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The trickle-down effect: Confronting drip irrigation constraints

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Abstract
Rapid industrialization and a growing global population have heightened the demand for agricultural products, placing immense pressure on essential resources like land and water. In India, particularly in arid and semi-arid regions, water scarcity is worsening as various sectors compete for this vital resource. Inefficient traditional flood irrigation systems result in significant water wastage, with effectiveness ranging from 25 percent to 40 percent. To address these challenges, farmers are increasingly adopting drip irrigation, a ground breaking technology that delivers water and nutrients directly to plant roots, reducing waste and enhancing crop yields. Drip irrigation is well-suited for various crops and terrains, offering the potential for water savings of up to 82 percent. However, the adoption of drip irrigation systems is hindered by several constraints, including technical issues like clogging and maintenance, infrastructural challenges such as insufficient electricity supply, financial barriers like high installation costs, and educational gaps in awareness and training. Overcoming these constraints is crucial to promoting widespread drip irrigation adoption, with a particular emphasis on addressing technical issues. A comprehensive approach, combining financial incentives, education, and technical support, is essential for making drip irrigation more accessible and contributing to sustainable and efficient agricultural practices.

Keywords: Drip irrigation, water scarcity, sustainable agriculture, agricultural constraints, resource management

Introduction
Agricultural production plays a pivotal role in the national economy, especially given the rising human population and rapid industrial and urban development, which have driven an increased demand for agricultural products. Two primary natural resources crucial to agricultural growth are land and water. The efficient and scientifically informed utilization of these resources is essential for the advancement of agriculture. However, it's essential to recognize that future competition for water resources from various users may limit the availability of water for expanding irrigated areas. This challenge is particularly pronounced in many of India's arid and semi-arid regions, where water scarcity is becoming an increasingly pressing issue. In India, a significant portion of freshwater is allocated to irrigation, with more than 90 percent of groundwater being used for this purpose. Furthermore, it's worth noting that the overall efficiency of flood irrigation systems typically ranges from 25 to 40 percent. This inefficiency underscores the urgency of adopting more efficient and sustainable irrigation practices to ensure the judicious use of water resources in agriculture. (Amarasinghe, 2007) [1].
In the conventional surface irrigation method, significant water losses occur during both water conveyance and application. These losses can be substantially mitigated when farmers transition to drip irrigation technology. Drip irrigation, also referred to as trickle irrigation or micro-irrigation, is an efficient method that minimizes water and fertilizer usage by delivering water slowly to the plant roots. This is achieved through a network of valves, pipes, tubing, and emitters, allowing water to either drip onto the soil surface or directly onto the root zone. Drip irrigation is especially well-suited for row crops like vegetables and soft fruits, as well as tree and vine crops, where one or more emitters can be installed for each plant. One of the significant advantages of drip irrigation is its adaptability to various farmable slopes and soil types. This system can achieve water efficiency levels of up to 82 percent, enabling the cultivation of a greater cropped area using the same quantity of available irrigation water, ranging from 31 to 46 percent more. It serves as a scientifically sound tool for the prudent use of irrigation water, actively promoting water conservation technology. By adopting this method, farmers can expand the cultivation of water-intensive, profitable crops to a broader

area, ultimately leading to higher yields.

Drip irrigation is a revolutionary agricultural technology that has transformed the way crops are cultivated worldwide. It offers numerous benefits, such as water conservation, increased crop yields, and reduced labor costs. However, despite its advantages, many farmers and agriculturalists face a range of constraints when adopting drip irrigation systems. In this article, we will explore challenges and constraints faced by drip irrigation adopters and discuss strategies to overcome them.

Methodology

This study was conducted to estimate the constraints faced by adopetrs of drip irrigation system in Kolar and Mandya districts of southern Karnataka (Figure 1). Selection of districts was based on the availability of water resources, type of irrigation system, cropping pattern and climatic condition. Kolar (Eastern dry zone) and Mandya (Southern dry zone) districts were selected as the study area. Kolar district is a water scarce area where vegetable cultivation occupies the major share of cultivated land. Mandya district is a Cauvery command area where in which diversified cropping pattern such as, sugarcane, paddy and vegetable cultivation could be observed based on the availability and source of irrigation water.

