HILL PUBLISHING

Advance in Biological Research, 2026, 7(2), 59-69
https://www.hillpublisher.com/journals/abr/
ISSN Online: 2635-0319

Assessment of Mango Pests, Pest Management Knowledge and Practices of Mango Growers in Selected Districts of Ari and Konso Zones, South Ethiopia Regional State

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How to cite this paper: Daniel Abebe, Damtew Atnafu, Kumsa Dida, Tesfaye Mengsha. (2026). Assessment of Mango Pests, Pest Management Knowledge and Practices of Mango Growers in Selected Districts of Ari and Konso Zones, South Ethiopia Regional State. *Advance in Biological Research*, 7(2), 59-69.
DOI: 10.26855/abr.2026.12.001

Received: July 16, 2026
Accepted: August 13, 2026
Published: September 8, 2026

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Abstract

Mango (*Mangifera indica* L.) is an important fruit crop that contributes significantly to the livelihoods and food security of smallholder farmers in southern Ethiopia. However, its productivity is increasingly constrained by major insect pests, particularly the mango fruit fly (*Bactrocera dorsalis*) and the white mango scale (*Aulacaspis tubercularis*). This study assessed the prevalence of these pests and examined farmers' pest management practices in Ari and Konso Zones, Southern Ethiopia. A total of 160 households were interviewed, and 480 mango trees across eight kebeles were systematically inspected for pest infestation. The results revealed pronounced spatial variation in pest distribution. In Konso Zone, mango fruit fly infestation was widespread, while white mango scale was not observed, likely due to ecological conditions and traditional management practices such as orchard sanitation and smoke fumigation. In contrast, Ari Zone exhibited severe infestation pressure from both pests, with 86.9% of trees affected by mango fruit fly and 76.6% by white mango scale. The findings further indicated low farmer awareness and limited adoption of effective pest management practices in Ari Zone, corresponding with higher perceived yield losses reported by farmers. The study concludes that pest incidence in mango production systems is highly location-specific and influenced by both ecological factors and farmers' knowledge and management practices. It recommends the development and implementation of integrated pest management (IPM) strategies tailored to local conditions, strengthened farmer training programs, and better integration of indigenous knowledge to enhance sustainable mango production in southern Ethiopia.

Keywords

Mango; integrated pest management; indigenous knowledge; smallholder

1. Introduction

Mango (*Mangifera indica* L.) is among the most economically and nutritionally significant subtropical and tropical fruit crops. Mango farming in Ethiopia has also gained significant traction, particularly in the Southern Nations, Nationalities, and Peoples' Region (SNNPR), where smallholder farmers cultivate mango on a large scale [1, 2]. Mango farming, apart from its role in household nutrition, is an excellent source of income for rural households.

The national production of mango in Ethiopia has recorded a tremendous increase in the past decade—from approximately 44,000 tons in 2008 to over 153,000 tons in 2022—mainly because of the expansion of cultivated areas in Oromia, SNNPR, and Amhara regions [3]. Despite this increase, the country's average yield remains around 7 t ha^{-1}, which is below

the global average of 9.5 t ha^{-1} [4]. One of the major constraints is insect pest infestation, which continues to reduce both yield and fruit quality.

The most destructive insect pests affecting mango production in Ethiopia are the mango fruit fly (*Bactrocera dorsalis*) and the white mango scale (*Aulacaspis tubercularis*). Fruit fly infestation causes internal fruit rotting, premature fruit drop, and poor market quality [5, 6], whereas white mango scale attacks leaves, twigs, and fruits, resulting in defoliation, twig dieback, and substantial yield losses [7, 4]. The pest was first reported in Ethiopia in 2010 and has spread rapidly because of inadequate quarantine measures and poor nursery sanitation [8].

Although chemical control options are available, they are often too expensive or inaccessible for most smallholder farmers. Consequently, many farmers rely on indigenous pest management practices such as smoke fumigation, pruning, and orchard sanitation [9, 10]. Pest prevalence also varies geographically. Fruit fly infestation is more common in Konso Zone, whereas both fruit fly and white mango scale are major constraints in Ari Zone [11, 12].

