, which currently uses 70% of all freshwater withdrawals globally on average. It is critical to evaluate our capacity to meet future water scarcity at the regional and national levels by carefully identifying the conditions that make micro irrigation (MI) systems the "foremost venture advanced engineering " in terms of realising the potential benefits and minimizing conveyance loss. The degree to which such technologies can reduce the amount of water that crops use. A low-pressure irrigation system that applies water through small devices that spray, mist, sprinkle, or drip is referred to as Micro Irrigation (MI). Applying a small amount of water infrequently and at low pressure micro irrigation. The system consists of a vast network of low-pressure pipes. Water emission outlets, sometimes referred to as emitters, are offered at predefined intervals. According to (Amarasinghe *et al*. 2004; Kijne and co., 2003) [1, 11], water productivity plays a significant role in estimating future water requirements. With a decrease in the depleted fraction and an increase in output, water conservation technology in agriculture advances. Micro irrigation, which sends water straight into the plant root zone via the soil surface or onto the soil surface extremely close to the plant, is one of the most recent advancements in irrigation technology. Recent advancements aimed at adapting micro irrigation to various conditions for specific applications necessitated by horticultural and agronomic requirements. Drip irrigation and sprinkler irrigation systems, which have seen a significant increase in commercial significance, can be generically categorized as micro irrigation systems. Drip irrigation, often referred to as trickling irrigation, involves applying water to the soil at extremely low rates and closer to the plant root zone, resulting in a highly beneficial high moisture content in the soil. A device that allows the delivery of water at high pressure, similar to natural rainfall, is an irrigation sprinkler. Irrigation water is distributed by an arrangement of pipes, usually by pumping. The method can be used for a minor irrigation event to aid in germination, depending on the drip line depth, flow rate, and soil constraints. The natural ability to apply small amounts of irrigation can help decision-makers make irrigation events near the conclusion of the cropping season more water-efficiently.

Widely spaced crops allow for the wetting of a smaller portion of the soil volume, thereby lowering unnecessary irrigation water losses. When the parliament recognized the importance and likely advantages of the method to double the farmer's income together with agricultural sustainability and environmental quality, micro irrigation became increasingly popular. The union government introduced the Pradhan Mantri Krishi Sinchai Yojana, also known as more crop per drop, as its comprehensive flagship initiative. The precision farming centres for development conduct research and offer technical assistance for the implementation of the plan. The provision of high-quality irrigation systems, including sprinkler and drip irrigation, as well as suitable services following the sale that satisfy farmers, is crucial.

Micro-irrigation technology

Micro-irrigation technology ensures water consumption efficiency of up to 50% to 90%. This is made possible by the fact that micro-irrigation considerably lowers the losses associated with conveyance, runoff, evaporation, seepage, and deep percolation. With the water conserved, it is possible to expand the area of irrigation or restore degraded or waste land. Modern irrigation methods increase yields by maintaining a steady moisture level in the crop's root zone. Spraying and harvesting are still possible in the dry area between tree rows even while water is being applied. Consequently, irrigation methods that increase yield while reducing water use, crop yield improvement technologies, and water-saving crop technologies can be roughly separated into three categories. The adoption of micro irrigation can save up to 70%–80% of water compared to conventional irrigation. It is the routine application of small volumes of water to the soil's surface, or as droplets under the soil's surface, tiny streams or miniature sprays using emitters or application tools placed along a water supply lateral line. A well-constructed drip irrigation system significantly reduces the amount of soil evaporation, deep percolation, surface runoff, and nutrient leaching. Despite the fact that beneficial evapotranspiration ET for field crops may be very low, effective irrigation technologies help establish better control over the flow of water (water control) to the crop roots, decrease detrimental evaporation and unrecoverable percolation from the field, and frequently increase beneficial evapotranspiration ET. Water vaporisation from the soil surface, the groundwater table's capillary edge, and land-based bodies of water are all included in evapotranspiration ET.

