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IA designed the study; AAA performed the experiments, PJP collected data, WA wrote the first draft of the manuscript; MASA performed the statistical analysis; ZAK reviewed the draft of the manuscript; all authors approved manuscript for publication.

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## Socio-Technical Barriers to Drip Irrigation Adoption in Fodder Farming: An Ex-Post-Facto Study from Ghayathi, Abu Dhabi, UAE

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**Abstract:**

This study explores the constraints and perceptions of fodder growers in Ghayathi, Abu Dhabi, regarding the adoption and maintenance of drip irrigation systems in an arid agricultural setting. Based on data from 150 farmers, the findings reveal high adoption rates driven by recognized benefits such as water savings (90%), increased yield (85%), and reduced labor (70%). However, technical challenges including emitter clogging (94.67%), pipeline leakages (79.33%), and rodent damage (71.33%) alongside limited education and modest landholdings, hinder effective system management. The study underscores the need for targeted extension services, accessible technical support, and affordable maintenance solutions to ensure the long-term sustainability of drip irrigation in fodder cultivation.



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## INTRODUCTION

Agriculture in the United Arab Emirates operates under some of the most extreme environmental conditions globally, marked by an arid climate, high temperatures, and limited freshwater resources. In the Western Region, particularly Ghayathi, the cultivation of fodder crops such as alfalfa, Rhodes grass, panicum, and sorghum play a vital role in supporting the livestock sector (Arshad *et al.*, 2023). However, these crops are highly water intensive, and their cultivation has led to significant over extraction of groundwater, raising concerns about long term sustainability (Abdulai *et al.*, 2011). To tackle the ongoing challenges in water management, advanced irrigation methods such as drip and subsurface drip systems have gained considerable attention (Chauhan *et al.*, 2017). These technologies aim to maximize water use efficiency by delivering moisture directly to the plant's root area, which helps reduce evaporation and deep percolation losses. In Ghayathi, the uptake of drip irrigation is believed to be relatively high, driven by government incentives and awareness campaigns.

However, widespread adoption of drip irrigation does not necessarily ensure its effective or sustainable use. Farmers in Ghayathi continue to face significant challenges in operating, maintaining, and repairing these systems under local conditions (Batchelor *et al.*, 2014). Studies conducted in other arid regions such as India, Oman, and Saudi Arabia have consistently identified common barriers to efficient system performance, including emitter blockage, rodent damage, and a general lack of technical knowledge (Adnan *et al.*, 2019). The success of drip irrigation, therefore, relies not only on the availability of appropriate technology but also on the strength of institutional support systems. Extension services and practical training are essential in equipping farmers with the skills needed for routine maintenance and effective water management (Arshad *et al.*, 2019).

This research seeks to address a critical gap by identifying and prioritizing the constraints faced by fodder producers in Ghayathi when adopting and managing drip irrigation systems. By exploring both technical and socioeconomic dimensions, the study aims to guide targeted strategies that can improve the long-term viability and impact of drip irrigation in the region's forage production sector.

## MATERIALS AND METHODS

The study was carried out in Ghayathi, Abu Dhabi (UAE), a desert region characterized by high temperatures, saline groundwater, and a strong reliance on irrigation for agricultural production. An *ex post facto* research design was adopted to examine existing conditions and farmer experiences without introducing experimental treatments or altering variables. This design is frequently used in agricultural and social science research to investigate retrospective cause and effect relationships (Balamurugan *et al.*, 2021). The research population consisted of fodder producers who had already implemented drip irrigation systems. A total of 150 farmers were selected using a proportionate random sampling method to ensure balanced representation across small, medium, and large farms. This technique is commonly employed in agricultural surveys to achieve fair representation across different farm sizes (Benouniche *et al.*, 2014).

Data collection was conducted using a structured interview schedule developed to capture detailed insights into the technical, economic, and institutional challenges associated with drip irrigation. The instrument was pretested with a small group of farmers to confirm its clarity, relevance, and reliability. Final interviews were conducted face to face in the local language, which helped ensure accurate and contextually appropriate responses. Both structured and semi structured interviews have proven effective in irrigation research for

gathering qualitative and quantitative data on farmer practices and perceptions (Zhang *et al.*, 2019).

