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Original Article

Sustainable Agricultural Development through Modern Micro-Irrigation Technology

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Abstract There is a global water and resource management crisis. In certain rapidly expanding economies, agriculture accounts for nearly all freshwater withdrawals worldwide, and the majority in others (WWDR, 2012). In the world, irrigation accounts for more than two thirds of blue water withdrawals. Since irrigated agriculture produces over one third of the world's food production (FAO, 2012), it is vital to the survival of the human race even though it only accounts for about 5% of all cultivated area. Overall, it is critical to modify the irrigation system for agriculture in order to increase productivity and production through appropriate water management. Adoption of cutting-edge micro-irrigation technology is therefore crucial for sustainable growth. Thus, micro-irrigation is a way to alleviate water scarcity in arid regions while also conserving soil and water resources. Additionally, micro-irrigation has the ability to turn agriculture from a subsistence crop into a profitable business.

Key words: *Water Management: Review, Micro-Irrigation Technology: Overview - Classification - benefits, Economics of Irrigation and Agriculture.*

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INTRODUCTION

The 1860s saw the start of the Micro-Irrigation Experiments in Germany, which led to the expansion and advancement of micro-irrigation technology. where irrigation systems used clay pipes to pump water. E.B. House's 1913 research at Colorado State University found that the technique was too costly for commercial usage; no more research was conducted on the subject until the 1920s (CICR Report, 2011). One of the biggest innovations in the business was the use of perforated pipes in Germany in the 1920s. But there is a connection between the work of Israeli scientist Symcha Blass in the 1930s and modern micro-irrigation technology. Based on this finding, he created the first drip irrigation system to receive a patent, and when affordable plastics were available in the 1950s following World War II, he advanced his concept significantly. Drip irrigation systems have become more and more common because to the affordability of plastic pipe used for water delivery lines. By the late 1960s, the drip irrigation idea had extended from Israel to Australia, North America, and South Africa, and finally the entire world. The micro-irrigation industry grew rapidly as a result of the introduction of suitable and affordable materials, namely, Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), and Low Linear Density Polyethylene (LLDPE) in 1977. Drip irrigation was first widely used in the 1970s to water vegetables and orchards in Australia, Israel, Mexico, New Zealand, South Africa, and the USA; at the time, its coverage was estimated to be 56,000 hectares (Kulkarni et al, 2006). In general, special irrigation is significant for the advancement of agriculture. Micro-irrigation technology is beneficial to agriculture since it maximizes productivity and output by using water for farming in an efficient manner. Because sustainable agricultural development depends on the management of groundwater supplies. Even so, one of the most dependable sources of water is groundwater.

However, it is anticipated that the strain on groundwater supplies would only rise with population growth. We must concentrate our efforts on establishing water-saving technologies, particularly for irrigation, since agriculture uses the majority of our water resources.

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Irrigated agriculture is becoming more and more crucial to meeting the global population's expanding food needs. In short, modern micro-irrigation technology plays a crucial role in providing crops with water, which is needed for agricultural development. The research has touched on this topic in passing.

OBJECTIVES

To study the role of micro irrigation technology in water management and the including sustainability of agricultural economically.

RESEARCH METHODOLOGY

This research is a descriptive study. The necessary primary and secondary data. Secondary- data was collected from Various websites including those of Government report, magazines, journals, other publications, etc. This data Was then analysed and reviewed to arrive at the inferences and conclusions.