On the other hand, if the amount of water in wells is less than what the power supply can absorb, farmers will likely increase the area that is irrigated by adopting micro irrigation systems. This is the situation in the majority of the hard rock regions of Saurashtra, central India, and the Indian peninsula. Well water is extremely scarce in these places as a result of low groundwater potential and over-exploitation. The amount of power that is currently available is greater than what is required to draw water from wells. As a result, farmers have a significant economic incentive to invest in microirrigation systems other than yield enhancement (Dhawan, 2000) [5]. Because more irrigated land could be covered by less water, irrigated farming would be more profitable. For instance, in the Michael region of central India, where groundwater is extremely scarce, farmers employ inexpensive drip irrigation systems to pre-irrigate cotton before the monsoon. Consequently, they may grow cotton across a bigger region because water availability has increased since the monsoon (Verma *et al*., 2005) [24]. At the aquifer level, there is no water savings in this situation.

The crops picked make up the third element. Agricultural Fields undergo uniformly application of irrigation water from micro-irrigation systems. The key to the overall strategy for managing limited water resources is demand management (Molden *et al*., 2001) [14]. In India, agriculture is the main competitive user of water that has been diverted. (GoI, 1999). Any new technology's adaption depends heavily on its economic return. The financial benefits of well-designed micro irrigation systems with greater engineering advancements to maintain water production more significant in financial evaluation and their applicability for different crops.

The prudent and essential requirement for making efficient use of available water is micro irrigation, an innovation technology. As a result, sustainable agriculture depends on water development and management innovations and interventions, effective irrigation methods guarantee that developing nations' crop production in arid and semi-arid regions actually saves water. Drip irrigation and sprinkler irrigation are the most common types of micro irrigation system. Kumar *et al*. (2008) [3] suggested that a variety of factors, including the type of crop and the distance between them, the type of micro irrigation technology used, the type of soil and the climate, are necessary for actual reduction in water use by employing micro irrigation technology. Any sort of irrigation in a commercial agriculture system can greatly lessen yield risks related to the climate that are brought on by water stress. Because it functions so well and provides a wide variety of options for timing and water application, micro-irrigation may provide an additional level of risk reduction compared to overhead irrigation systems. The irrigation schedule is equally crucial when using micro irrigation. Less water use results in less nutrient leaching. Plants can also receive the nutrients they require by applying nutrients at the proper moment.

Drip irrigation is a sort of micro irrigation system that delivers low pressure water to plants gradually, precisely, and uniformly using tiny plastic tubing pipes. Depending on how much water is required, this often irrigates the soil to keep it moist. Surface irrigation is the conventional irrigation technique that doesn't include any machinery. This method is inefficient and results in a higher rate of water loss since water must flow across the surface of agricultural land to reach the crops. Types of drip irrigation includes surface and subsurface drip irrigation. Surface drip irrigation, Drip irrigation is one of the most current irrigation techniques. By supplying water to the plant's root zone slowly and directly, this method reduces evaporation losses. As a result, the fundamental principle of drip irrigation is to provide little amounts of water right to the plants where they can absorb it. Sub surface drip irrigation, in order to make sure that the applied water is accessible to a significant section of the plant root system, it is used to give water to plant roots while maintaining the soil surface in a relatively dry state. Drip lines are often built 10 to 30 cm beneath the soil's surface. The modern irrigation technique known as drip irrigation, on the other hand, uses pipes to carry water straight to the roots of the crops, assuring a reliable and fruitful supply. Crop production is increased and the rate of water loss is reduced by this technology. When compared to conventional irrigation, the adaptation of drip irrigation can conserve as much as 70%–80% of water.

