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Research Article

Participatory Evaluation and Demonstration of Tensheratach (Horizontal Frame Hive) in Kofale District of West Arsi Zone of Oromia, Ethiopia

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Abstract

The study was conducted in Kofale District of west Arsi zone with the objectives of to demonstrate and evaluate the horizontal frame hive under frames conditions, to create awareness about this hive technology in the study area, and to assess farmers' perceptions and preferences of the new hive technology. The district was purposively selected based on potentiality for honey production. Two kebele's were selected purposively based on potential of beekeeping. Selected farmers were organized into two Farmer Research and Extension Groups (FREGs) comprising 20 members. Awareness creation training and experience sharing field day was carried out to facilitate experience exchange among participants. The horizontal frame hive was demonstrated and evaluated alongside the traditional hive under actual farm conditions. Honeybee colonies were introduced at trial sites and routinely inspected to monitor their development. At maturity, honey was harvested and extracted using a mechanical extractor. The data collected were analyzed using simple descriptive statistics and partial budget analysis, while farmers' preferences and perceptions were analyzed using a five-point Likert scale rating method. The results of the analysis show that an average honey yield of 23.40 kg/hive and 6.21 kg/hive was obtained from horizontal frame hives and traditional hives, respectively. The result showed that there is a statistically significant difference ($p<0.05$) between horizontal frame hives and traditional hives. The cost benefit analysis also showed that the highest net benefit (12,490 ETB/hive) was obtained from horizontal frame hive as compared to traditional hive (2,150 ETB/hive). Moreover, farmers' perception results also show that the horizontal frame hive was preferred by participant farmers for its ease of management and inspection, honey quantity and purity, savings in labor and time, and reduced colony disturbance and mortality. Therefore, the horizontal frame hive is recommended for further scaling up to reach a greater number of farmers with this beneficial technology.

Keywords

Honey Yield, Demonstration, FREG, Horizontal Frame Hive, Technologies

1. Introduction

Beekeeping is a vital livestock sub-sector that significantly enhances the livelihoods of people in many countries [1]. (FAO, 2012). It serves as a key strategy for poverty alleviation in developing nations [2]. At the household level, beekeeping provides nutritional benefits, income opportunities,

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and ecological security. Additionally, it supports increased crop production through honeybee pollination [2, 3]. The sector tends to be most profitable when modern beekeeping technologies and their full applications are employed [4]. Moreover, beekeeping contributes to economic activity by creating jobs for more than two million people [5]. However, traditional methods, which result in low production, poor quality products, and limited marketing efforts, have kept the sector largely subsistence based [6].

Ethiopia possesses immense potential for beekeeping due to its suitable climate and diverse vegetation, providing abundant nectar and pollen sources for honeybees [7, 8]. The country's favorable conditions support around 10 million bee colonies, with 5 to 7.5 million managed colonies and the remainder being feral [9, 10]. This makes Ethiopia a leader in Africa in both honeybee colony population and honey production, ranking among the top ten honey-producing countries worldwide [11]. Estimates suggest Ethiopia's annual honey production potential is approximately 500,000 tons of honey and 50,000 tons of beeswax [12]. However, current output remains low at about 53,000 tons of honey and 5,400 tons of beeswax, representing only around 10% of this potential [13]. This shortfall is mainly due to limited adoption of improved beekeeping technologies and insufficient beekeeper skills.

Ethiopian beekeeping employs three types of hives: traditional, transitional, and frame hives [14, 15]. Traditional hives dominate the landscape, accounting for approximately 95.73% of all hives, while transitional and frame hives represent only 1.30% and 3.33%, respectively. However, traditional hives significantly constrain honeybee productivity and bee product quality, with average yields of merely 5 to 7 kg per hive [16]. In contrast, transitional hives can produce approximately 15 kg per hive, while improved box hives yield 20 to 30 kg per hive per season [17]. Consequently, adopting improved beekeeping technologies and practices enables beekeepers to generate surplus honey production. To solve these problems, the Adami Tulu Agricultural Research Center (ATARC) has been conducting several research studies on the development and adaptation of beekeeping technologies. Among the innovations developed, the Tensher-atach (horizontal frame hive) has shown superior productivity, with a potential honey yield of 24.81 kg per hive. It also offers advantages in terms of low cost, ease of management, and higher economic returns compared with both modern and traditional beehives [18]. Despite these considerable advantages, this beehive technology has not yet been demonstrated to local beekeepers or evaluated under on-farm conditions with active farmer participation. This gap was mainly due to the lack of an appropriate demonstration approach based on the "learning by doing" principle. Therefore, this study was initiated to demonstrate and evaluate horizontal frame hive to the farming community, raise awareness of the technology in the study area, and assess farmers' perceptions and preferences regarding the new hive technology.