Review of Water Management and MI System

One major obstacle to the continued sustainable development of humanity is water management. A major portion of the water supply is unusable and has a highly uneven spatial distribution, which leads to the water management controversy. of the total land mass on Earth, 32% of it is in Asia, and 21% is in North and Central America. These regions have the largest areas of arable land. With the exception of the former USSR, only 21% of the planet's landmass is in Asia. Even today, the irrigated area makes up slightly more than 25% of all arable land, having made up only 18.5% in 1984. Up from 63% in 1989, 64% of the world's irrigated land was in Asia in 1994. The availability of arable land and the demand for irrigation water are significantly unequal as a result. Irrigation covered 37% of Asia's arable land in 1994. India possesses the biggest arable terrain among Asian countries, accounting for over 39% of the continent's total area. India lacks more arable land than only the United States of America (Source: WWDR, 2012). 20% of all cultivated area is used for irrigated agriculture, which produces about 40% of the world's food (Source: FAO, 2012). One of the biggest stresses on freshwater resources is the need for water for agriculture and sanitation. In certain rapidly expanding economies, up to 90% of the GDP is derived from agriculture (Source: WWDR, 2012).

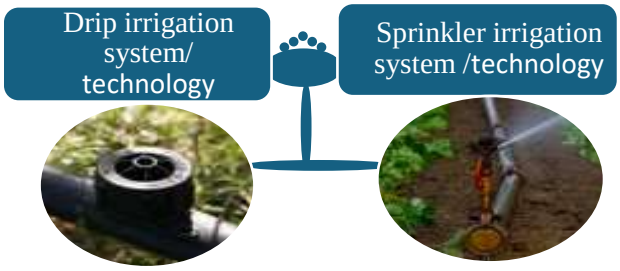
Rainfed and irrigated agriculture together are predicted to use more water in agriculture globally in the future. One of the main resources utilized by businesses for manufacturing, homes for everyday needs, and farmers for irrigation is groundwater. The use of groundwater for both residential and industrial purposes has grown significantly, and irrigated agriculture is becoming more and more crucial to meeting the world's growing population's food needs. Since many of the economies in these regions are dependent on groundwater, the surge in groundwater-irrigated agriculture has also had a significant positive socioeconomic impact on a large number of rural people across Asia, the Middle East & North Africa, and Latin America (GW-MATE, 2010). Currently, there are over 301 million hectares of arable land worldwide, of which 38% are suitable for groundwater irrigation. An estimated 545 km3/year, or 43% of the total consumptive irrigation water use of 1277 km3/year, is used for groundwater extraction for irrigation. The United States (17 million ha), China (19 million ha), and India (39 million ha) are the nations with the most territories supplied with groundwater for irrigation. References: D'oll (2009), FAO (2010), Shiklomanov et al. (2000). It goes without saying that both the careful management of the water used for agriculture and the sustainable growth of humankind depend greatly on the proper use of freshwater resources. As a result, it is imperative to modify the agricultural irrigation system in order to increase agricultural productivity and production through appropriate water management; hence, adoption of contemporary micro-irrigation technology is required for sustainable development.

What is Micro-Irrigation?

This is a contemporary technique of irrigation that involves applying water to the surface or subsurface of the land using emitters such as foggers, sprinklers, drippers, and other devices. The two most popular micro-irrigation techniques are sprinkler and drip irrigation. The slow application of continuous drips, tiny streams, or tiny sprays of water above or below the soil's surface is known as micro irrigation. You will get knowledge about the classification and key components of micro irrigation systems in this session. When compared to traditional surface irrigation, micro irrigation systems are more efficient in conserving water and maximizing water usage. In addition, it lessens soil erosion, water usage, weed growth, and cultivation expenses. You may use micro irrigation on any type of terrain. Micro irrigation can be beneficial in undulating terrain, rolling topography, hilly places, barren land, and locations with shallow soils.

Classification of Micro-Irrigation System / Technology

There are two general types into which micro irrigation systems can be divided:



. This, drip and sprinkler irrigation systems differ significantly in terms of water flow rate, operating pressure needed, and wetted area measured. An area's water flow rate is the volume of water released at a specific moment. It is stated in either gallons per minute (gpm) or liters per minute (lpm). Pressure losses due to system components and field elevation effects must be made up for by the system operating pressure.