The most efficient way to provide nutrients and water to crops for growth is drip irrigation, which is the current type of micro irrigation. With drip irrigation scheduling, it is possible to apply agricultural pesticides more precisely and effectively while maintaining a lower and more stable soil matric potential, which mitigates salinity problems. In some cases, the technique lessens crusting and compaction of the soil and prevents puddle compaction. The soil now has a greater ability to permeate. (D. Suresh Kumar *et al*.) (2016) [25] came to the conclusion that drip irrigation has a significant impact on conserving resources, lowering cultivation costs, improving plant growth quality, increasing yield, and increasing farm profitability.

Multiple cropping systems can have a positive impact on the development, productivity, and quality of a variety of crops. The system's intricacy improves plant health, maintains disease and fungal pressure, inhibits weed growth, and limits the number of potential hosts. Drip irrigation systems are more cost-effective to operate than traditional irrigation systems, may be automated, and provide extra infrastructure benefits. Plastic is used for the vast majority of the system's components, which reduces corrosion damage and provides a variety of design alternatives. The design parameters must take into account how the land's contour affects the pressure and flow needs. An AI-based agricultural software can be used to remotely operate micro irrigation's autonomous feature to ensure that the crop gets exactly the right amount of water. When selecting when to irrigate, farmers gain from having precise, current data. Such technologies are becoming more adaptable in terms of matching field size and shape. Furthermore, because of the installation's extremely long economic life, it is possible to grow cheap commodity crops.

When it comes to crops, precision drip irrigation in micro irrigation has a lot going for it. It makes it possible to increase crop yield, protect the soil, make it more fertile, and keep water resources safe no matter what the weather is like. According to (Yahasaswini Sharma al) (2015) [22], the use of precision farming will increase soil productivity, lower production costs, and lessen farming's impact on the environment. (Nathanlarson and co.al) (2015) looked into water-saving technology. This case study explains why people didn't use the technology because they couldn't afford it. The adoption depends on the size of the farmers' land holdings because of the high cost of the investment. The system's resale value is frequently very low. Farmers require support from both the public and private sectors for rapid adoption.

Table 1: Water use efficiency with drip irrigation system

Crop	Yield increased,%	Water saving,%	Increase in water use efficiency,%
Banana	52	45	176
Chilly	45	63	291
Grapes	23	48	136
Groundnut	91	36	197
Sweet lime	50	61	289
Pomegranate	45	45	167
Sugarcane	33	56	204
Tomato	50	31	119
Water Melon	88	36	195

Source: INCID (1994), Drip Irrigation in India, New Delhi

Water use efficiency with drip irrigation system: Sprinkler Irrigation, according to (Dupriez and De Leener) (2002) [7], resembles rainfall. Sometimes, the phrase "overhead irrigation" is used. The water is sprayed onto the soil in the form of a spray through a network of tubes and pumps. It does a great job of evenly dispersing water and meeting the plant's regular needs. It is a form of manufactured rain. However, wind speed has a significant impact on how well water is applied during sprinkler irrigation, especially during the daytime when the air is warm and dry, and if the application rate is low and the droplets are small. Sprinkler irrigation is a way of applying irrigation water that throws water through the air, comparable to natural rainfall in controlled conditions, in contrast to other irrigation methods, which apply water directly to the soil or root zone. It is popular because it is adaptable and reasonably priced. Through a network of pipes, pump valves, and sprinklers in this system, sprinklers that have a rotating mechanism and rotate with the help of the system's water pressure shoot water into the air. It maximizes water conservation by fusing high calibre with low cost.