After collection, the data were coded, categorized, and entered into Genstat statistical software for analysis. Descriptive statistics such as frequency and percentage distributions were used to identify and rank the constraints reported by farmers. In addition, cross tabulation techniques were applied to examine relationships between socio economic variables and perceived constraints, providing deeper understanding of the factors that affect irrigation system performance and management.

## RESULTS AND DISCUSSION

### Major constraints faced by fodder growers

The study revealed a range of challenges encountered by fodder producers in Ghayathi in their efforts to adopt and manage drip irrigation systems. The most commonly reported issue was the clogging of emitters and laterals, affecting 94.67 percent of respondents. This technical constraint is primarily attributed to the use of saline water, inadequate filtration infrastructure, and insufficient maintenance practices, all of which contribute to reduced irrigation efficiency and diminished crop productivity. Similar findings were reported by Natwadia *et al.* (2022), who identified emitter clogging as a prevalent problem in arid environments, often linked to poor water quality and limited filtration capacity.

The second most frequently cited constraint was leakage in pipelines, reported by 79.33 percent of farmers. Such leakages disrupt the uniform distribution of water and lead to increased operational costs. Damage to laterals during harvesting was noted by 72.67 percent of respondents, typically resulting from interference by machinery or manual labor. Rodent and animal damage was another significant concern, affecting 71.33 percent of the sample. This reflects the ecological vulnerabilities associated

with open field cultivation. Comparable challenges were documented by Patel *et al.* (2018) in Saudi Arabia, where rodent damage remains a persistent issue, particularly in remote or less supervised farming areas.

Maintaining stable water pressure emerged as another technical difficulty, reported by 68 percent of farmers. This suggests possible shortcomings in system design or operational management. Furthermore, 60 percent of respondents indicated a lack of technical knowledge required for routine maintenance and repair, underscoring the need for improved training and extension services. Prajpa *et al.* (2016) similarly emphasized that inadequate farmer training can significantly compromise the performance and longevity of drip irrigation systems.

Economic constraints were also evident. Approximately 40 percent of farmers reported that spare parts were costly, while 31.33 percent identified the high initial installation cost as a major barrier. Zhou *et al.* (2008) observed comparable concerns among smallholder farmers in India, where both capital investment and recurring expenses have limited the broader adoption of drip irrigation technologies.

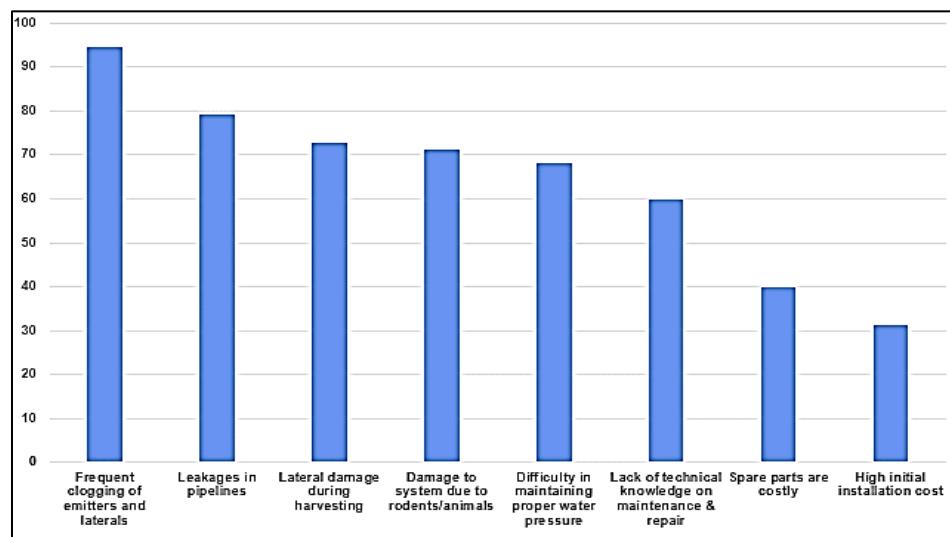
The findings, summarized in table 1, underscore the importance of a comprehensive support framework that addresses both technical and economic barriers. As noted by Venot *et al.* (2014), the long-term success of drip irrigation in arid regions depends not only on the availability of appropriate technology but also on access to training, maintenance services, and affordable inputs. The distribution and intensity of these constraints are visually represented in Figure 1.