2. Materials and Methods

2.1. Description of Study Area

The study was conducted in Kofale district, which is located 279 km south of Addis Ababa. Geographically, the district is located between 7°9′60″N latitude and 38°49′59.99″E longitude. The district is bordered by Shashemene district to the northwest, Kokosa district to the south, the SNNP Region to the west, Gedeb Asassa district to the east, Kore district to the north, and Dodola district to the southeast [19]. Most of its areas are highlands (90%) and mid highlands (10%) with an altitude ranging from 2,200 to 3,200 m-a-s-l. The mean annual rainfall of the district is 1,800 mm, which varies between 2,000 mm and 3,050 mm. The district experiences bi-modal rainfall distribution, characterized by small rains from March/April to May and the main rainy season extending from June to September/October. The average annual temperature is 19.5°C and it ranges from 17°C to 22°C [20].

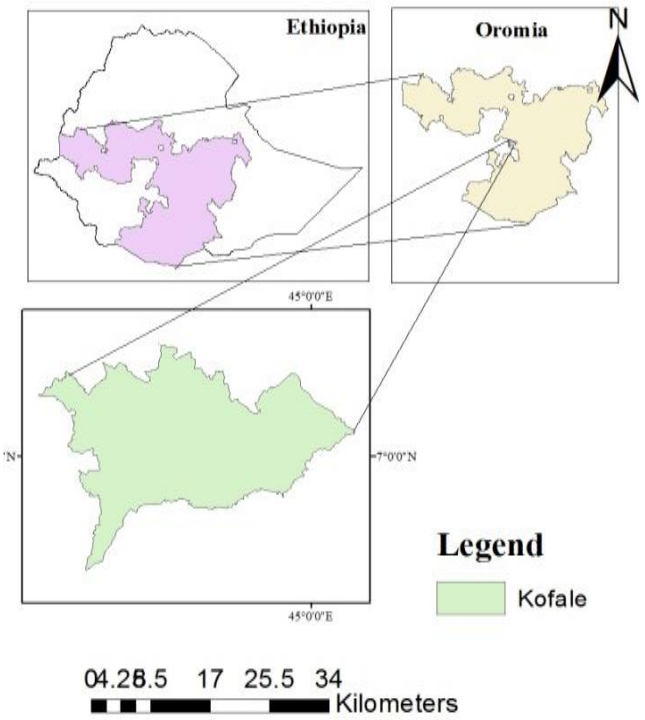

Figure 1. Map of the study area.

2.2. Site and Farmers Selection

The target district Kofale was selected purposively for the implementation of the experiments because of its potential in honey production. Two kebeles and 20 farmers (10 from each kebele) were selected based on accessibility, honey production potential, interest in accepting the technology and willingness to provide their colonies for the demonstration. In each kebele, one Farmer Research and Extension Group (FREG) comprising 10 farmers was established. Within each FREG, four hosting farmers were

selected, with the remaining members serving as participant farmers. Farmer profiling was conducted with the participation of development agents (DAs) and community leaders.

2.3. Roles and Responsibilities of Stakeholders in Hive Technology Demonstration Process

The success of this project depends on it more than the efforts of researchers alone; it requires active participation and clear commitments from all relevant stakeholders. To ensure coordinated action, the main stakeholders were identified, and their respective roles and responsibilities were clearly defined and agreed upon. The demonstration platform included farmers, the research center, Development Agents (DAs), and district experts, with each group assigned specific tasks aligned with their capacity and mandate. A detailed overview of these stakeholders and their roles is summarized in Table 1.

Table 1. Roles and responsibilities of participants in technology demonstration process.

Stakeholders	Roles and responsibility
Participant farmers	Participating in training and field day, contributing colonies and managing, maintaining accurate records, teaching neighbour farmers about technology, honey harvesting and marketing and reporting emergencies
Agricultural office	Selecting farmers, monitoring colony development and participating in training and field day
Research centre	Preparing manuals and providing training for farmers and DAs, monitoring the technology implementation process, organizing field days with district agriculture offices and taking necessary data and writing scientific report

2.4. Training and Input Provision

Following the establishment of the Farmer Research and Extension Groups (FREGs), theoretical and practical training was provided to farmers, development agents, and district experts, as horizontal frame hives were new to beekeepers in the district. The training covered bee biology, beekeeping systems, routine colony management and inspection, colony transfers from traditional hives to horizontal frame hives, honey harvesting and post-harvest handling, bee product marketing, and the advantages of horizontal frame hives. The primary aim of the training was to create awareness among farmers, development agents, and district experts regarding improved beekeeping technologies. All necessary inputs were delivered to the trial farmers, including horizontal frame hives with frames, refined beeswax, queen excluders, smokers, water sprayers, hive chisels, bee brushes, honey sieves, and protective clothing. Experience-sharing sessions and a field day were organized to supplement theoretical training.