Sprinklers are utilized on nearly all types of soil, although, with the exception of thick clay, sandy soils with high infiltration rates, uniform water distribution, and higher efficiency are ideally suited for them. Whereas uniform distribution is challenging, permeable soil sections can be effectively irrigated by a spray system. With careful consideration of nozzle size and operating pressure, the system is suitable for the majority of row crops and tree crops. For wavy surfaces, water can be sprayed on top of them and utilized. When there are numerous plants in a short space, a sprinkler system is designed to apply water that is suitable for irrigating crops. It works best for oil seeds and vegetable crops. The water is transported by pipelines, which results in seepage and evaporation losses that amount to 20% in well-irrigated areas and 50% in canal-irrigated areas. Depending on the way the water travels, the micro sprinklers are referred to as small sprays, micro sprays, jets, or spinners. They can also be classified as I low- to medium-range overhead sprinkler systems based on the throw's diameter. ii) long-range weapon sprinklers. Micro emitter flow rates range from 3 gpm to 30 gpm, depending on the size and line pressure. The two primary types of sprinkler systems are perforated pipe systems and rotating head or revolving sprinkler systems based on how they are configured to spray or sprinkle water. The Department of Agriculture and Farmers Welfare (DA&FW) offers a variety of subsidy programs to encourage farmers to use sprinkler irrigation in micro irrigation, which focuses on improving farm-level water use efficiency.

Sprinklers, solar pumps, and other forms of irrigation The farmers are supported financially by the federal government @ 45 percent of the indicative unit cost for other farmers and 55 percent for small and marginal farmers. In addition, incentives from the state government help reduce farmers' share. This is a choice that is good for the environment because it saves fresh water and can be made to fit any size of farm, from sprinklers used to irrigate crops at home to those used in large size farms to irrigate crops.

Table 2: Relative Irrigation Efficiencies (%) for Various Irrigation Methods

Irrigation Efficiencies	Method of Irrigation		
Conveyance efficiency	Surface (%)	Sprinkler (%)	Drip (%)
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

Source: Sivanappan (1997)

Fertigation through autonomous microirrigation system

Fertilization is the process of adding soluble nutrients to soil and water through irrigation. Most of the time, it is done to high-value crops like ornamental, fruit, and vegetable trees. With the introduction of systems like drip irrigation and sprinkler irrigation, the use of the fertigation process has increased. This effective technique uses slow, continuous drops of water applied above or below the soil surface to accurately distribute fertilisers to the root zone. Drip irrigation can be employed to use all soluble nutrients throughout the fertigation process. However, nitrogen and potassium are the most commonly used nutrients because they can move slowly with irrigation water.

Application of fertiliser to boost crop output is known as fertilisation, increase fertilizer effectiveness, and reduce leaching. This increases fruit quality, yield, and growth. When used in conjunction with drip irrigation or micro-irrigation, this strategy produces a practical way to supply nutrients near to the root zone of plants.

Agriculture is one of India's major water uses. Accepting micro irrigation may lead to an improvement in produce quantity and quality while reducing water usage significantly. This process can be adjusted to spoon feed nutrients and water at the proper periods to manage plant stress, growth deficits, and crop yields. Drip irrigation systems demand more management and handling than seepage or sprinkler irrigation systems and are often more expensive. It keeps the soil healthy while reducing water use by up to 70% and increasing yield by up to 90%. Drip fertigation is a pooled method of drip irrigation that gives the same amount of nutrients to different crops at different times. Depending on the type of crop and the crucial growth stage, fertilizers are synchronized with plant requirements. In the root zone, soil nutrient concentration is controlled within a narrow range, and nutrients applied to this zone are efficiently utilized. However, split fertilizer application incurs very little labor expense with the fertigation method.

Fertilization systems can be utilized with or without mulch, like all irrigation systems, although they perform best when drip-irrigated with higher-value polythene mulch. There are a lot of potential benefits to micro irrigation. For drip fertigation, a fertilizer that dissolves fast is optimal. Its selection is based on price, the other salt ingredient, the crop, and its growth stage. It must be present in a specified quantity. The uniform administration of nutrients over the field at any point of the season and in accordance with the needs of the crop is one of this method's benefits. When fertilizer is used, the likelihood of crop damage is decreased. The amount of water applied to the readily available mobile nutrients, such as nitrogen, can control the soil profile. To increase crop nutrient and water absorption and decrease nutrient leaching, a drip fertigation system that has been carefully constructed transports water and nutrients at the proper rate and time. Drip fertigation with a variety of mobile fertilizers, such as N, P, and K, increases yield, induces early flowering, and significantly improves crop quality.

