The Pharma Innovation Journal 2023; SP-12(12): 2580-2583

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(12): 2580-2583

www.thepharmajournal.com
Received: 13-09-2023
Accepted: 16-10-2023

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Perceived benefits and constraints in adopting drip irrigation: A location analysis of mango orchard farmers under APMIP in Chittoor district

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Abstract
This study delves into the key benefits and challenges faced by mango farmers adopting drip irrigation in Chittoor district, Andhra Pradesh. Chittoor is leading producer with an area and production of 77.64 thousand hectares and 9.3 lakh tons respectively. Employing a multi-stage sampling technique with a convenience approach, the study gathered data from a sample of 40 farmers, the study identified eleven benefits and eight major constraints impacting drip irrigation adoption. Structured questionnaires utilizing Likert scale responses and analysis through the Garrett ranking technique revealed that increased production (67.25), water conservation (66.25) and affordability due to subsidies (65.88) stood out as the most significant benefits perceived by farmers. Conversely, the major concerns encompassed are clogging of pipes (68.88), high installation costs (67.50) and damage inflicted by animals or fire (64.25).

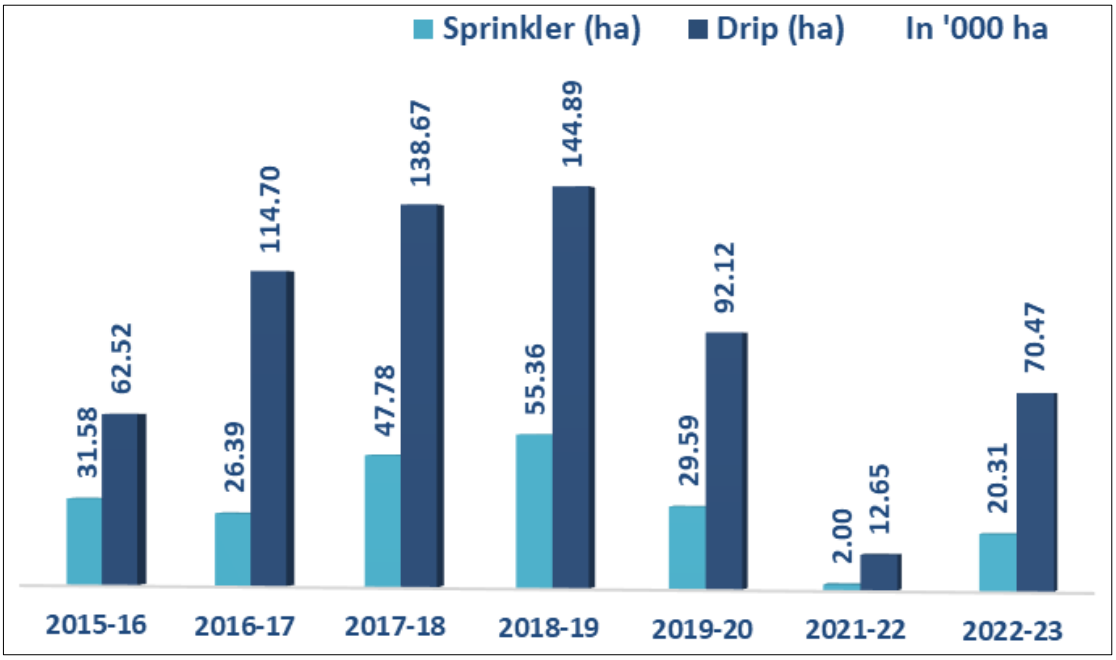
Keywords: Adopting drip irrigation, mango orchard farmers, production

Introduction
India is a developing agrarian economy faces the challenge of poor agricultural water management. With over 80% of available water channelled towards irrigation, the agricultural sector remains the major water consumer, fuelled by agricultural intensification (MOWR, 1999) [1]. This highlights the urgent need for improved water management practices to ensure sustainable agricultural growth and water security in India. Though India has the largest irrigated area in the world, the coverage of irrigation is only about 40 percent of the gross cropped area as of today.