2.5. Honeybee Colony Establishment and Management

The horizontal frame hive was demonstrated alongside the traditional hive under actual farm conditions. Honeybee colonies were transferred from traditional hives to Tensheratach (horizontal frame) hives with the participation of researchers, experts, development agents (DAs), field assistants, and farmers at each site. These sites were in areas where bee forage plants were abundantly available. All colonies were maintained under shade within their respective apiaries, and routine seasonal management practices were applied. These practices included: feeding, regulation of hive temperature and shading and protection from pests and predators. During periods of forage shortage, honeybee colonies were provided with recommended supplementary feeds. The primary diet consisted of sugar syrup supplemented with flour from beans, chickpeas, and barley.

2.6. Data Collection and Analysis

Both qualitative and quantitative data were collected through personal observation, measurements and interview. The collected data were yield data, type and number of stakeholders participated by gender in training, field visits, farmer's perception on the different attribute of the technology, costs and income gained. In addition, perception data were collected using focus group discussion during evaluation periods. The preference towards the technology have been collected from farmers participated on field day by interviewing and discussing with them another day after they have visited the technology. The collected quantitative data was analyzed using descriptive statistics in SPSS version 20. Farmers preference and perception were analyzed using five-point Likert scale rating method. Net income (NI) was used to assess the profitability of the improve beehive technology that was demonstrated.

$$TR=q*p \quad (1)$$

Where q= yield obtained (kg/hive) and p farm gate price in birr/kg.

$$IN=TR-TVC-FC \quad (2)$$

Where NI = Net income, TR= Total Revenue, TVC= Total Variable Cost and FC= Fixed Cost.

3. Results and Discussion

3.1. Capacity Building Training and Field Day

Training was provided to farmers, Development Agents (DAs), and agricultural experts by researchers. The training covered bee biology, beekeeping systems, routine colony management and inspection, colony transferring methods, honey harvesting and post-harvest handling, bee product marketing, and the advantages of horizontal frame hives. A total of 71 participants were trained, including 63 farmers, 3 DAs, 3 experts, and 2 supervisors (Table 2). Of the total trainees, 88.7% were male and 11.3% were female. A mini field day was also organized to create awareness and facilitate experience and knowledge sharing among farmers. At this field visit event, a total of 54 participants attended, including 46 farmers, 3 DAs, 3 agricultural experts, and 3 supervisors (Table 2). Most farmers demonstrated strong interest in the horizontal frame hives due to several advantages: better honey yield and earned income, easy colony inspection, simplified harvesting, greater durability, lower labor requirements, and improved swarm control.

Table 2. *Participants of training and field day.*

Participants	Training			Field day		
	Male	Female	Total	Male	Female	Total
Farmers	56	7	63	38	8	46
Experts	3	-	3	2	-	2
DAs	2	1	3	2	1	3
Supervisors	2	-	2	3	-	3
Total	63	8	71	45	9	54

Figure 2. *Farmers field visiting (left side) and participants training (right side).*

3.2. Honey Yield Performance of the Demonstrated Hives

The horizontal frame hive produced a significantly higher honey yield (23.40 kg/hive), than the traditional hive (6.21 kg/hive) (Table 3). These values are slightly higher than the national average honey yields of 5 kg for traditional hives and 15-20 kg for modern hives, indicating the relatively high production potential of beekeeping in the study area. The present results are also in close agreement with [21] who reported 5.88 kg and 20.64 kg per hive per year for traditional and modern hives, respectively. A study in western Ethiopia reported broader yield ranges: 3-15 kg per harvest for traditional hives, 10-35 kg for transitional hives, and 6.25-50 kg of crude honey for movable-frame hives, further highlighting the variability and potential of hive-based honey production across different systems and regions.

Table 3. Mean honey yield obtained from horizontal frame hives and traditional hives.

Hive type	Honey yield (kg/hive) (N=8)			
	Minimum	Maximum	Mean	Std. Division
Horizontal frame hive	16.4	29.46	23.40[a]	4.668
Traditional hive	2.8	10.70	6.21[b]	3.008