Through fertilisation, it may be possible to ensure that the root zone obtains the proper amount of nutrients and water to satisfy the plant's overall and short-term requirements for these two inputs. Fertilizer compatibility, or the ease with which a number of fertilizers mix together without precipitating insoluble salts, has an impact on drip irrigation. Fertigation uses less fertiliser than conventional granular fertiliser systems. The procedure causes a 50% reduction in the amount of fertilizer needed and increases the plants' ability to use fertilizer effectively. It is less likely that groundwater will become contaminated when there is less chance of leaching. Drip irrigation reduced weed pressure in crops. Drip irrigation and fertigation provide fewer water and nutrient resources for weeds, whereas conventional fertilization and furrow irrigation increase the use of nutrients by weeds in crop rows.

The use of drip irrigation or micro-irrigation provides creative answers to problems that have persisted for ten years. An increase in yield and better produce quality, control over the concentration of nutrients in the soil solution, and flexibility in the timing of fertilizer application in relation to crop demand based on the physiological stage and development of crops are all potential advantages of implementing a fertigation programme. Another benefit is that drip irrigation uses less energy because it distributes fertilizer without the need for additional effort. By combining drip irrigation with fertigation scheduling, farmers can achieve all of their environmental objectives while minimizing nitrate losses. Due to the high initial construction costs for fertigation systems, drip irrigation is thought to be the most expensive irrigation technology to set up and maintain. It also requires a large amount of manpower for installation, removal, and seasonal maintenance. Any defect in a fertigation system can result in yield loss and erratic development, so regular maintenance is necessary for the system to function properly. A fertigation technique that is prone to clogging is drip irrigation. High-quality irrigation water and the right fertilizer are essential to avoid blockage. Watering techniques that assist farmers in ensuring the health of their crops are at the heart of smart watering. Fertigation is a useful tool for applying nutrients to drip-irrigated crops if steps are taken to ensure that the application is uniform. It is an effective method for applying portions of fertilizer in a precise manner during the crop growing season. When a fertigation system is put into place, there are numerous advantages. However, there are disadvantages, such as the need for upkeep and the high cost of the initial investment. Take into account these costs. Benefits may outweigh disadvantages depending on the producer's needs, making fertigation a useful tool for nutrient and water management. Fertigation is an automated irrigation system that is a good investment and really makes a difference.

Table 3: Saving in fertilizer and increase in crop yield under fertigation

Crop	Saving in fertilizer, %	Increase in Yield, %
Sugarcane	50	40
Banana	20	11
Onion	40	16
Cotton	30	20
Potato	40	30
Tomato	40	33
Castor	60	32
Okra	40	18
Broccoli	40	10

Source: NCPAH, (2001), National Committee On Plasticulture Applications In Horticultur,
Progress report 2001, Ministry Of Agriculture, Gol, New Delhi

Benefits of micro irrigation

For agricultural water usage efficiency, advances in technology and water management are required, along with higher crop yields. Numerous demand management systems and initiatives have been introduced in Indian agriculture to conserve water and improve the current water usage efficiency. The main advantages of this method are a rise in irrigation water production and water savings during continuous deficit irrigation for places with severe water shortages. In the case of vines, it has been found, claim (Sanchez-Martin *et al.*) This MI type resulted in lowered emissions of nitrous oxide N2O when broadcast ammonium sulphate was given to the soil between 2008 and 2010: 70% lower than furrow irrigation in a loamy soil texture and 28% lower in a sandy clay loam texture treated with digested pig slurry, Ca(H2PO4)2, and K2SO4. Sub surface irrigation has various advantages over surface drip. Since the tubes lie underground, there is no disruption of the functioning of the cultural institution, and they are not need to be removed and reinstalled at the conclusion of each season. Applying water to the soil as opposed to directly on it lowers the possibility of NO3 leaching. The sprinkler is the sort of micro irrigation that may produce the most water per hour. There, we can grow plants that require a lot of water. There are no concerns with using treated wastewater (sewage) in this kind of system. Sprinklers and sprayers are the most practical solution in situations when a high degree of filtration or a crop protection cover is required (due to a high level of erosion, for the control of pests and diseases, against frost, etc.).

