

Research Article

Assessments on Improved Beekeeping Technology in Selected Districts of Jimma and Ilu Abba Bora Zone, Southwestern Oromia

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Abstract

Beekeeping plays an important role in improving rural livelihoods through honey production, income generation, and employment creation. The use of improved beekeeping technologies can enhance honey productivity, improve product quality, reduce labor requirements, and increase the economic benefits obtained by beekeeping households. This study assessed the status and perceived benefits of improved beekeeping technologies in selected districts of Jimma and Ilu Abba Bora zones, Southwestern Oromia. A combination of household surveys, focus group discussions, key informant interviews, and field observations was employed to generate both qualitative and quantitative data. Findings revealed that although improved beekeeping technologies, such as modern and transitional beehives, safety materials, and honey harvesting tools, were available, their utilization remains limited across the study districts. A considerable proportion of beekeepers still rely on traditional hives and locally made tools due to high initial costs, limited technical knowledge, inadequate extension support, and weak market linkages. Households that utilize improved technologies experienced higher honey yields, higher-quality honey, reduced labor requirements, and better income opportunities. However, challenges such as a lack of adequate training and limited access to improved technology continue to hinder wider uptake. The study concludes that improving the performance of the beekeeping sector requires coordinated interventions to strengthen agricultural extension services, expand access to affordable beekeeping equipment, provide practical and continuous training, and improve market linkages. These measures could promote the wider utilization of improved beekeeping technologies and contribute to increased honey productivity and improved livelihoods among beekeeping households in Southwestern Oromia.

Keywords

Improved Beekeeping, Technology Utilization, Market Linkage, Southwest Oromia

1. Introduction

Beekeeping is one of the most important livestock subsectors contributing significantly to rural livelihoods in many developing countries [20, 27]. Ethiopia is endowed with diverse agroecological zones and favorable climatic conditions that

support abundant nectar and pollen-producing flora, making it one of Africa's most suitable countries for apiculture [21, 34]. Despite this enormous potential, the country's annual honey

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and beeswax production remains far below its estimated capacity per year [12, 19, 25]. This production gap is largely attributed to the dominance of traditional beekeeping systems, which rely on inefficient hives and poor management practices that reduce yield and quality [14, 15].

Beekeeping in the Jimma and Ilu Abba Bora zones of southwestern Oromia was an important component of rural livelihoods and agricultural activity.

The area is characterized by diverse flora and favorable climatic conditions, which are conducive to honeybee foraging and the production of high-quality honey [13, 24, 30]. Most beekeepers in the area still rely on traditional methods, particularly the use of traditional hives hung on tall trees within forested areas, which limit honey yield and quality [11, 33].

To improve productivity, improved beekeeping technologies such as modern box hives, colony management techniques, and disease control practices have been introduced [4, 10, 17].

To increase the production and productivity of honey and beeswax, different improved technologies have been disseminated to the farmers through governmental and non-governmental organizations to improve honey production potential. Moreover, Jimma Agricultural Engineering Research Center (JAERC) has developed and demonstrated various improved beekeeping technologies, including modern hives, horizontal beehives, nuclee box hives, and honey processing equipment. Despite these achievements, the actual use of these technologies among beekeepers has remained low. Assessment is needed to identify the factors that constrain the utilization of improved beekeeping technologies. Therefore, this study was initiated to assess farmers' perceptions, the current status of its utilization, as well as the main constraints of improved beekeeping technologies in the study area.

2. Research Methodology

2.1. Description of the Study Area

The study was conducted in four districts located within two major administrative zones of Southwestern Oromia, Ethiopia. In Jimma Zone, the research covered Sigimo and Gera districts, while in Ilu Abba Bora Zone, the study was undertaken in Alle and Yayyo districts. These areas were purposely selected due to their strong tradition of beekeeping and favorable agro-ecological conditions. Beekeeping is a key source of rural income, practiced by a large proportion of households. Rainfall in the region is generally high and well distributed, supporting the growth of natural forests and multipurpose trees that serve as important sources of nectar and pollen. Temperatures remain moderate throughout most of the year, creating favorable conditions for honeybee survival and productivity.

2.2. Data Types and Sources of Data

Both qualitative and quantitative types of data were col-

lected from primary and secondary sources to ensure the reliability and completeness of the study. The study gathered primary data directly from sample beekeeper households through structured questionnaires, focus group discussions (FGDs), key informant interviews (KIIs), and field observations. These methods helped capture detailed information on beekeeping practices, technology use, constraints, and farmers' perceptions.