### Socio-economic profile of respondents

Examining the socio-economic profile of fodder growers in Ghayathi provides important context for understanding their agricultural practices and their ability to adopt and manage irrigation technologies, as summarized in table 2.

**Table 1.** Constraints experienced by fodder growers (rank-wise) in adopting drip irrigation technology, n=150.

Constraint	Frequency	Percentage (%)	Rank
Frequent clogging of emitters and laterals	142	94.67	1
Leakages in pipelines	119	79.33	2
Lateral damage during harvesting	109	72.67	3
Damage to system due to rodents/animals	107	71.33	4
Difficulty in maintaining proper water pressure	102	68.00	5
Lack of technical knowledge on maintenance & repair	90	60.00	6
Spare parts are costly	60	40.00	7
High initial installation cost	47	31.33	8

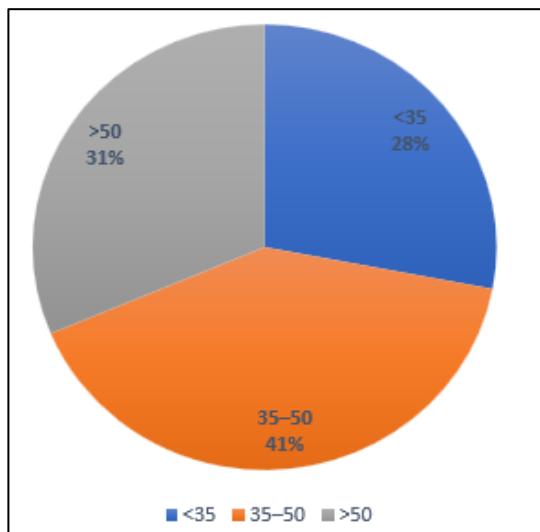
**Fig. 1.** Constraints Experienced by Fodder Growers in Adopting Drip Irrigation Technology.**Table 2.** Socio-economic Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Age	<35	42	28.00
	35–50	61	40.66
	>50	47	31.33
Education	Illiterate	38	25.33
	Primary	48	32.00
	Secondary	53	35.33
	Higher Secondary & above	11	7.33
Fodder Cultivation Area	Small (<2 donums)	52	34.66
	Medium (2 – 4 donums)	67	44.67
	Large (> 4 donums)	31	20.67

### Age distribution

The majority of farmers (40.66%) were between 35 and 50 years old, followed by those above 50 (31.33%) and those under 35 (28%). This indicates a balanced mix of mid-career and experienced individuals actively involved in fodder cultivation. Similar age related patterns have been observed in studies from India and

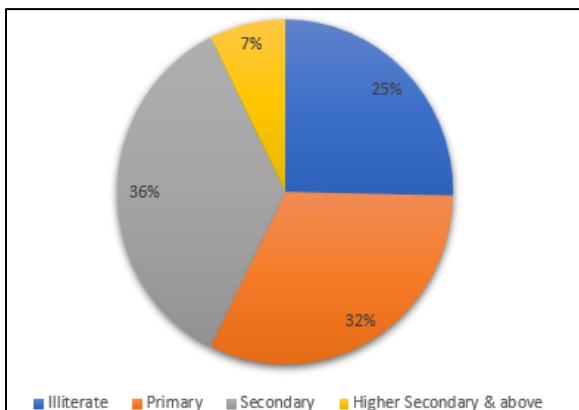
Oman, where middle-aged farmers tend to be more open to adopting new agricultural technologies due to their active roles in farm decision making (Shubham *et al.*, 2023). Figure 2 illustrates the age distribution, highlighting the predominance of middle-aged farmers.