Despite the increasing threat posed by these pests, information on their local prevalence, severity, and management remains limited. Furthermore, indigenous knowledge has rarely been integrated into formal pest management programs [13, 14]. Therefore, this study was conducted to assess the prevalence and severity of the major mango insect pests and document farmers' perceptions and management practices in Ari and Konso Zones, Southern Ethiopia.

2. Materials and Methods

2.1 Description of Study Area

The study was conducted in 2025 in large mango-producing kebeles of Konso and Ari Zones, southern Ethiopia. In general, survey areas included Karat Zuria and Karat Town Zuria woredas (Konso Zone) and South Ari and Baka Dawula woredas (Ari Zone). Both Belg (dry season) and Meher (main rainy season) were used for collecting data to determine seasonal pest dynamics.

Karat Zuria District lies between 5°15′-5°30′ N and 37°15′-37°30′ E, at an altitude of 1,500-2,000 m a.s.l., with mean annual rainfall of 600-1,200 mm and temperatures of 17-25°C. A semi-arid to sub-humid agro-climatic condition is faced by the area, with an average annual rainfall of about 716 mm.

South Ari District spans altitudes of 501-3,500 m.a.s.l., yearly rainfall of 1,401-1,600 mm, and temperatures between 10.1-25°C. Baka Dawula District spans latitudes of 5.0067°-6.19° N and longitudes of 36.30°-36.73° E, and has approximately 83,000 inhabitants. Farming is the primary economic activity in all districts.

2.2 Data Collection Methods

A multistage sampling technique was used. For every zone, four kebeles (two per district) were randomly chosen in coordination with local agriculture offices. From each kebele, 20 mango-producing farms were purposively chosen on the basis of criteria such as orchard size, accessibility, and production experience, reaching a total of 160 interviewed farmers.

2.3 Survey and Field Assessment

Data on household demography, mango cultivation practices, occurrence of pests, and control methods were collected using semi-structured questionnaires. The instrument contained open- and closed-ended questions. Development agents assisted in household interviews and field data collection trained on pest identification, damage symptom recognition, survey procedures, and consistent application of the pest severity rating scale (0-4). The training included identification characteristics of mango fruit fly and white mango scale, recognition of pest damage symptoms, proper tree inspection techniques, and standardized recording of field observations. Before the actual survey, a pilot assessment was conducted on mango trees to test and harmonize data collection procedures among enumerators. Differences in pest identification and severity scoring were discussed and corrected during the field exercise to improve consistency and reliability of observations across data collectors.

2.4 Data Collection Procedure

2.4.1 Household Survey and Pest Assessment

60 (sixty) mango trees were randomly sampled in each kebele for a total sample of 480 trees. 10-20 fruits/leaves per tree from different canopy positions were visually examined for pest infestation. Insect damage caused by mango fruit fly (*Bactrocera dorsalis*) and white mango scale (*Aulacaspis tubercularis*) was evaluated using a 0-4 insect damage scale

adapted from [15,16] as below:0 = no infestation, 1 = mild (1-25%), 2 = moderate (26-50%), 3 = severe (51-75%), 4 = extremely severe (76-100%)

$$\textbf{Service Index}\ (\%) = \frac{\sum(score\ X\ number\ of\ sampled\ at\ the\ scored)}{(total\ samples\ X\ \max score)} X100$$

Infestation rate (%) was calculated based on [17]as:

$$\textbf{Infestation Rate}(\%) = \frac{\text{number of infested fruits or leaves}}{\text{number of observed}} X100$$

2.5 Data Analysis

Quantitative information from the field survey was summarized using descriptive statistics (frequencies and percentages) employing SPSS version 16.0 [18].

3. Results and Discussion

3.1 Socio-Economic Characteristics of Mango Farmers

The socio-economic characteristics of mango farmers in Konso and Ari Zones are presented in Table 1. The variables assessed included gender, age, household size, and education level of the respondents. The results indicated that mango production in both Konso and Ari Zones was predominantly managed by male farmers, accounting for 72.5% and 75.0% of respondents, respectively. Female participation was comparatively lower, representing 27.5% in Konso and 25.0% in Ari. This suggests that mango production activities, including orchard management decisions, input utilization, and marketing practices, are mainly controlled by men.