Power saving: Electricity savings is one of the main advantages of employing a drip irrigation system (Andal, 2011) [26]. Drip irrigation greatly minimizes the amount of time a pumpset needs to run by using less water. As a result, each unit of land requires significantly less electricity to irrigate (Narayanamoorthy, 2004) [16]. When compared to flood irrigation, Narayanamoorthy (1996 and 2001) [17-18] found that the usage of drip irrigation in Maharastra resulted in power savings of 44% for sugarcane, 37% for grapes, and 29% for bananas. In a similar vein, a field investigation conducted by Narayanamoorthy in 2004 [19] revealed that sugarcane could be cultivated in Pune and Ahmednagar with corresponding power reductions of 41% and 48%.

Cost effective: Compared to traditional irrigation methods building a drip irrigation system versus conventional irrigation techniques, costs a fixed amount that fluctuates with the crop (Andal, 2011) [26]. Crops that are widely apart require less fixed capital, while those that are closely spaced require more fixed capital (NABARD, 1989). Despite having a higher initial cost, the drip system has the best benefit-to-cost ratio because of its higher yields, water savings, and lower cultivation costs. By allowing water to gradually percolate to plant roots, it also has the ability to conserve water and nutrients. (Sivanappan, 1994) [23].

Fertilizer saving: The right balancing of water and nutrients is the key to a high yield and high-quality crop. If fertilizer solution is applied and drip irrigation is used, the root zone could have access to the right amount of water and nutrients, satisfying the plant's long-term and short-term needs for these two inputs (Patel and Rajput, 2001) [21]. Fertigation enables the preservation of fertilizers and the sparing use of fertilizer in accordance with the nutrient needs of the plants. Because it stops fertilizer from leaching, it is also thought to be environmentally friendly.

Economic impact of MI: Several research investigations have already been conducted that demonstrate the economic benefits of water-saving irrigation systems. Numerous Indian research studies during the past ten years have calculated the financial benefits of drips. For instance, the financial advantage from increased yields varies depending on the crop. Cereals cannot be affected, thus. A 10% increase in yield results in an additional 400–500 kg of wheat, or $300–$3750/ha of irrigated wheat. Pomegranate production must rise by 10% in order to receive an additional gain of 6000 kg/ha, or Rs. 90000/ha. Pomegranate production must also increase by at least 60000 kg per ha each year. The cost of system installation has a considerable impact on the economic performance of drip in addition to the incremental value of outputs.

When selecting investment priorities, including when providing subsidies, it is critical to understand the social benefits of drip irrigation. Government subsidies for micro irrigation systems are based on the theory that they have a positive externality effect in terms of water conservation, as stated by Dhawan (2000) [5], hence cost-benefit analyses that do not take societal costs and benefits into account are conceptually flawed. It makes sense to take the advantages of water conservation and transform them into cash based on market rates or more land that may be irrigated in areas where available water in wells is extremely scarce. Well owners are frequently not informed of the opportunity cost of water waste in terms of water conservation. Saving water therefore offers no private advantages. Geohydrology establishes a cap on how much water a farmer can withdraw from a well in areas with hard rock, like the Kolar district in Karnataka. Both the price at which water is sold and the opportunity cost of drinking it are considerable in these places (Deepak *et al.*, 2005) [4]. As a result of the water that was conserved, the adopters would also save money.