**Fig. 2.** Distribution of respondents according to their age.

### Educational background

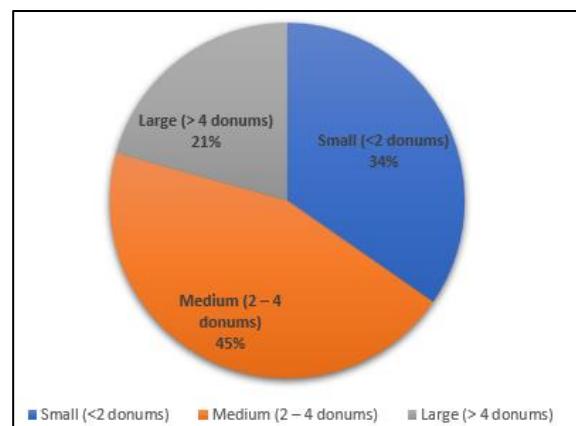
Education levels among respondents varied. About 35.33% had completed secondary education, 32% had primary education, 25.33% were illiterate, and only 7.33% had attained higher secondary education or above. This suggests a moderate level of formal education, which can influence how effectively farmers adopt and manage advanced irrigation systems. You et al. (2014) found that limited education often correlates with reduced technical understanding and lower efficiency in managing drip irrigation systems. Figure 3 shows the educational background of the respondents.



**Fig. 3.** Distribution of respondents according to their educational level.

### Fodder cultivation area

Most farmers operated on medium-sized plots (2–4 donums), accounting for 44.67% of the sample. Small plots (less than 2 donums) made up 34.66%, while large plots (more than 4 donums) represented 20.67%. This distribution suggests that most growers work on a modest scale, which may limit their ability to invest in and maintain drip irrigation systems. Similar landholding patterns have been reported in semi-arid regions of India, where small and medium scale farmers often face greater financial and technical barriers to adopting irrigation innovations Parmar and Thorat (2016). Figure 4 illustrates the distribution of fodder cultivation areas.



**Fig. 4.** Distribution of respondents according to Fodder Cultivation Area.

These findings highlight the need for extension services that take into account the educational backgrounds and farm sizes of growers. As Kaur et al. (2021) emphasized, customized training and support programs are essential to address knowledge gaps and promote the sustainable adoption of agricultural technologies in farming communities with limited resources.

### Relationship between fodder cultivation area and irrigation system type

The analysis of irrigation system usage across varying plot sizes in Ghayathi reveals distinct patterns in technology adoption. Surface drip irrigation equipped with online emitters emerged as the most widely used method. It was adopted by 45 farmers with small plots, 55 with medium

plots, and 27 with large plots. This distribution suggests a strong preference for surface drip systems, particularly among medium scale farmers who appear to benefit from an optimal balance between operational capacity and resource availability. These findings align with trends reported in other arid and semi-arid regions. For instance, Boithi et al. (2014) observed that medium sized farms in India were more likely to adopt drip irrigation, owing to their improved access to financial and technical resources and their ability to manage system complexity. Similarly, Kumar et al. (2021) reported higher adoption rates among medium scale farmers compared to smallholders, who often face greater financial and technical limitations.

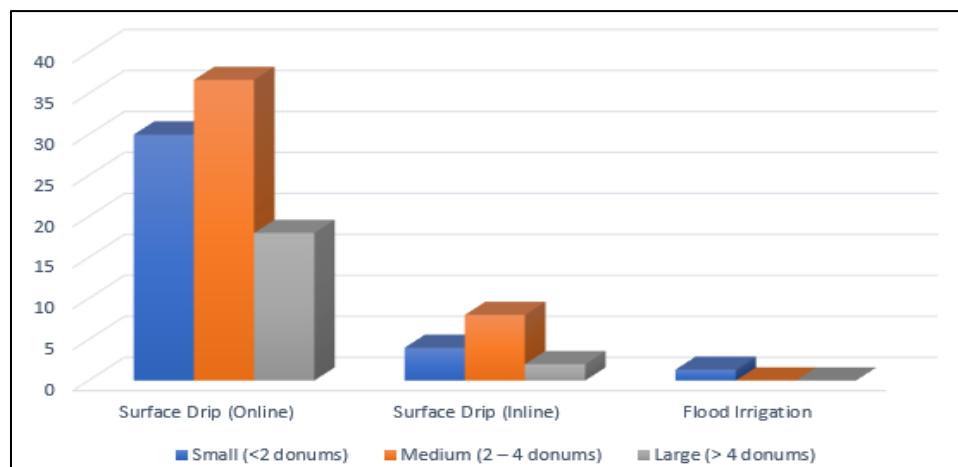
In contrast, surface drip systems with inline emitters were less commonly adopted. Only 6 small plot farmers, 12 medium plot farmers, and 3 large plot farmers reported using this method. The relatively low uptake may be attributed to the higher installation costs and technical demands associated with inline systems. Kulecho and Waetherhead (2006) also noted that although inline systems offer high efficiency,

their adoption is often constrained by the complexity of installation and maintenance. Flood irrigation, once a traditional method, has become nearly obsolete in Ghayathi. Only 2 small plot farmers reported using it, with no adoption among medium or large plot holders. This decline reflects a broader transition toward more water efficient irrigation technologies, a trend that has been documented globally in regions facing water scarcity Kaur and Tanwar (2020).

