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Impact and implications of drip irrigation systems in Indian agriculture: A comparative analysis

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Abstract

Water scarcity is becoming a growing issue in agriculture, affecting plant growth, yield, and the full potential of seeds and fertilizers. Micro-irrigation systems have become essential tools for addressing this crisis, saving water, energy, and fertilizers while also generating employment opportunities. Drip irrigation stands out as being particularly effective among them. Water is precisely applied to crops using drip irrigation, both above and below the soil's surface. With this approach, water usage is maximized and waste is reduced. This paper provides an insightful review of research on the impact of drip irrigation on agriculture, as well as its performance evaluation in managing existing water sources. Drip systems are a flexible solution because they can be used in all of India's diverse regions, including the North, Northeast, Central, East, and South. Drip irrigation has the potential to transform farming economics. Farmers' earnings are increased as operational costs are reduced. Furthermore, it increases cropping intensity over time and contributes to overall productivity improvement. As water scarcity persists, adopting innovative solutions such as drip irrigation becomes critical to ensuring agricultural sustainability and food production.

Keywords: Micro-irrigation systems, saving water, drip irrigation, water usage, and agricultural sustainability

Introduction

Irrigation is the process of carefully supplying water to plants when they need it. Its primary purposes are to support the growth of crops, maintain attractive landscapes, and rehabilitate soil in dry regions or during periods of insufficient rainfall. In the context of India, irrigation holds immense historical significance. Many individuals in rural areas depend on farming as their main source of income, and the entire population relies on the crops cultivated by these farmers for their food. Therefore, it is crucial to introduce advancements in irrigation techniques to boost agricultural productivity, which, in turn, can accelerate overall development in the country.

Impact on Water Conservation

One of the most significant impacts of drip irrigation is its ability to conserve water. India faces water scarcity challenges in many regions, and traditional irrigation methods often result in wastage of this precious resource. Drip irrigation delivers water directly to the roots of plants, minimizing evaporation and runoff. This precise water application reduces water usage by up to 50% compared to conventional methods (Ramya & Saranya 2017) ^[5], helping to address water scarcity issues and ensure a more sustainable water supply for future generations.

Increased Crop Productivity: Drip irrigation ensures that crops receive a consistent and controlled water supply. This

results in improved crop growth and higher yields. Farmers can optimize water and nutrient delivery, reducing the risk of overwatering or underwatering, which can be detrimental to crops. Increased crop productivity not only benefits farmers by enhancing their income but also contributes to food security for the growing population of India. Drip system helps to get high quality products, increase crop yields and high fertilizer-used efficiency (Qureshi *et al.* 2001; Sivanappan 2002, Namara *et al.* 2005) ^[2, 7, 8].

Enhanced Soil Health

Drip irrigation minimizes soil erosion and compaction, as it delivers water directly to the root zone without causing surface runoff. This helps maintain soil structure, fertility, no problem of soil salinity (Narayanamoorthy 1997) ^[3], which is crucial for sustained agricultural production. Healthy soils lead to healthier crops, reducing the need for excessive chemical fertilizers.

Energy Efficiency

Compared to traditional flood irrigation, drip irrigation is more energy-efficient. It requires less energy for pumping and distribution of water. This reduces the carbon footprint associated with agriculture, contributing to environmental sustainability.

Economic Benefits for Farmers

Drip irrigation can be a game-changer for smallholder

farmers in India. By conserving water, improving crop yields, and reducing labour and fertilizer costs, farmers can increase their income. Additionally, the precision of drip

irrigation allows for the cultivation of high-value cash crops, further boosting the economic well-being of farming communities.

Table 1: Shows the benefits of drip irrigation farmers and no. expressing the advantages

S. No.	Benefits of Drip irrigation farmers	No. expressing the advantages	
		Number (n= 30)	Percent (%)
1.	Saving of water	28	93.33
2.	Saving of labor cost for irrigation	22	73.33
3.	Uniform application	27	90.00
4.	Improved quality of produce	20	66.67
5.	Easy method of irrigation	26	86.67
6.	Decreased weed growth	21	70.00
7.	Increased crop yield	23	76.67

(Sathyapriya *et al.* 2017) ^[6]

Environmental Implications

Drip irrigation helps protect natural water bodies from contamination due to runoff of chemicals and fertilizers. This has positive implications for the environment, as it reduces water pollution and protects aquatic ecosystems.

Challenges and Implications

While the adoption of drip irrigation in India offers numerous benefits, there are challenges and implications to consider. The initial cost of setting up a drip irrigation system can be a barrier for many small-scale farmers. Access to financing and government subsidies can help address this challenge. Additionally, farmers may need training to properly install and manage these systems. Maintenance and servicing of drip irrigation systems are crucial for their long-term effectiveness. Clogging of drip lines and damage to components can affect the system's performance. Training and support services must be readily available to address these issues.

Economic viability of investment in drip irrigation

While cultivating brinjal using Drip Micro Irrigation (DMI) can yield significantly higher farm business income compared to conventional irrigation, it's crucial to note that this increased income doesn't represent the actual profit. This is because we haven't accounted for the costs, depreciation, and interest associated with installing the drip irrigation system. Moreover, the longevity of the drip system plays a critical role in assessing its net present value (NPW).

Drip irrigation is a capital-intensive technique, so it's essential to evaluate its economic viability. The average capital cost of a drip system is approximately Rs. 36,928 per acre without subsidies. Many states, including Tamil Nadu, offer substantial subsidies, typically around 50% of the capital cost, through government schemes to promote the adoption of drip irrigation in various crops.

The NPW and the Benefit Cost Ratio (BCR) have been calculated both with and without subsidies at different discount rates. As expected, the NPW is slightly higher with subsidies than without. For instance, at a 10% discount rate, the NPW for a drip system with a five-year lifespan is Rs. 8,89,548 per acre without subsidies and Rs. 9,06,945 per acre with subsidies. The BCR is quite attractive, ranging from 4.36 to 4.64 without subsidies and slightly higher with subsidies.

The NPW and BCR are sensitive to the lifespan of the drip system. Ideally, a drip system's life is around 5 years, but it can extend to 10 years with proper maintenance. The results show that as the lifespan of the drip system increases, the NPW rises significantly, albeit with a marginal increase in BCR.

Since vegetable prices can be volatile and often decline as the market gets flooded with produce, it's important to analyse how changes in prices affect NPW and BCR. Assuming a significant drop in brinjal prices to Rs. 10 per kilogram from the previous range of Rs. 15-20 per kilogram, both NPW and BCR decline considerably. Nevertheless, investing in drip irrigation remains an attractive proposition (Waghmare *et al.* 2020) ^[1].

In the context of investing in DMI, it's also essential to estimate the payback period. The results indicate that the investment is fully recovered in the first year of the project, making it financially appealing despite potential price fluctuations in the vegetable market.

Conclusion

- Drip irrigation is a high efficient water saving techniques suitable for high value crops as well as vegetable crops, flower crops, fruit crops.
- This technique prevent disease by minimizing water content with the leaves, steam, fruit and flowers. Reduce weed growth.
- In all those advantages there is major problem in drip irrigation system is salt accumulation nears root zone of the crop.
- Marginal farmers (land holding < 1ha) have less tendency due to high initial cost and short lifespan of drip pipes, but this irrigation system's came profitable who's landholding large, it save labor, time, money.
- Drip irrigation become very beneficial now day of India because of it several advantage and adaptability. It's is the best option for dry land area.

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