Energy can be saved by a few MI devices, particularly low pressure and gravity systems like drip tapes, micro tube drips, and simple drips. Farmers in many water-scarce places do not have a problem with the marginal cost of using electricity. As a result, they do not see any benefit to themselves from saving energy. However, if one wants to determine the viability of the system from a macroeconomic perspective, it is essential to consider the full cost of supplying energy to the farms while evaluating the economics of irrigation using the system. In addition, we consider the price of water for irrigation (which varies from Rs. 1.5 to Rs. 2.5 in north Gujarat to Rs. 6 in Kolar) as an indicator of the economic value of water.

Government policy

Agriculture largely depends on water in order to produce enough food to feed the world's expanding population. Due to the decreasing amount of land and water available per person, India must almost double its food production. India has 1.38 billion people and 4 percent of the world's fresh water. Agriculture uses 80 percent of the country's water resources, but only 38% of the country's water is used effectively. In 877 blocks, 17 percent of the country's groundwater is over- or nearly-over-exploited, and new areas are being added to the list each year. This has resulted in a shortage of drinking water, a problem with the quality of the water, and degradation of the land, in addition to reducing the potential for irrigation. The states of Tamil Nadu, Gujarat, and Punjab are precise examples. The government may need to consider making microirrigation mandatory in as many of these critical and semi-critical areas as possible in order to rectify the situation. The country's watershed program was the driving force behind the widespread adoption of microirrigation. The government of India has implemented the Pradhan Mantri Krishi Sinchai Yojana (PMKSY)-Per Crop More Drop initiative, which was launched by the Ministry of Agriculture and Farmer's Welfare to address issues related to farming irrigation and provide a solid foundation for the expansion of micro irrigation. This effort aims to boost the efficiency of water use (Per Drop More Crop and Income) and offer irrigation to every farm in the nation (Har Khet Ko Pani). Through an integrated approach, the program aims to achieve convergence of irrigation investments at the field level while simultaneously enhancing farm efficiency, equality, sustainability, and resilience.

To improve water use efficiency and reduce wasteful water losses from irrigated agricultural crops, the government has promoted micro irrigation systems that combine drip and sprinkler irrigation and link meso and macro watersheds at the basin level. For micro irrigation systems, the PMKSY primarily consists of four parts: the Accelerated Irrigation Benefits Programme, the Per Drop More Crop and Income, the Har Khet Ko Pani, and the Integrated Watershed Management Programme (IWMP). The implementation of PMKSY can save up to 40-80% of water through increased water use efficiency, also saving of fertilizers with average reduction of about 28%. This scheme prioritize us to handle green and blue water resources together by adopting holistic and integrated water management approach. To encourage micro irrigation the central government has invested Rs. 5000 crore in Micro Irrigation Fund. The Planning Commission could convince states to allocate separate funds to (a) conventional irrigation projects and (b) micro irrigation adoption. The states will be motivated to modify their irrigation strategy and legal framework as necessary as a result of this. In addition, the States will be compelled to expand the areas under micro irrigation either for the existing surface water resources or for forward linking of their conventional irrigation projects if the assistance from the Central Government is made available only for micro irrigation.

Farmers may construct micro irrigation with the help of the state government and an additional subsidy utilising better irrigation techniques to meet their difficulties. The state government will provide marginal and small-scale farmers with an additional subsidy through the Micro Irrigation Fund in addition to the additional 55% subsidy that the federal government has already provided for micro irrigation systems. By adopting integrated water resource management, the PMKSY successfully addresses issues and adds value to agricultural system growth. The government's ultimate goal of doubling farmers' incomes will be ably supported by this, and marketing and processing will generate growth through the program. This will also strengthen agriculture and its related industry development. The National Council For Precision Farming (NCPF) primary goal will be to promote high-tech interventions like micro-irrigation and precision farming for the growth of horticulture, other suitable field crops, and agroforestry. The NCPF may pursue the following potential objectives:

(i) To make it easier for the horticulture, other suitable crops, and agroforestry in the country to grow by using high-tech interventions and applications like plastic cultivation, precision farming, and other new technologies.