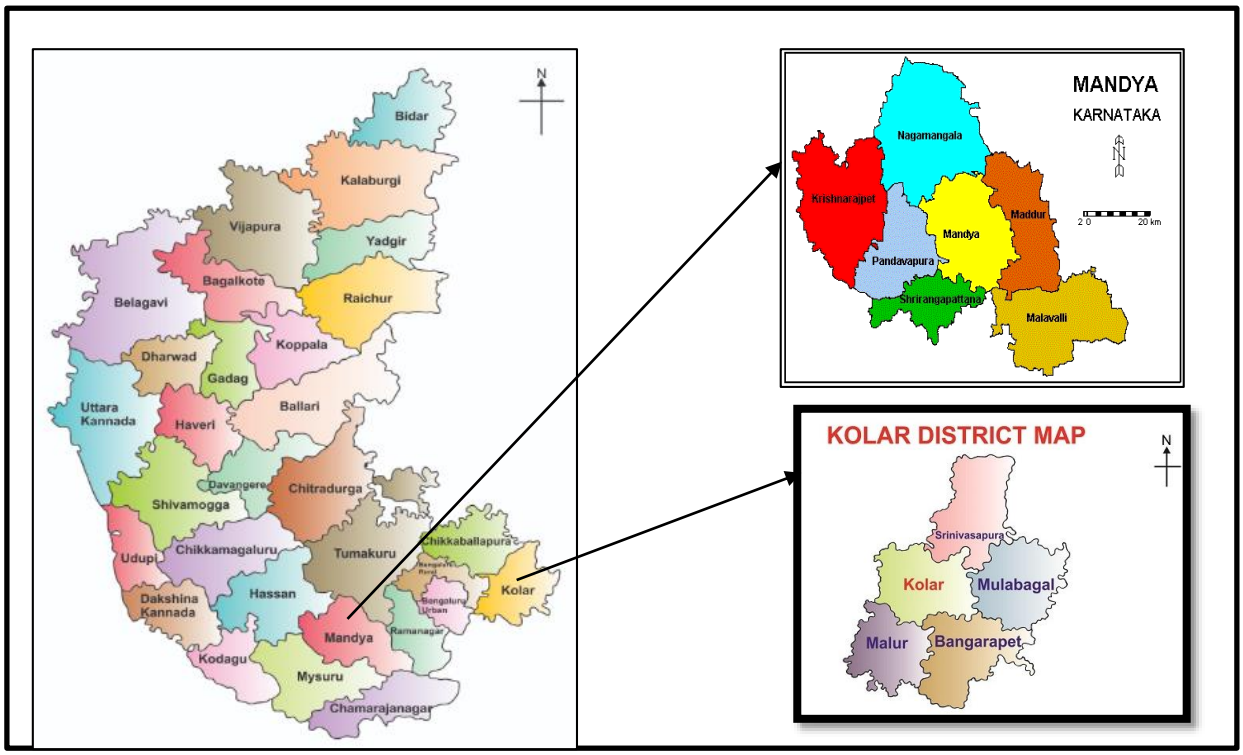

Fig 1: Map showing Mandya and Kolar district of Karnataka state

In order to address the objectives of the study two categories of farmers were sampled which was farmers who have adopted drip irrigation and not adopted the same. Total sample size of 150 were drawn from both Mandya district (60 sample farmers) and Kolar district (90 sample farmers). The information on major constraints faced by the sample farmers were collected by using pre structured interview schedule through personal interview method. The collected data were classified, tabulated and statistically analyzed. While ranking the major constraints faced by the drip irrigation adopters mean percentage score (MPS) method has been used.

$$MPS = \frac{\text{Total percentage obtained from elements of each major constraints}}{\text{Total number of elements}}$$

Results and Discussion

Constraints faced by the adopters of micro irrigation system were classified into four categories namely: technical, infrastructural, financial and educational constraints. The data regarding these constraints had been presented under following heads.

Technical constraints faced by the adopters of micro irrigation system

In Table 1, the technical constraints associated with the adoption of micro irrigation systems were assessed. Notably, the foremost concern among farmers was the 'clogging of drippers due to suspended materials,' with a significant 91.3% of farmers perceiving this as the most critical technical issue, ranking it as the top constraint. Following closely, 'damage to laterals or micro tubes during inter-cultivation' was the second most important technical constraint, recognized by 89.3% of respondents.

Subsequently, 'improper maintenance of laterals during the off-season' was identified as a significant issue by 85.3% of the farmers and held the third rank. 'Lack of technical knowledge' was perceived as the fourth most important constraint, with 81.3% of farmers recognizing its significance. Additional technical constraints, including the 'requirement for frequent maintenance,' 'blockage of water pipelines,' 'the need for pressure to discharge water,' and 'lack of awareness about crop water requirements and fertigation schedules,' were considered comparatively less significant, ranking fifth, sixth, seventh, and eighth, respectively, among the technical constraints.