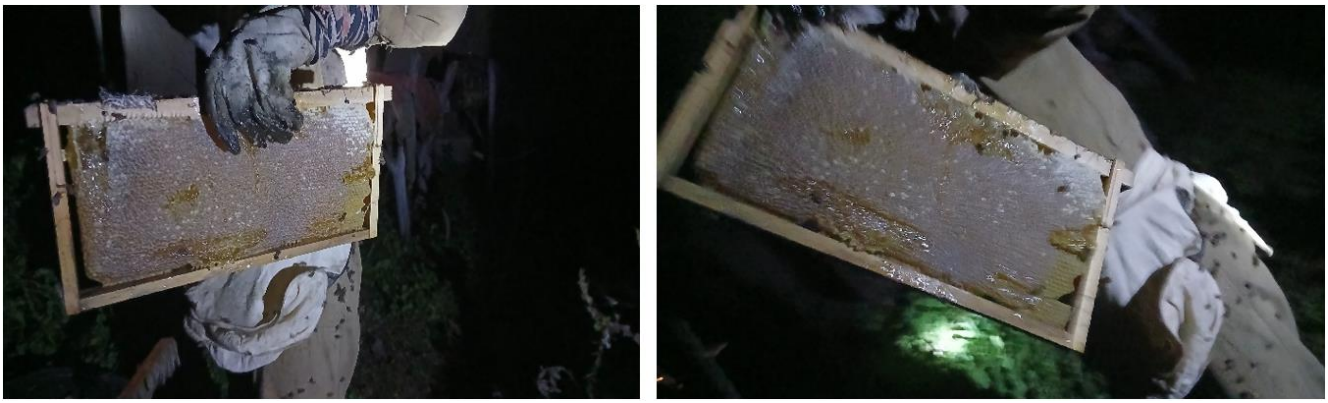

Figure 3. Partial views of the harvested honey.

3.3. Cost Benefit Analysis

The cost benefit analysis result showed that the highest net benefit (12,490 ETB/hive) was obtained from horizontal frame hive as compared to traditional hive (2,150 ETBV/hive) (Table 4). This result agreed with the finding of [22] who reported that box hives significantly enhanced smallholder profitability over traditional hives, even when accounting for approximately 20% higher input costs and price variability. [23] also reported that box hives generate higher returns and profitability compared to traditional hives.

Table 4. Costs and returns of horizontal frame hives and traditional hives.

Parameters	Horizontal frame hive	Traditional hive
Yield obtained kg/hive (Y)	23.40	6.21
Honey sale price kg/ETB (Q)	1,200	750
Total Revenue (TR) =TR=Y*Q	28,080	4,650
Beeswax cost/ETB	3,200	0.00
Hive stand cost/ETB	2,340	0.00
Feeding cost/ETB	3,650	1,100
Labor cost/ETB	5,200	1,200
Transportation costs/ETB	1,200	200
Total costs /ETB	15,590	2,500
Net benefit/ETB	12,490	2,150

3.4. Farmers' Perception and Preference of the Demonstrated Hive Technology

The response of the farmers on the demonstrated hives was collected from 20 randomly selected farmers. Attributes such as ease of operation, honey yield and quality, durability, time and labor savings, ease of colony inspection and harvesting, and swarm control were used to compare the demonstrated beehives. Farmers were asked to rank each hive attribute from 1 to 5, where 1 = very poor, 2 = poor, 3 = neutral, 4 = good, and 5 = very good, based on the criteria they identified. Horizontal frame hive scored higher than the traditional hive for all selected criteria, including labor and time saving, ease of harvesting, ease of inspection, honey yield, honey quality, and reduced colony disturbance and death. The total score for the horizontal frame hive was 28, with a mean score of 4.7, while the traditional hive scored 17 with a mean score of 2.8. Accordingly, the horizontal frame hive ranked first, whereas the traditional hive ranked second (Table 5).

Table 5. Farmers' perception and preference towards of the demonstrated hive technology (N = 20).

Parameters	Horizontal frame hive	Traditional hive
Labor and time saving	5	3
Easy for harvesting	4	3
Easy for inspecting	5	2
Honey yield	5	3
Purity of honey	5	3
Less colony disturbance and death	4	3
Total score	28	17
Mean score	4.7	2.8
Rank	1st	2nd

NB: 1. Very poor 2. Poor 3. Good 4. Very good 5. Excellent.

4. Conclusions and Recommendation

Pre-extension demonstration of the horizontal frame hive was conducted in Kofale District of West Arsi Zone. The demonstration result revealed that the horizontal frame hives were given better honey yield (23.40 kg/hive) as compared to the traditional hives (6.20 kg/hive). Profitability analysis results also revealed that using the horizontal frame hive is better for getting higher returns. Moreover, horizontal frame hive was preferred by participant farmers due to its ease of management and inspection, honey quantity and purity, savings in labor and time, and reduced colony disturbance and mortality. Therefore, the horizontal frame hive is recommended for wider scaling up to reach more farmers with this promising technology.

Abbreviations

ETB Ethiopian Birr
N Number
Kg Kilogram
Std Standard

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Author Contributions

Taye Beyene: Conceptualization, Formal Analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing

Mekonen Woldetsadik: Investigation, Methodology, Supervision

Desta Abi: Investigation, Methodology, Supervision

Data Availability Statement

The data supporting this study's findings are available from the first and corresponding authors upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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