The age distribution showed that mango farming was practiced mainly by economically active and experienced farmers. In Konso Zone, the highest proportions of respondents were within the age groups of 19-28 years and 39-48 years (30.0% each), followed by 49-58 years (25.0%). In Ari Zone, the majority of mango farmers were aged 39-48 years (42.5%), followed by 29-38 years (35.0%). The dominance of middle-aged farmers indicates that mango production is largely maintained by farmers with considerable farming experience and interest in long-term perennial crop investment.

Regarding family size, most mango-producing households had relatively large families. Households with seven or more members represented 47.5% in Konso and 41.25% in Ari, followed by households with 5-6 members (25.0% and 26.25%, respectively). Large family size may provide additional labor for orchard management activities such as pruning, harvesting, sanitation, and other farm operations. However, it may also increase household consumption demands and influence farmers' investment capacity.

The educational status of respondents revealed that a large proportion of mango farmers had limited formal education. Farmers who never attended school accounted for 41.25% in Konso and 43.75% in Ari, while only 3.75% and 6.25% had diploma or first-degree education, respectively. The relatively low education level may affect farmers' ability to access and utilize improved mango production technologies, pest management recommendations, and agricultural extension services. Therefore, farmer training programs should emphasize practical demonstrations and locally understandable communication methods.

Household headship followed a similar pattern to respondent sex distribution, with male-headed households representing 72.5% in Konso and 75.0% in Ari, while female-headed households accounted for 27.5% and 25.0%, respectively. The dominance of male household heads indicates the major role of men in decision-making related to mango production activities in the study areas.

Table 1. Socio-economic characteristics of mango farmers in Konso and Ari Zones

Socio-economic characteristics	Category	Konso (%)	Ari (%)
Sex	Male	72.50	75.00
	Female	27.50	25.00
Age (years)	19-28	30.00	8.75
	29-38	12.50	35.00

Table 1 Continued

Socio-economic characteristics	Category	Konso (%)	Ari (%)
	39-48	30.00	42.50
	49-58	25.00	11.25
	>59	2.50	2.50
Family size (members)	1-2	10.00	8.75
	3-4	17.50	23.75
	5-6	25.00	26.25
	≥7	47.50	41.25
Education level	Never attended school	41.25	43.75
	Grade 1-8	37.50	35.00
	Grade 9-12	17.50	15.00
	Diploma/First degree	3.75	6.25
Household headship	Male	72.50	75.00
	Female	27.50	25.00

3.2 Experience and Income from Mango Production

Farmers' experience in mango production varied between Konso and Ari Zones (Table 2). In Konso Zone, the majority of respondents (52.5%) had less than 11 years of mango production experience, while only 7.5% had more than 24 years of experience. In contrast, mango farmers in Ari Zone were relatively more experienced, with 47.5% of respondents having more than 24 years of mango production experience, followed by 43.75% having 12-24 years of experience.

Despite differences in production experience, annual income obtained from mango sales was generally low in both study areas. In Konso Zone, 40% of farmers earned less than 1,000 Ethiopian Birr annually from mango production, while this proportion was considerably higher in Ari Zone (76.25%). Only a small proportion of farmers reported higher income levels. In Konso Zone, 15% of respondents earned more than 10,000 Ethiopian Birr per year, whereas no respondents in Ari Zone reported income above this level.

The findings indicate that although mango production experience was relatively higher among farmers in Ari Zone, this did not correspond to higher income generation. Overall, most mango producers in both zones obtained limited financial returns from mango production.