Micro-Irrigation: Overview

There are two parts to the amount of water lost by crops: evaporation losses from the soil and the crop, and a portion of it known as evapotranspiration (ET). All

losses incurred as a result of water distribution to the land are included in the other portion (Fereres and Soriano, 2006). The ratio of water volumes needed for the crop's consumptive demand during growth to the water given from the source is known as irrigation efficiency (Planning Commission, 2004). In India, micro-irrigation (MI) methods like as sprinkler and drip irrigation were first developed as water-saving innovations. By using a low pressures delivery system consisting of a network of pipes with tiny emitters (also known as drippers) integrated into them, water is directly and sparingly supplied to the crop's root zone in drip irrigation. Compared to flood irrigation, which causes a significant variance in soil moisture levels, this approach helps maintain soil moisture levels at consistent levels. Based on crop variety and soil conditions, this strategy has been demonstrated in multiple field studies to increase water use efficiency by 80–90% (INCID, 1994; Sivanappan, 1994).

The advantages of drip and micro irrigation go beyond just conserving water. According to several studies (See ICID 2006; Andal 2010; Mitra 2011; CICR 2011), the technology also offers the additional advantages noted below: Because of the improved air: water ratio, it raises agricultural yields and productivity, which boosts farm revenues.

1. The application of extremely modest amounts of water directly to the root zone minimizes weed issues and soil. Additionally, the method lowers air humidity, which may lessen the likelihood of pests.
2. Higher quality crop yield. Produce quality will increase if water is applied consistently and evenly throughout the field.
3. It lowers agricultural expenses mostly by saving energy and labour. Because weeding is less expensive, labour costs are lower. Because a low horsepower motor can produce the same output by running it for a little amount of time each day, the system also lowers electricity expenditures. Estimates suggest that the technique can save up to 278 kWhr/ha of electricity for orchard crops planted widely apart and 100 kWhr/ha for crops cultivated close together. [Braun 2009]
4. It can result in social empowerment, particularly for rural women [IWMI 2006].
5. Better fertilizer use efficiency and balanced nutrient use (Narayanamoorthy, 2010). Drip irrigation systems are recommended to be used with water-soluble fertilizers (WSF). These fertilizers are ideal for fertigation, which guarantees that the root zones receive 10 nutrients, resulting in little to no nutrient loss. By employing this approach instead of traditional water application techniques, the fertilizer use efficiency can be boosted by up to 95%. (In line with KRIBHCO).
6. Additionally, it lessens issues with salinity, ground water pollution, and water logging. The constant, modest application of water keeps the concentration of salt below dangerous levels. The primary reasons it lowers cultivation expenses are labour and energy savings. Because weeding costs are lower, labour costs are also lower. Because a low HP motor may produce the same output by running it for a little amount of time each day, the method also lowers electricity expenditures. Some estimations state that the approach can save 100 kWhr/ha for crops grown tightly together and 278 kWhr/ha for crops planted in wide-spaced orchards. [2009, Raman] i. Higher quality crop output. The quality of the produce will increase with the consistent and ongoing application of water across the field.
7. Because the water flow rate may be adjusted, it works well on various types of soil and on undulating terrain [INCID 1994].

Micro-Irrigation and Economics of Irrigation and Agriculture

Impact on Economics of Irrigation

The method also improves the economics of irrigation by reducing the number of pumping hours needed to irrigate an area. This not only prolongs the life of the pump by lowering wear and tear but also saves a significant amount of money and energy. Both adopters and nonadopters think that the adoption of this technology has reduced the amount of water needed to irrigate a field, which makes this possible. Though economics may succeed, resource conservation may suffer since irrigation cost savings also contribute to an increase in the irrigated area, which raises the overall amount of water utilized to previous levels and necessitates the use of greater energy for irrigation. For improved farm economics, some of the irrigation economic benefits of drip irrigation may therefore also be lost. Without drip irrigation, however, irrigating this extended area would result in a significant rise in water demand, which could have extremely negative environmental effects. One way to prevent such extremes is with drip irrigation. In addition to these direct benefits, technology also plays a positive role in the economics of irrigation by guaranteeing a timely and sufficient supply of water to the farm, which helps eliminate most of the variability associated with farming and productivity and ensures yield, productivity, and income for the farmer. A farmer can sign long-term contracts and exert more market power when yield and total production are guaranteed. Because technology fosters greater adaptability and lessens conflict in irrigation, it also positively affects the transaction costs associated with irrigation. But even if irrigation is merely implemented at the village or household level, its full economics won't materialize until adoption occurs on a large enough scale over a sufficient period of time and space to convert savings into inter-farm and inter-sectoral transfers.