Secondary data were obtained from published and unpublished materials, including reports from agricultural offices, research institutions, development organizations, journal articles, and relevant policy documents. These sources provided background information, contextual understanding, and supportive evidence for interpreting the primary findings.

2.3. Sampling Method and Sample Size

A three-stage sampling technique was employed to select representative sample respondents for the study. In the first stage, two (2) districts were selected from each zone, ensuring coverage of major beekeeping areas across the study zones. In the second stage, from each selected district, three (3) kebeles were purposively chosen based on the intensity of beekeeping activities, accessibility, and availability of beekeeping technology interventions.

In the third stage, a total of 267 beekeeper households were selected using a simple random sampling method from the list of beekeeper farmers in the selected kebeles. This approach ensured that every household had an equal chance of being included in the study.

Sample Size Determination

The total sample size was determined using Yamane's sample size determination formula (1967), which provides an appropriate sample size for a given population at a 95% confidence level:

$$n = \frac{N}{1+N(e)^2}$$

2.4. Data Collection Methods

Primary data were collected using a semi-structured questionnaire administered to a sample of beekeeper households. In addition to the household survey, Key Informant Interviews (KIIs) were conducted with agricultural experts and kebele-level extension service providers to obtain technical insights and institutional perspectives on beekeeping practices and technology utilization.

Furthermore, Focus Group Discussions (FGDs) were carried out with groups of farmers. These discussions were designed to capture diverse views, shared experiences, and community-level perceptions related to beekeeping technologies, constraints, and opportunities. The interactive nature of FGDs helped generate in-depth qualitative information that complemented the household survey data.

Secondary data were obtained through a review of existing

reports, policy documents, and academic studies related to livestock feed resources, beekeeping development, and rural livelihoods. The secondary information provided context and supported the interpretation of the primary findings.

2.5. Method of Data Analysis

The data collected were analyzed using both descriptive methods. Descriptive statistics such as means, frequencies, and percentages were employed to summarize household characteristics. In addition to the descriptive measures, the results were presented using tables and figures to enhance clarity and facilitate comparison across variables.

3. Result and Discussion

3.1. Socioeconomic Characteristics of Beekeepers

Socioeconomic characteristics of households significantly influence improved agricultural practices, including beekeeping technologies [9, 16, 22]. The results of the study revealed that beekeeping was mainly undertaken by men (97.75%), while women accounted for 2.25% of households' beekeepers. With respect to educational status, the majority (47.56%) of households had completed their primary education.

Table 1. Socioeconomic Characteristics (dummy variables).

Variables		Frequency	Percentage
Level of education	Illiterate	94	35.22
	Primary	127	47.56
	Secondary	39	14.6
	Tertiary	7	2.62
Status Marital	Married	256	96.04
	Single	8	2.99
	Divorced	3	1.12
Sex	Male	261	97.75
	Female	6	2.25

Computed from survey data, 2024

The survey results revealed that the average age of the household was 41.2 years, ranging from 20 to 68 years. This indicated that beekeeping in the study area was practiced by an active age group who are capable of utilizing improved technologies. This finding is similar to [1, 8, 28], who reported that active adult farmers play a significant role in the adoption of improved apiculture technologies in southwestern Ethiopia.

Table 2. Socioeconomic Characteristics (continuous variables).

Variables	Mean	Std. D
Age of households	41.20	10.929
Experience in beekeeping technology	9.00	4.890
Livestock owned (TLU)	1.341	1.04
Family size	5.14	2.92

Computed from survey data, 2024

3.2. Sources of Improved Beekeeping Technologies

The study revealed that the majority of households (46.2%) accessed improved beekeeping technologies through government extension services, highlighting the continued role of government institutions in technology dissemination to small-holder beekeepers. In addition, markets accounted for 38.9% of the sources, indicating that commercial channels also play a significant role in providing improved technologies to rural households.

These findings are consistent with [7, 18], who reported that government organizations remain the most common source of agricultural technologies in rural areas.

Table 3. Households' Sources of the improved beekeeping Technology.

Sources	Frequency	Percentage
Government	123	46.2
NGOs	23	8.7
Market	104	38.9
Research centers	17	6.2

Computed from survey data, 2024

3.3. Households Having Improved Beekeeping Technology

As illustrated in Figure 1, among the interviewed households, 43% reported owning modern beehives, while 47% had access to beekeeping accessories. This indicates that a portion of farmers are adopting improved technologies, though the majority still rely on traditional practices.

These findings are consistent with Doyo and Abebe (2023), who noted that the use of modern beekeeping technologies is gradually increasing due to their higher efficiency, productivity, and ease of management compared to traditional methods. Promoting wider access to improved hives and accessories,

along with technical support and training, is essential to enhance adoption rates, improve honey yields, and support the overall modernization of beekeeping in the study area.