Table 2. Mango producer experience and income in Konso and Ari Zones

Variable	Konso Zone (%)	Ari Zone (%)
Experience (years)		
< 11 years	52.5	8.75
12–24 years	40.0	43.75
> 24 years	7.5	47.5
Income from mango sales (ETB/year)		
< 1,000	40.0	76.25
1,001-4,000	35.0	22.5
4,001-10,000	7.5	1.25
>10,000	15.0	0

3.3 Orchard Characteristics and Knowledge Sources

The orchard characteristics of mango farmers varied between Konso and Ari Zones (Table 3). Narrow tree spacing was commonly practiced in both study areas, with 50% of farmers in Konso and 55% in Ari maintaining mango trees at spacing distances of less than 5 meters.

The number of mango trees owned by farmers was generally low in both zones. In Konso Zone, 50% of respondents owned fewer than five mango trees, while 31.25% owned 6-10 trees and 18.75% owned more than 11 trees. In Ari Zone, 62.5% of farmers had fewer than five mango trees, 37.5% had 6-10 trees, and none of the respondents owned more than 11 trees.

Most farmers cultivated mango on small landholdings. About 75% of respondents in Konso and 80% in Ari had mango orchards ranging from 0.01-0.03 hectares. Only a small proportion of farmers had larger mango orchard sizes (0.07-1.0 hectares) in both Konso (7.5%) and Ari (7.5%) Zones.

Regarding knowledge sources, mango production knowledge was mainly obtained from informal sources. In Konso Zone, 47.5% of farmers obtained knowledge from family members or ancestors, followed by 27.5% from neighbors. Similarly, in Ari Zone, 43.75% learned from neighbors and 41.25% from family members or ancestors. Only a small proportion of farmers received mango production information from formal or institutional sources (2.5% in Konso and 3.75% in Ari).

Table 3. Orchard characteristics and knowledge sources of mango growers in Konso and Ari Zones

Variable	Konso Zone (%)	Ari Zone (%)
Tree spacing		
<5 meters	50.0	55.0
Number of mango trees		
<5 trees	50.0	62.5
6-10 trees	31.25	37.5
>11 trees	18.75	0
Orchard size		
0.01-0.03 ha	75.0	80.0
0.04-0.06 ha	17.5	12.5
0.07-1.0 ha	7.5	7.5
Knowledge source		
Neighbors	27.5	43.75
Family/Ancestors	47.5	41.25
Formal/Institutional sources	2.5	3.75
Seedling source		
Government nurseries	77.5	48.75
Markets/Informal sources	22.5	51.25

3.4 Mango Production and Harvesting Practices

The survey results showed that mango production in Konso and Ari Zones followed a biannual harvesting pattern (Table 4). Farmers in both study areas reported two main harvesting periods. The first harvesting period occurred from December to January, while the second harvesting period was reported between April and May.

Regarding the harvesting stage, farmers showed differences in their preference for mango fruit maturity at harvest. In Konso Zone, the majority of farmers (95%) harvested mango fruits at the fully ripe stage, whereas 63.5% of farmers in Ari Zone reported harvesting fully ripe fruits. A smaller proportion of farmers in both zones harvested fruits at partially ripe stages.

The results indicate that harvesting practices were mainly based on farmers' traditional experience and local production conditions. The differences observed between Konso and Ari Zones suggest variation in farmers' harvesting decisions and management practices.

Table 4. Summary of mango production and harvesting practices in Konso and Ari Zones

Practice	Konso Zone (%)	Ari Zone (%)	Observation
Backyard farming	100	100	All mango orchards were located near homesteads
No pruning practice	60	71.25	Farmers reported no regular pruning practice
Use of compost/manure	65	20	Organic manure use varied between zones
Use of inorganic fertilizer	0	0	No farmers applied inorganic fertilizer
Harvesting at fully ripe stage	95.0	63.5	Majority harvested fully ripe fruits
Harvesting at partially ripe stage	5.0	36.5	Some farmers harvested partially ripe fruits
Harvesting period	December–January and April–May	December–January and April–May	Two harvesting periods were reported

3.5 Farmers' Knowledge of Pest Damage and Yield Losses

Farmers in both Ari and Konso Zones reported awareness of major mango pests affecting production (Table 5). In Ari Zone, 92.5% of respondents identified fruit flies and white mango scale as the major damaging pests of mango. Farmers reported that fruit fly infestation caused internal fruit rotting, premature fruit dropping, reduced fruit quality, and drying symptoms on mango plants. White mango scale infestation was reported to cause leaf yellowing, drying of twigs, and fruit deformation.