Overall, the data presented in table 3 indicate that the size of the cultivated area significantly influences both the choice and extent of irrigation technology adoption. Medium sized plots exhibit the highest rates of modern drip system usage, underscoring the need for irrigation support programs that are tailored to farm size. Facilitating access to appropriate technologies for both small- and large-scale producers is essential for promoting sustainable irrigation practices. This relationship is further illustrated in Figure 5.

**Table 3.** Fodder cultivation area vs irrigation system.

Fodder cultivation area	Surface drip (Online)		Surface drip (Inline)		Flood irrigation	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Small (<2 donums)	45	30.00	6	4.00	2	1.33
Medium (2 – 4 donums)	55	36.67	12	8.00	0	0.00
Large (> 4 donums)	27	18.00	3	2.00	0	0.00



**Fig. 5.** Distribution of respondents according to fodder cultivation area vs irrigation system.

### Perceived benefits of drip irrigation

Farmers in Ghayathi reported several notable advantages associated with the use of drip irrigation, reflecting its suitability for agriculture in arid environments. The most widely recognized benefit was water conservation, cited by 135 farmers, representing 90 percent of the sample. This highlights the system's effectiveness in preserving water, which is a critical and limited resource in the region. These findings are consistent with the work of Kanga'u et al. (2012), who found that drip irrigation can reduce water consumption by 30 to 70 percent compared to conventional irrigation methods in water scarce areas.

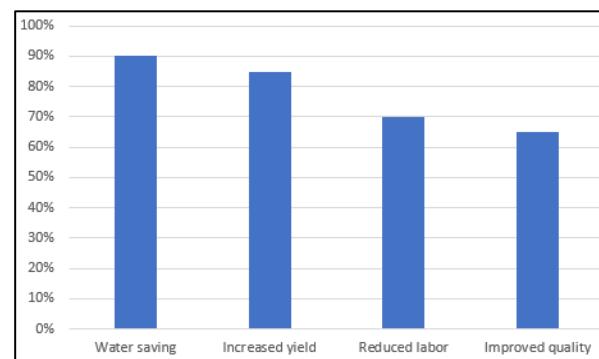
The second most frequently mentioned benefit was increased crop yield, reported by 128 farmers or 85 percent of respondents. This suggests that drip irrigation contributes significantly to productivity improvements. Dadheech et al. (2024) similarly documented substantial yield gains in vegetable and fodder crops under drip irrigation in semi-arid regions of India. Labor savings were also noted by 105 farmers, accounting for 70 percent of the sample. This indicates that drip irrigation reduces the manual effort required for irrigation tasks. Kumar et al. (2022) observed that labor reduction was a key factor influencing adoption among medium scale farmers.

Improved crop quality was reported by 98 farmers, or 65 percent of respondents, suggesting that precise and consistent water delivery enhances plant health and uniformity. Natwadia and Parmod (2022) also emphasized that controlled irrigation improves crop uniformity and reduces the incidence of disease. These findings, summarized in table 4, are supported by international research, including studies conducted by FAO and ICARDA, which highlight the transformative role of drip irrigation in improving smallholder farming outcomes in dryland regions.

Overall, the results reinforce the importance of promoting drip irrigation as a sustainable and productive approach to agriculture in water limited settings such as Ghayathi. Figure 6 illustrates the distribution of farmers based on their recognition of key benefits, including water conservation, increased yield, labor savings, and improved crop quality.