Table 1: Technical constraints faced by the adopters of micro irrigation system

(n=150)

Sl. No.	Constraints	Frequency	Percentage	Rank
1	Clogging of drippers by suspended materials	137	91.3	I
2	Damage of laterals /micro tube during inter cultivation	134	89.3	II
3	Improper maintenance of laterals during off season	128	85.3	III
4	Lack of technical know-how	122	81.3	IV
5	Requirement of frequent maintenance	121	80.7	V
6	Blockage of water pipe line	124	82.7	VI
7	Need for pressure to discharge water	118	78.7	VII
8	Lack of awareness about crop water requirement and fertigation schedule	104	69.3	VIII
9	Damage of micro-tube /laterals by squirrel and rats	95	63.3	IX

Whereas, 'damage of microtube/laterals by squirrels and rats' was perceived by only 63.3 percent respondents and was ranked at last position.

Based on the information presented in the table, it is evident that 'clogging of drippers due to suspended materials' emerged as a significant technical challenge encountered by those who adopted micro irrigation systems. The next most important constraints were the 'damage to laterals during inter-cultivation' and the 'improper maintenance of laterals during the off-season,' ranking second and third, respectively. The fourth most critical technical constraint was the 'lack of technical knowledge.' This constraint may be attributed to the limited availability of technical guidance provided by extension personnel, as reported by the farmers. In many cases, it appears that such advice was primarily offered by dealers at the time of the drip irrigation system's installation. The findings are in accordance with the findings of Sasane *et al.* (2011) [2] and Chandran and Surendran (2016) [3] who reported that clogging of drippers and lack of technical awareness were the major constraints in adoption of micro irrigation system.

Infrastructural constraints faced by farmers in the study area

The findings presented in Table 2 shed light on the infrastructural constraints faced by farmers. Notably, the most prominent concern among them was the 'insufficient supply of electricity for irrigation,' with a substantial 88% of farmers identifying this as their top infrastructural challenge, ranking it as the first constraint. Following closely, the 'unavailability of technical staff working in the fields' was recognized as the second most important infrastructural constraint, with 78.7% of farmers expressing this concern. In the third position, 'poor after-sales services provided by the companies' was perceived as an issue by 58.6% of the respondents. On the other hand, the 'lower quality of pipes and micro-tubes' was considered a constraint by only 49.3% of farmers and ranked fourth. The least concerning constraints were 'the unavailability of timely spare parts' and 'the inadequate distribution network in rural areas,' which occupied the last ranks. These results underline that the 'insufficient supply of electricity for irrigation fields' was the most significant infrastructural constraint. This issue might be attributed to the poor and irregular supply of electricity in the study areas, which hinders farmers' ability to provide proper irrigation to their fields. The 'unavailability of technical staff working in the fields' was the next important constraint, emphasizing the need for skilled personnel in agricultural settings.

Table 2: Infrastructural constraints faced by the adopters of micro irrigation system

(n=150)

Sl. No.	Constraints	Frequency	Percentage	Rank
1	Insufficient supply of electricity for irrigating fields	132	88.0	I
2	Timely unavailability of technical staff working in the field	118	78.7	II
3	Services by the companies are poor after sales	88	58.6	III
4	Lower quality of pipe and micro-tubes	74	49.3	IV
5	Generally, timely spare parts are not available	32	21.3	V
6	Inadequate distribution network in rural areas	26	17.3	VI

Financial constraints

According to the findings presented in Table 3, it is evident that 92.7 percent of the surveyed farmers considered the 'initial installation cost' as a significant financial constraint, ranking it as their top concern. Following closely, 82.7 percent of the farmers identified 'insufficient subsidy provision' as their second-most perceived constraint. 'Inadequate credit facilities for farmers' ranked third, with 75.3 percent of respondents acknowledging this issue. 'High maintenance costs' and the 'complex loaning procedure' were ranked fourth and fifth, respectively, by 70.7 and 68.7 percent of the farmers. Notably, 'higher costs of liquid fertilizers' was the least concerning constraint, with only 55.3 percent of farmers reporting it. The predominant concern among farmers appears to be the prohibitively 'high initial installation costs,' which can deter small and marginal farmers from adopting micro irrigation systems. This reluctance may stem from a lack of awareness regarding the cost-benefit ratio associated with installing such systems. The issue of 'insufficient subsidy provision' may be attributed to the government's decisions, as subsidies depend on budgetary allocations and broader economic considerations. Consequently, the government has the flexibility to adjust subsidy provisions for drip irrigation systems based on their budgetary constraints and other financial factors.