Farmers in Ari Zone estimated that severe infestation of these pests could result in losses of almost the entire mango crop. The perceived level of yield loss varied among farmers depending on the severity of pest occurrence and orchard conditions.

In Konso Zone, all interviewed farmers identified fruit flies as the major mango pest. None of the respondents reported the occurrence of white mango scale infestation in their orchards. This observation was also supported by field assessment conducted during the survey period, where no visible white mango scale infestation was recorded in the surveyed locations.

Overall, fruit flies were recognized as the major mango pest in both study areas, while white mango scale was reported only in Ari Zone. Farmers in Ari perceived higher mango yield losses due to the presence of multiple pest problems compared with farmers in Konso Zone.

A summary of pest presence, symptoms, and estimated yield losses in both zones is presented in Table 5, and visual symptoms of mango pest damage are shown in Figure 1.

Table 5. Farmers' knowledge of mango pests, damage symptoms, and estimated yield losses in Ari and Konso Zones

Zone	Main Pests Identified	Reported Damage Symptoms	Estimated Yield Loss	Presence of White Mango Scale
Ari	Fruit flies and white mango scale	Internal fruit rotting, premature fruit drop, reduced fruit quality, yellowing of leaves, drying of twigs, and fruit deformation	Nearly 100% loss in severe infestation cases (farmers' perception)	Yes
Konso	Fruit flies	Internal fruit rotting and premature fruit drop	Significant yield loss reported (not quantified)	No

Figure 1. Symptoms of mango fruit fly and white mango scale damage as observed in farmers' fields. (a) white mango scale insect heavily infested mango tree, (b) farmers burn fallen fruits and leaves, (c) mango tree free from white mango scale and fruit fly, (d) unmarketable mango fruit damaged by mango fruit fly, (e)infected mango fruits, (f) white mango scale on leaves, and (g) mango fruit fly infested on ripe fruit.

3.6 Farmers' Knowledge of Pest Management Practices and Adoption of Control Methods

Survey results showed differences in mango pest management practices between farmers in Konso and Ari Zones (Table 6). No chemical pesticide application was reported by farmers in either study area.

In Konso Zone, farmers reported using indigenous pest management practices against mango fruit flies. The main methods included smoking using plant residues and animal dung, as well as orchard sanitation activities such as removal and disposal of fallen fruits. In contrast, farmers in Ari Zone reported no use of cultural or chemical pest control methods.

The adoption reasons for indigenous pest management practices in Konso Zone varied among farmers. Most respondents (72.5%) indicated that the practices were commonly known community practices, while 20% adopted them because they were simple to apply. A small proportion of farmers reported that the methods were less hazardous (5%) or inexpensive (2.5%).

Overall, the results showed that farmers in Konso Zone practiced some indigenous mango pest management methods, whereas farmers in Ari Zone did not report any pest control practices.

Table 6. Indigenous pest control methods and adoption reasons by mango farmers in Konso and Ari Zones

Zone	Pest Control Methods Used	Chemical Use	Main Adoption Reasons	Adoption Rate (%)
Konso	Smoking using plant residues and animal dung; removal and disposal of fallen fruits	None	Community practice (72.5%), simple to use (20%), less hazardous (5%), cheap (2.5%)	Practiced
Ari	No pest control method reported	None	Lack of pest management practices reported	0

3.7 Incidence and Severity of Mango Pests

The survey revealed differences in the incidence and severity of mango pests between Ari and Konso Zones (Table 7). Mango fruit fly infestation was recorded in both study areas. The average fruit fly incidence in Ari Zone was 96.7%, with a severity index of 72.52% and a mean severity score of 3.87 on a 0-4 scale. In Konso Zone, fruit fly incidence was 82.5%, with a severity index of 61.88% and a mean severity score of 3.30.