(ii) To make it simpler for farmers, businesses, and the government to communicate with one another. The government is a promoter of a number of relevant technologies, particularly micro-irrigation. to assist governments in the planning, propagation, implementation, and smooth delivery of a variety of plans, projects, and programs for the efficient use of land and water resources. This includes incorporating a variety of cutting-edge agricultural and horticultural technologies for increased productivity and utilization efficiency.

The current irrigation policy for canal/reservoir systems is solely focused on crop protection and is based on the reservoir's water supply. In order to increase GNP value addition, future irrigation policies ought to be based on water efficiency and broadly geared toward modernizing agriculture. Because they preserve water while simultaneously increasing crop yields, micro irrigation technologies can assist in this regard. As a result, it is critical that all canal commands promote micro irrigation technologies as much as possible. It is necessary to incorporate the micro irrigation system into the process of designing dams and reservoirs in order to expand the area that is irrigated and improve water efficiency.

Challenges for adopting micro irrigation technology

Micro irrigation is a relatively new technique, but it has a lot of promise and overall advantages, and it is important for managing water resources. The industry that supplies the necessary equipment is crucial. It is now having trouble, and scaling it up is difficult. Some of the significant issues with funding planning and technology implementation were not able to be resolved because of pricing and administrative delays in scheme enrolment, which began in 2006. This constrained window contributed to a decline in the adoption rate of micro irrigation technology, as well as delays in subsidy reimbursement and a shortage of installation funding as the subsidy fell from 55% to 35%. Budget cuts were said to have slowed the introduction of more recent micro irrigation systems between 2013 and 2016. In most Indian states, the state government's negligence is only present for a few months of the year (with the notable exceptions of Gujarat and Tamil Nadu). Only a few farmers can therefore submit an application. The expensive price of micro irrigation systems is a significant disadvantage of using the technology. Drip irrigation systems are often more expensive than portable or traditional sprinkler irrigation systems. Due to the requirement for a lot of piping and filtration equipment as well as the risk of farm machinery damaging the tiny pipes in the soil, installation costs are expensive per square foot. The main problem with this technology is emitter obstruction. The main input for a micro irrigation system is energy. Electricity is the sole practical source for large-scale projects, yet even with related assistance programmes, not every farmer can afford it. trip tubing damage frequently takes the form of widened orifices and holes chewed in the sides. Some insects will create cocoons inside the water distribution tubes' emitter outputs. Cocoons develop when the system is turned off for a while. Combating these insects is only allowed during long intervals. Using pesticides that include chlorinated hydrocarbons can effectively repair ant damage. However, these substances should only be utilized with the utmost care because they are typically poisonous and persistent in the environment. In general, side pipes with a wall thickness of at least 15 mils (0.38 mm) are advised to guard against damage by ants and other insects.

Conclusion

Micro irrigation is one water-saving method that can make the most of the water that is already available. The improvements in water conservation methods, lower water costs, and higher yields from steady moisture levels in the crop's root zone are the notable advantages of micro irrigation technology. When compared to conventional irrigation, the use of micro irrigation can save up to (50-90%) of water, fertilizer (28.5%) and energy (30.5%). In accordance with this initiative, Marginal and small-scale farmers can receive financial support of up to 55% through the Pradhan Mantri Krishi Sinchai Yojana, while other farmers can receive financial support of up to 45%. The findings are on the elements that encourage the adoption of micro irrigation. Adoption of drip and sprinkler irrigation systems for widely spread crops would significantly increase the amount of real water savings and water productivity increases at the field level, ultimately leading to overall water and electricity savings. In order to keep the productivity of water more relevant to economic criteria, further technological approaches may integrate economic consideration.

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