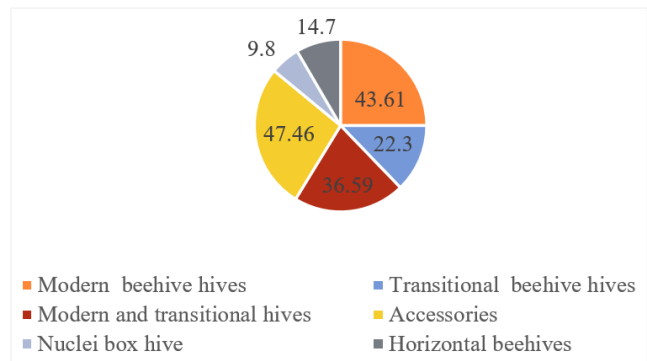


Figure 1. Improved beekeeping technology tools.

3.4. Households’ Use of Safety and Processing Equipment

The study revealed that beekeepers in the study area use various protective and processing materials in their beekeeping activities, although the utilization rates differ across items (Table 4). Only 20% of households reported using safety materials, indicating a growing but still limited interest in improving honey quality and ensuring safety during harvesting. The findings highlight a considerable gap in the use of essential beekeeping tools, including protective materials and processing equipment. Limited access to these materials potentially affects honey productivity, product quality, and the overall efficiency of beekeeping practices. Similar to studies reported by [6, 23, 35], inadequate availability of modern beekeeping tools reduces colony performance, honey yield, and post-harvest quality.

Table 4. Households having protective materials and processing equipment.

Accessories	Frequency	Percentage
Protective materials		
Bee suit	55	20.5
Bee veil	40	15.4
Gloves	70	26.2
Smoker	33	12.5
Boots	68	25.4
Harvesting and Processing Equipment		
Bee brush	17	6.3
Uncapping fork	28	10.5

Accessories	Frequency	Percentage
Honey extractor	28	10.4

Computed from survey data, 2024

3.5. Bee Colony Management Practices

The study revealed that households engage in a variety of bee colony management activities, although the intensity and frequency of these practices vary. The most commonly practiced activity was hive inspection (46.4%), indicating that beekeepers actively monitor hive conditions, identify pest or disease infestations, and assess colony health. In contrast, activities such as feeding bees (16.2%) and providing water (5%) were practiced less frequently. This suggests that management interventions to support bee colonies during periods of forage scarcity or adverse environmental conditions are still limited. In line studies reported by [5, 26], inadequate colony management, especially during dearth periods, negatively affects colony strength and honey productivity.

Table 5. Households’ bee colony management practice.

Bee colony management	Frequency	Percentage
Hive inspection	70	46.4
Water	24	5
shelter	66	24.9
Bee feeds	32	16.2
Bee forages	23	7.5

Computed from survey data, 2024

3.6. Beekeepers’ Perceptions of Improved Beekeeping Technologies

Understanding the perceptions of beekeeper households toward improved beekeeping technologies is essential for designing effective interventions and promoting technology utilization. The survey revealed that farmers perceive several advantages associated with the use of improved technologies. The main benefits reported were higher honey yield (73.3%), better honey quality (79.2%), and ease of harvesting (67.1%). These positive perceptions indicate that beekeepers recognize the potential of modern technologies to enhance productivity and product quality. Conversely, households also identified certain challenges of improved beekeeping technologies. The major constraints included high cost (55%), the need for technical skills (38.9%),

and the unavailability of the technology (32.2%). These perceived limitations highlight barriers that may hinder widespread adoption and underscore the importance of capacity building, technology accessibility, and financial support (Table 6). Previous studies have shown that farmers’ perceptions strongly influence their willingness to adopt improved apicultural technologies [3, 17, 24].

Table 6. Farmers 'perceptions of improved beekeeping technology utilization.

Perception	Occurrence	Percentage
Increases honey yield	196	73.3
Ease for harvesting	179	67.1
Improve honey quality	211	79.2
High cost	147	55.0
Unavailable	104	38.9
Needs skill	86	32.2

Computed from survey data, 2024

3.7. Farmers’ Preference for Improved Beekeeping Technologies

The survey results indicated that households exhibit varying preferences for different types of improved beekeeping technologies. Among these, modern beehives were the most preferred, with 49.8% of households indicating their choice. Farmers favored modern hives due to their advantages, including higher honey yields, ease of harvesting, and improved colony management, compared to traditional hives.