Irrigation ensures reliable water supply for crops, boosting yield and quality. Proper management maximizes economic benefits and minimizes environmental impacts, making it vital for food security, sustainable agriculture, and farmer livelihoods. Micro-irrigation further boosts efficiency by reducing water, fertilizer, and electricity needs while protecting groundwater, making it a better choice for farmers (Suryavanshi and Buttar., 2018) [2].

The Indian government has implemented various initiatives like Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), which includes subsidies for drip irrigation adopters, to expand the area under this efficient technology. In Andhra Pradesh, one of India's leading states, the Andhra Pradesh Micro Irrigation Project (APMIP) was launched on November 3rd, 2003 which aims to enhance crop productivity by promoting water-efficient practices through the adoption of micro-irrigation systems.

Adoption of APMIP in Andhra Pradesh
Under the APMIP, the farmers get subsidies based on the categories of the farm size. From the year 2015-16 to 2022-23 (figure 1) both sprinkler and drip irrigation have seen an upward trend, drip irrigation has consistently dominated, contributing a total of 6,36,029 hectares compared to sprinkler's 2,13,012 hectares.

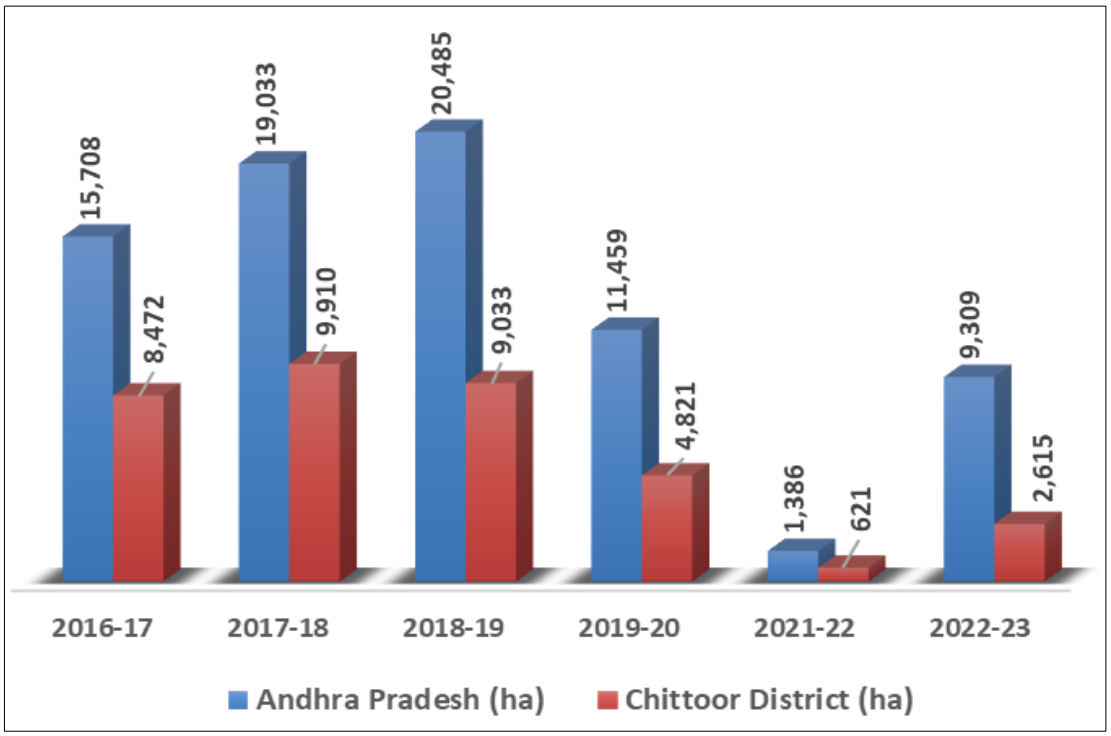


Source: DA&FW (2023) retrieved from https://pmksy.gov.in/mis/rptAchievement.aspx accessed as on 15.07.2023.

Fig 1: Adoption of APMIP from 2015-16 to 2022-23 in Andhra Pradesh

Adoption of APMIP in Mango orchards in Andhra Pradesh and in Chittoor district

In Andhra Pradesh, Chittoor district stands as the leading producer, encompassing an area of 77.64 thousand hectares with a production of 9.3 lakh tons. Krishna, Anantapur, and Vizianagaram districts also contribute significantly to the state's prestigious mango production (MOFPI, 2019) [19].