Economics of Agriculture:

It has been demonstrated that the technology has a positive impact on agriculture's profitability through a number of positive effects. A few of these benefits include the ability to cultivate more crops annually as a result of technological adoption because water is available for the following season as well. As a result, the technology aids in increasing cropping intensity, which raises revenue and improves agronomics. Research indicates that the technology can also aid in

increasing the area under cultivation, which can lead to the benefits of economies of scale in agronomics. Additionally, the technique increases the yield from currently planted crops, which has a favourable effect on land productivity and increases the profitability of agriculture for those who embrace it. Since most users reported minimal disagreements and a good influence on income and higher incomes, the technology also directly affects farmers' prosperity. In addition, according to two thirds of adopters, the technique increases and guarantees income, which lessens the vulnerability of smallholders and ensures advancement for both large and small holders who have embraced drip irrigation. More than half of the users have also been able to boost their savings and investments thanks to the technology thanks to their guaranteed and rising incomes.

Adoption has a good effect on lowering the overall amount of labour employed on farms. This is beneficial in two ways: first, it helps farmers deal with the labour scarcity that is occurring in India's rural areas. In addition, it saves the farmer a significant amount of labour costs by increasing the wage for agricultural labour in addition to the number of labour days worked. By using less fertilizer, which should improve both the soil's quality and economy, technology also affects the sustainability and economics of agriculture. According to the respondents, adoption has a beneficial impact on both the total cost of farming and the cost of harvesting, which results in a significant cost advantage. Due to its proven ability to influence the adoption of high-value, less water-intensive crops, technology also aids in the prosperity of farmers. Additionally, it improves agricultural output and the sustainability of water resources. In addition to influencing overall production quantity, technology also contributes to overall income growth. To cover the initial capital outlay, the technology generates a recurring stream of benefits on both the cost and revenue side. Through its favourable effects on higher market prices and greater market power, technology also contributes to the profitability and sustainability of agriculture. With regard to price risk, which technology is unable to directly guard against, both of these effects assist farmers in obtaining a better price for their produce in the marketplaces.

SUMMERY

The economics of agriculture and irrigation both stand to benefit greatly from this technology. Nevertheless, it seems that the latter is dependent on a few other services. Drip, sprinkler, spray, subsurface, and bubbler irrigation are all forms of micro-irrigation, and each has a special significance. Among them, drip is the drylands' most effective method of delivering water and nutrients, and they live up to the maxim "saving water is saving life." Advantages of drip irrigation include conserving water due to its high irrigation efficiency, energy, boosting agricultural yield, controlling weed growth, lowering salinity in the water, lowering labour costs, and so on. The benefits of using sprinklers (an asset in places with limited water and undulating terrain) include improved seed germination, reduced labour costs, fertilizer and pesticide application, protection from frost, and crop cooling. Thus, micro-irrigation has the ability to move agriculture from a subsistence to a commercial activity.

CONCLUSIONS:

Finally, it can be said that, an undeniable fact that a lot of water is needed for agricultural. However, for the equitable and sustainable growth of the country, the role of sustainable agricultural development becomes significant. Thus, it will undoubtedly be advantageous to use contemporary micro-irrigation technology to its full potential in order to accomplish sustainable agricultural development. Furthermore, the government ought to support micro-irrigation. We can conclude that this goal is accomplished by "Per Drop More Crop" and "Use a Micro-Irrigation Technology" together!

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Conflicts of interest

There are no conflicts of interest.

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