In addition, processing equipment ranked third in preference, with 43.7% of households expressing interest. This reflects a growing awareness among farmers of the importance of post-harvest handling and honey quality improvement through the use of modern processing tools, which aligns with evidence showing that improved honey processing technologies significantly enhance product quality and market value (11, 4).

Table 7. Respondent’s preference for improved beekeeping technology.

Improved Technology	Preference (%)	Ranks
Modern Beehive	49.8	1st
Nuclei box hive	17	4th
Processing equipment	43.7	3rd

Improved Technology	Preference (%)	Ranks
Protective materials	46.5	2nd

Computed from survey data, 2024

3.8. Access of Beekeepers to Institutional Services

Institutional support plays a crucial role in encouraging smallholder beekeepers to adopt and utilize improved beekeeping technologies. The survey results revealed that 53.93% of households have access to extension services related to improved beekeeping, while 42.32% of households reported receiving training on modern beekeeping practices. However, the majority, 57.68% of households, had never received any training, highlighting a significant gap in capacity-building efforts.

Access to market information is another critical factor influencing beekeepers’ ability to sell honey at fair prices. About 62.29% of households reported having access to honey market information, whereas 37.71% lacked access, limiting their market opportunities and income potential. In terms of technology adoption, only 48.2% of households had access to improved beekeeping technologies, while the majority, 51.8%, continued to rely solely on traditional tools and practices.

These findings are consistent with Lagasse (2018), who noted that inadequate extension services and insufficient training significantly constrain the adoption of improved beekeeping technologies.

Table 8. Respondents' access to institutional support.

Variables	Response	Frequency	Percentage
Access to extension services	Yes	123	53.93
	No	144	46.07
Access to training on beekeeping	Yes	113	42.32
	No	154	57.68
Access to improved technology	Yes	102	48.20
	No	165	51.80
Access to honey market information	Yes	169	62.29
	No	99	37.71
Access to credit services	Yes	13	42.87
	No	254	57.13

Computed from survey data, 2024

3.9. Major Constraints of Improved Beekeeping Technology

The results indicate that beekeepers in the study area face several significant challenges that hinder the adoption and effective use of improved beekeeping technologies. Lack of improved hives is the most critical constraint, reported by 24% of respondents, suggesting that essential modern equipment is either unavailable or inaccessible. This is followed by a lack of processing equipment (21%), highlighting gaps in value-addition capacity, such as honey extractors and filtering tools. Lack of safety materials (17%) ranks third, showing that beekeepers often lack protective gear, which affects both productivity and safety in hive management.

Other notable constraints include weak market linkage (15%), which limits beekeepers’ ability to sell their products at fair prices, and lack of initial capital (13%), restricting their ability to invest in improved technologies. Lastly, weak technical skills (10%) indicate insufficient training and extension support, which reduces the effective utilization of available technologies. These findings are consistent with previous research by [2, 29, 31, 32], which highlighted that limited access to improved hives and weak market systems are persistent challenges in the apiculture sector.

Table 9. Constraints of improved beekeeping Technology Utilization.

Constraint	Percentage	Ranks
Lack of initial capital	13	5th
Lack of safety materials	17	3rd
Weak market linkage	15	4th
Lack of improved hives	24	1st
Weak technical skill	10	6th
Lack of processing equipment	21	2nd

Computed from survey data, 2024

4. Conclusion and Recommendation

The study revealed that some beekeeping households have begun using improved technologies, but the majority still rely on traditional tools and locally available materials. As a result, many farmers are unable to fully realize the benefits of modern beekeeping practices, such as higher honey yields, better colony management, reduced labor, and improved product quality. This limited adoption has constrained productivity gains in honey production across the study area. Key challenges hindering modernization include significant knowledge gaps, which limit farmers’ capacity to effectively manage and utilize improved hives, and the lack of reliable

market linkages, which restrict opportunities for expanding sales and achieving better profitability.

To enhance and sustain the use of improved beekeeping technologies, it is recommended to improve farmers’ capacity through technical training and awareness programs that can equip beekeepers with the skills needed for effective technology use. Establishing demonstration sites provides practical learning opportunities, allowing farmers to observe and apply improved practices. Subsidizing the cost of technologies or improving affordability can increase access, particularly for resource-limited households. Strengthening extension services and technical support is critical to facilitate adoption, while promoting market linkages ensures farmers can sell their products at fair prices, incentivizing continued use of improved technologies. Additionally, providing access to protective and processing equipment can improve honey quality, safeguard beekeeper safety, and support overall technology uptake.

Author Contributions

Hussein Abba Gissa: Conceptualization, Data curation, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing

Lemma Gutema: Conceptualization, Formal Analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Writing – review & editing

Kumale Sadesso: Data curation, Investigation, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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