Source: DA&FW (2023) retrieved from https://pmksy.gov.in/mis/rptAchievement.aspx accessed as on 15.07.2023.

Fig 2: APMIP in Andhra Pradesh & Chittoor Mango Orchards from 2015-16 to 2022-23

From figure 2, it is observed that the drip irrigation adoption in Andhra Pradesh's mango orchards witnessed an initial increase in adoption from 2016-17 to 2018-19, expanding from 15,708 hectares to 20,485 hectares. However, declines are followed in 2019-20 and 2021-22 before a slight rebound in 2022-23. Currently, the total area under drip irrigation stands at 77,380 hectares.

Chittoor district, as a major mango producer it has 35,472 hectares under drip irrigation, accounting for over 40% of the state's total area. This is reflected as the district's consistent adoption, as seen in the annual coverage areas ranging from 8472 hectares in 2016-17 to 2615 hectares in 2021-22.

Benefits of Drip Irrigation in Mango Orchards

Several studies have demonstrated the positive impact of drip irrigation on orchard crops, including mangoes. Sujatha and Harris (2000) [5] reported increased production in arecanut orchards utilizing drip irrigation. Similarly, Ganeshamurthy *et al.* (2018) [6] observed enhanced productivity and water use efficiency (WUE) in mango orchards equipped with drip systems. Kumar *et al.* (2008) [7] further emphasized the potential for significant water-saving and productivity improvements at the field level through the adoption of drip irrigation in widely spaced row crops like mangoes, particularly in arid and semi-arid conditions with deep groundwater tables or saline aquifers. Access to credit and subsidies incentivizes microirrigation (MI) adoption among small and marginal farmers, particularly for orchard crops like mangoes. Initial water requirements for these crops are significantly lower compared to field crops.

Notably, cash crops like groundnut, cotton, and castor, and fruits like mango and banana, demonstrate markedly higher incremental net returns compared to food crops like bajra and wheat (Narayanamoorthy, 1997; Narayanamoorthy, 2004) [8, 9].

Fertigation with nutrients, coupled with optimal drip irrigation to replenish evapotranspiration losses, significantly increased mango fruit size and weight (Simrandeep *et al.,* 2023) [10]. Balanced vegetative growth and optimal fruiting, crucial for high yields, were achieved through these practices. Additionally, they facilitated effective pest and disease management (Reddy I.S., 2022) [11].

Constraints faced under Drip Irrigation

While drip irrigation offers a multitude of benefits in mango orchards, its adoption faces several challenges. Dinakar and Singh (2020) [12] highlight the high initial cost and demanding maintenance needs as prominent hurdles. Clogging of drippers and microtubes, further exacerbated by damage from rodents, animals, and fire, add to the operational complexities (Parmar and Thorat, 2016) [13]. Furthermore, the limited availability of insurance for drip systems (Vishwaradhya *et al.,* 2021.) [14] acts as another deterrent for potential adopters. Addressing these constraints through financial support, technological advancements, and robust insurance schemes is crucial for maximizing the potential of drip irrigation in mango cultivation.

Research Methodology

This study was conducted in Chittoor district, Andhra Pradesh, a largest producer of mango with high micro-irrigation adoption. A multi-stage sampling technique was employed, first selecting two prominent mango-growing mandals with drip irrigation. Within each mandal, four villages were chosen, and then five farmers per village who actively uses micro-irrigation were selected through a convenience approach. This resulted in a final sample of 40 farmers, providing valuable insights into their micro-irrigation practices in mango orchards. A review of existing literature revealed eleven key benefits and eight major challenges associated with drip irrigation for farmers. To rank these benefits and challenges based on farmer preferences, a structured questionnaire with Likert scale based questions were developed for farmer interviews and Garrett ranking technique was used to rank constraints and benefits.

Likert's Scale Technique

A Likert scale is a measurement tool employed to gauge attitudes or opinions by asking respondents to indicate their level of agreement or disagreement with a given statement. For example: Strongly agree to strongly disagree rating from 5 to 1.