Table 3: Financial constraints faced by the adopters of micro irrigation system

(n =150)

Sl. No.	Constraints	frequency	Percentage	Rank
1	Initial installation cost is very high	139	92.7	I
2	Subsidy release is less and irregular	124	82.7	II
3	Inadequate credit facilities for the farmers	113	75.3	III
4	High cost of maintenance	106	70.7	IV
5	Loaning procedure is complex	103	68.7	V
6	Higher cost of liquid fertilizers	83	55.3	VI

The findings are in accordance with the findings of Sasane *et al*. (2011) [2]; Bhingardeve *et al*. (2012) [4] and Bhuriya *et al*. (2016) [5] who reported that high initial cost and inadequate credit facilities for the farmers were the major constraints of micro irrigation system.

Educational constraints

As indicated in Table 4, the most prominent educational constraint in adopting micro irrigation systems was the absence of 'Farmers training programs for installation.' This concern was reported by 89.3 percent of the farmers and held the top ranking. Following closely, 84 percent of farmers recognized the need for 'sufficient demonstration events' to motivate and enhance their skills for adopting this technology, ranking it as the second most significant constraint. In the third position, 'Lack of direct access to experts specializing in drip irrigation systems for effective adoption' was identified by 81.3 percent of the farmers. Conversely, 'Inadequate awareness about the advantages of drip irrigation systems' was perceived by 62.7 percent of farmers and ranked fourth in terms of significance. Other constraints, such as the 'absence of organized campaigns to promote drip irrigation systems,' 'challenges faced by less-educated farmers in using this technology,' and 'limited knowledge about the operation of micro irrigation systems,' were identified as the fifth, sixth, and least significant constraints in the adoption of micro irrigation systems, respectively.

Table 4: Educational constraints faced by the farmers in adoption of micro irrigation system

Sl. No.	Constraints	Frequency	Percentage	Rank
1	Farmers training are not arranged for its installation	134	89.3	I
2	Inadequate number of demonstrations organized to motivate and develop skills for MI adoption	126	84.0	II
3	Lack of individual's contact with experts related to micro irrigation system for effective adoption	122	81.3	III
4	Inadequate awareness about the advantage of micro irrigation system	94	62.7	IV
5	Lack of systematic campaign for popularizing the micro irrigation system	87	58.0	V
6	Less educated/illiterate farmers feel difficulty in using micro irrigation system	75	50.0	VI
7	Lack of knowledge about the operation of micro irrigation system	55	36.6	VII

From the above findings it can be concluded that most of the farmers under study area are lack of understanding about operating, maintenance and advantage of micro irrigation system due to lack of special campaigns, trainings, demonstrations and less contact with experts to make the people aware about micro irrigation technology.

The findings was supported by the findings of Patel *et al*. (2012) [6] and Bhuriya *et al*. (2016) [7] who reported that lack of technical knowledge and training facilities were the major constraints in adoption of drip irrigation system.

Category wise overall position of constraints

The overall position of constraints as perceived by the farmers in adoption of drip irrigation system as presented in table 5. Results from the below table revealed that majority of the farmers faced the 'technical constraints' (80.21 MPS) in adoption of micro irrigation system and similarly the 'technical constraints' were the second important categories of constraints (74.23 MPS). The constraints under the categories like 'educational constraints' and 'infrastructural constraints' were the accorded third and fourth ranks (66 and 52.2 MPS), respectively.

Table 5: Category wise overall position of constraints as perceived by the farmers in adoption of micro irrigation system

Sl. No	Constraints	No. of statements	Mean percentage score	Rank
1	Technical constraints	9	80.21	I
2	Financial constraints	6	74.23	II
3	Educational constraints	7	66.00	III
5	Infrastructural constraints	6	52.2	IV

Conclusion

The study's overall assessment of these constraints reveals that technical constraints are the most pronounced issue, with a mean percentage score of 80. Financial and educational constraints follow closely behind, with mean percentage scores of 74 and 66, respectively. These findings suggest that while addressing financial and educational constraints is crucial, an emphasis on technical solutions, especially those related to clogging prevention and system maintenance, should take precedence in promoting the widespread adoption of micro irrigation.

In conclusion, the results highlight the need for a comprehensive approach involving financial incentives, education, and technical support to alleviate the challenges faced by micro irrigation adopters. By addressing these constraints, stakeholders can contribute to more sustainable and efficient agricultural practices, ensuring that micro irrigation becomes more accessible and widely adopted in the farming community.

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