**Table 4.** Perceived benefits of drip irrigation.

Benefit	Frequency	Percentage (%)
Water saving	135	90%
Increased yield	128	85%
Reduced labor	105	70%
Improved quality	98	65%



**Fig. 6.** Distribution of respondents according to perceived benefits of drip irrigation.

### Maintenance practices among fodder growers

Although the advantages of drip irrigation are widely acknowledged, the maintenance practices among fodder growers in Ghayathi exhibit considerable variability and, in many cases, remain inadequate. The most commonly performed routine was weekly filter cleaning, reported by 112 farmers, accounting for 74.67 percent of the sample. This was followed by monthly flushing of irrigation lines, practiced by 98 farmers or 65.33 percent. Monitoring water pressure was carried out by 90 farmers,

representing 60 percent, while checking for emitter clogging was reported by 82 farmers or 54.67 percent.

Additional maintenance activities included replacing damaged laterals, reported by 72 farmers or 48 percent, and cleaning sediment traps, noted by 63 farmers or 42 percent. However, only 60 farmers, equivalent to 40 percent, engaged in rodent control, and even fewer just 52 farmers or 34.67 percent utilized technical services for system upkeep. These figures suggest that while basic maintenance routines are relatively well understood and practiced, more specialized and preventive measures are frequently neglected, likely due to limited access to professional support and training.

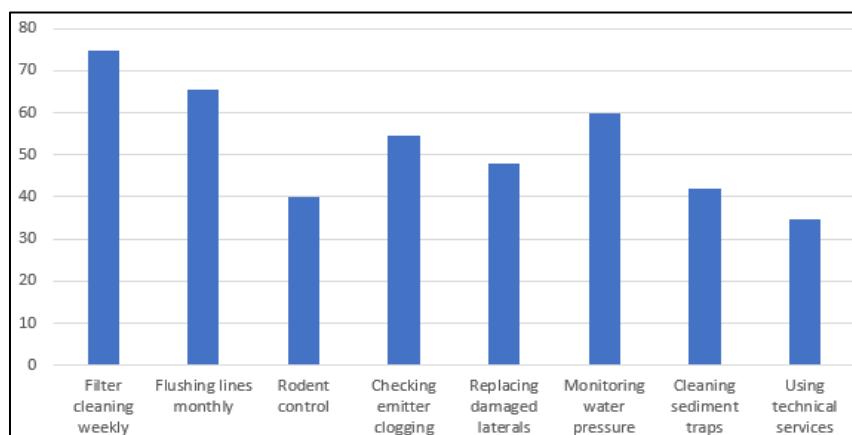
These findings are consistent with observations by Arshad et al. (2024), who reported that inadequate maintenance significantly compromises the efficiency and lifespan of drip

irrigation systems in the UAE. Kumar et al. (2019) similarly found that many farmers overlook routine upkeep due to insufficient technical knowledge and lack of access to professional services. Friedlander et al. (2013) emphasized the importance of regular and comprehensive maintenance for system durability and advocated for extension programs that prioritize hands on training in system management and pest control.

The results presented in table 5 point to a clear need for strengthening extension services and implementing focused capacity building programs. Supporting farmers with practical knowledge and access to affordable maintenance resources is essential for preserving the long-term functionality of drip irrigation systems in arid regions such as Ghayathi. Figure 7 provides a visual overview of farmer participation in key maintenance activities.

**Table 5.** Maintenance practices.

Practice	Frequency	Percentage (%)
Filter cleaning weekly	112	74.67
Flushing lines monthly	98	65.33
Rodent control	60	40.00
Checking emitter clogging	82	54.67
Replacing damaged laterals	72	48.00
Monitoring water pressure	90	60.00
Cleaning sediment traps	63	42.00
Using technical services	52	34.67



**Fig. 7.** Distribution of farmers based on maintenance practices followed.

## CONCLUSION

This study confirms that drip irrigation is widely adopted in Ghayathi for its water conservation and yield improvement benefits. However, its overall effectiveness is constrained by persistent technical difficulties, inconsistent maintenance practices, and socio-economic limitations. Medium scale farmers show the highest levels of adoption, yet challenges such as emitter clogging and limited access to technical expertise remain prevalent. To ensure the long-term sustainability and impact of drip irrigation in arid farming systems, it is essential to strengthen farmer training, expand access to maintenance services, and implement supportive policy interventions.

## CONFLICT OF INTEREST

There is no conflict of interest.

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