Garretts Ranking Technique

Garrett's ranking technique was applied to assess the importance of constraints and benefits identified by farmers who have adopted micro-irrigation systems. Garrett's formula for converting ranks into percentages is as follows

$$\text{Percent position} = (100*(R_{ij}-0.5))/N_j$$

Where,

R_{ij} = rank given for i^{th} factor (constraints and benefits) by j^{th} individual

N_j = number of factors (constraints and benefits) ranked by j^{th} individual

Results and Discussion

In the study area, farmers were asked to rank the benefits and constraints. The collected data was analyzed using the Garrett's ranking method to identify the most significant benefits and challenges faced by micro-irrigation users and is represented as follows.

Benefits of Drip Irrigation as perceived by Mango Orchard Farmers.

Mango farmers clearly prioritized the core benefits of drip irrigation as observed from table 1, ranking increased production (67.25) and water conservation (66.25) highest. Financial incentives like affordability through subsidies (65.88) and reduced labor costs (62.63) also hold significant weight. While secondary benefits like weed control (62.88) and time savings (64.75) are appreciated, factors like adaptability to uneven terrain (58.63) and ease of fertilizer application (63.63) are less critical.

Notably, the low ranking of skillful labor requirement (57.50) suggests farmers are confident in adapting to the technology despite initial skill needs. Overall, drip irrigation offers tangible improvements in yield, resource efficiency, and financial viability, making it a highly attractive option for mango farmers in the study area.

Table 1: Perceived benefits of drip irrigation by Mango orchard farmers.

S. No.	Benefits	Average Garrett's Score	Rank
1	Increases production	67.25	I
2	Controls weed growth	62.88	VII
3	Conserves water	66.25	II
4	Useful in undulated topography	58.63	X
5	Saves time	64.75	V
6	Subsidies makes drip affordable	65.88	III
7	Minimizes labor costs	62.63	VIII
8	Effective in droughts	65.25	IV
9	Minimizes evaporation	62.50	IX
10	Need of skillful labour	57.50	XI
11	Easy to apply fertilizers	63.63	VI

Overall, the ranked benefits demonstrate the significant positive impact that drip irrigation have on mango farming by enhancing productivity, optimizing resource utilization, and reducing labour costs.

Challenges Faced by Mango Orchard Farmers in Adopting Drip Irrigation

As per the garret ranking scale analysis the presented in table 2. The most significant challenge, ranked 1, is clogging of pipes (68.88), highlighting the susceptibility of drip emitters and pipes due to hard water and maintenance practices. Farmers also identified the high cost of installation (67.50) and difficulty finding replacement parts (59.75) as major hurdles.

The maintenance costs (55.75) were considered less impactful, damage from rodents, animals, and fire (64.25) emerged as a moderate concern. Interestingly, limited post-installation support (50.50) and insurance coverage (52.38) were ranked lower, suggesting that these areas might be less problematic for farmers in the study area.

Table 2: Perceived constraints of drip irrigation by Mango orchard farmers.

S. No.	Constraints	Average Garrett's Score	Rank
1	Clogging of pipes	68.88	I
2	High cost of installation	67.50	II
3	Maintenance costs are high	55.75	V
4	Affects Soil quality	48.63	VIII
5	Difficult to find replacement parts	59.75	IV
6	Limited post-installation support	50.50	VII
7	Prone to damage from rodents, animals, and fire	64.25	III
8	Insurance Coverage	52.38	VI

Notably, impact on soil quality (48.63) was perceived as the least significant constraint, indicating that farmers generally acknowledge the benefits of drip irrigation for soil health.

Conclusion

The major significant benefits perceived by the drip irrigation adopting mango farmers are increased production, water conservation and affordability due to subsidies ranking highest. The farmers appreciate the easy adaptability and ease of fertilizer application, their focus clearly lies on maximizing yield, resource efficiency and financial viability. The relatively low ranking of labor skill requirement suggests confidence in adopting the drip technology.

Clogging of pipes, high installation costs and animal/fire damage emerge are the biggest concerns among the mango farmers considering drip irrigation, while soil quality and post-installation support are less important. Maintenance costs, while present, are ranked lower than initial investments and technical challenges. This suggests that financial feasibility and system robustness are primary considerations for adopting drip irrigation.

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