White mango scale infestation was recorded only in Ari Zone, where the incidence was 90.0%, the severity index was 67.50%, and the mean severity score was 3.60. No white mango scale infestation was recorded in the surveyed areas of Konso Zone, resulting in zero incidence and severity values.

Overall, mango fruit fly was present in both zones, while white mango scale infestation was observed only in Ari Zone. The highest pest incidence and severity values were recorded in Ari Zone.

Table 7. Mean incidence and severity index of mango pests in Ari and Konso Zones

Pest	Zone	Incidence (%)	Severity Index (%)	Mean Severity Score (0–4 scale)
Mango fruit fly	Ari	96.7	72.52	3.87
Mango fruit fly	Konso	82.5	61.88	3.30
White mango scale	Ari	90.0	67.50	3.60
White mango scale	Konso	0	0	0

4. Discussion

The dominance of male respondents in mango production in both Konso and Ari Zones indicates that mango farming activities are mainly managed by men. This pattern reflects the broader structure of smallholder agriculture in Ethiopia, where men often have greater access to land ownership, agricultural resources, and farm decision-making processes. The relatively lower participation of women may limit their involvement in important aspects of mango production, including pest management decisions, access to agricultural training, and adoption of improved technologies. Similar findings have been reported in Ethiopian agricultural systems, where gender disparities influence access to agricultural services and productivity-enhancing technologies [19].

The predominance of middle-aged farmers suggests that mango production is largely maintained by experienced and economically active farmers. Mango, being a perennial fruit crop, requires long-term investment and continuous management before reaching maximum productivity. Therefore, farmers with longer farming experience may have greater interest in maintaining mango orchards due to accumulated knowledge and expected long-term benefits. Similar observations were reported by Asfaw et al. [20], who indicated that perennial crops are commonly managed by mature farmers because of their long production cycles.

The large household sizes observed in both zones may provide additional family labor for mango orchard activities such as harvesting, pruning, sanitation, and pest management. However, large household dependency may also reduce investment capacity by increasing household consumption demands. The high proportion of farmers with limited formal education may affect access to improved mango production technologies, pest management information, and extension services. Therefore, farmer training programs should consider local education levels and emphasize practical demonstrations and farmer-to-farmer learning approaches.

Mango production in both zones was mainly practiced as backyard farming, with limited use of external inputs. The absence of inorganic fertilizer application indicates that mango production remains largely dependent on traditional

management systems. Although mango trees can survive under low-input conditions, inadequate nutrient management may limit fruit yield and quality.

The low level of pruning practice observed among farmers may negatively affect orchard productivity. Proper pruning improves canopy structure, enhances sunlight penetration, facilitates harvesting, and reduces pest and disease pressure by improving orchard ventilation [1]. However, many smallholder farmers lack knowledge and technical support regarding appropriate pruning methods.

The majority of farmers harvested mango fruits at the fully ripe stage, particularly in Konso Zone. While fully ripe fruits have better eating quality, harvesting at this stage increases vulnerability to mechanical damage and post-harvest deterioration. Mature-green harvesting is generally recommended for mango intended for marketing because it improves shelf life and reduces losses during transportation and storage [21].

Farmers demonstrated relatively good awareness of major mango pests, particularly fruit flies. Fruit flies were identified as the dominant pest in both Ari and Konso Zones, while white mango scale was mainly reported in Ari Zone. The recognition of pest symptoms by farmers indicates that pest problems are highly visible and directly affect mango production.

Fruit flies are among the most destructive mango pests worldwide because larvae develop inside fruits, causing internal breakdown, premature fruit dropping, and loss of market value. Previous studies have reported significant mango yield losses associated with fruit fly infestation, depending on pest population density, mango variety, and environmental conditions [22, 5, 23].

The occurrence of white mango scale only in Ari Zone may indicate differences in pest distribution between the two production areas. Ecological conditions, orchard management practices, and movement of infested planting materials may influence the spread and establishment of scale insects. White mango scale has been reported as an important mango pest causing leaf yellowing, twig drying, and fruit quality reduction [24].

The absence of chemical pesticide use in both zones indicates limited adoption of modern pest management technologies among mango farmers. However, farmers in Konso practiced indigenous pest management methods, including orchard sanitation and smoking using plant residues and animal dung.

Cultural control methods such as removal and destruction of infested fruits, orchard sanitation, and soil disturbance are important components of integrated pest management for fruit flies because they reduce breeding sites and pest population buildup [25]. The use of smoking practices by farmers may provide temporary repellency effects, although its effectiveness requires further scientific evaluation.

The complete absence of pest management practices among Ari farmers suggests a critical gap in knowledge, training, and extension support. Integrated pest management programs combining farmer education, orchard sanitation, monitoring, and environmentally safe control methods are needed to improve mango productivity and reduce economic losses.

The higher incidence and severity of mango pests recorded in Ari Zone compared with Konso indicate differences in pest pressure between the two areas. Fruit fly incidence was high in both zones, confirming its status as the most important mango pest in the study area. Similar high infestation levels of fruit flies have been reported in mango-producing regions of Ethiopia and other tropical countries [26,25].

The absence of white mango scale infestation in Konso, despite its high occurrence in Ari, may be associated with differences in environmental conditions, orchard management practices, and pest establishment. Cultural practices such as sanitation, pruning, and removal of infested plant parts can reduce pest population development and contribute to lower infestation levels [27].

Overall, the results demonstrate that mango production in Ari and Konso Zones is constrained mainly by insect pest problems, particularly fruit flies and white mango scale. Strengthening integrated pest management approaches, improving farmer training, expanding extension services, and promoting improved orchard management practices are essential strategies for increasing mango productivity and improving farmers' livelihoods

5. Conclusion

This study revealed that mango production in Ari and Konso Zones is affected by important insect pest problems, particularly mango fruit fly and white mango scale. Mango fruit fly infestation was recorded in both study areas, whereas white mango scale infestation was observed only in Ari Zone. The highest pest incidence and severity were recorded in Ari Zone. Farmers in Ari also reported higher perceived yield losses associated with severe pest infestation; however, these losses were based on farmers' observations and were not experimentally quantified in this study.

In contrast, farmers in Konso Zone practiced indigenous pest management methods, including orchard sanitation and smoking using locally available materials, which may contribute to reducing pest pressure. The findings further indicated that limited access to pest management information, inadequate extension support, and low adoption of improved orchard management practices are important challenges affecting effective mango pest management.

Overall, improving mango production in southern Ethiopia requires strengthening farmer knowledge, promoting integrated pest management (IPM) approaches, improving access to extension services, and combining locally practiced management strategies with scientifically validated pest control options. Addressing these challenges will contribute to improved mango pest management, enhanced production potential, and improved livelihoods of mango-growing communities in the study areas.

6. Recommendations

Based on the findings of this study, the following recommendations are proposed:

- Provide practical, field-based training for mango farmers on pest identification, monitoring, and integrated pest management practices.
- Promote effective indigenous pest management practices, such as orchard sanitation and removal of infested fruits, while evaluating and improving their effectiveness.
- Strengthen agricultural extension services to improve farmers' access to technical information on mango production and pest management.
- Establish regular pest monitoring and early warning systems to detect and manage mango pest outbreaks before severe crop losses occur.
- Promote access to improved and pest-tolerant mango varieties and quality planting materials through certified sources.
- Encourage the participation of women and youth in mango production training programs and technology adoption activities.
- Develop area-specific integrated pest management (IPM) strategies considering the differences in pest occurrence and farming practices between Ari and Konso Zones.
- Conduct further research on biological control, indigenous pest management practices, resistant varieties, and sustainable pest management options for mango production in Bottom of Form

Acknowledgments

We sincerely thank the Jinka University Office of the Vice President for A/T/T/R/C/Service for their generous financial support, which made this study possible. Our heartfelt appreciation also goes to the dedicated mango farmers who shared their time, knowledge, and fields with us. Special thanks are extended to the local offices of South Ari, Baka Dawula, and Karat Zuria and Karat Town Zuria kebeles for their valuable information and assistance during data collection. We are also grateful to all the orchard owners for their kind cooperation and permission to conduct field assessments on their farms.

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