***Original Research Article***

**Pre-Scaling Up of Modern Beekeeping Technology in Lowanaje Kebele of Dambal District, Sitti Zone, Somali Regional State.**

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# Abstract

*Beekeeping in Ethiopia, particularly in the Somali region, remains predominantly traditional, resulting in low productivity and limited economic impact despite the country's immense apicultural potential. This project aimed to enhance honey production and agro-pastoral livelihoods in the Dambal district by introducing and pre-scaling modern beekeeping technologies through a participatory research approach. Twenty-five agro-pastoralists were organized into PAPREG groups and trained on modern hive management, with 15 modern hives distributed for comparative evaluation against traditional systems. Results revealed a substantial increase in honey yield from modern hives (17.9 kg/year) compared to traditional ones (7 kg/year), alongside improved perceptions regarding honey quality and hive manageability. Cost-benefit analysis demonstrated higher profitability for modern hives despite elevated initial investments. While high costs and skill requirements were identified as adoption barriers, participants recognized the yield advantage, ease of management, and superior product quality offered by modern hives. The findings affirm that participatory introduction of improved beekeeping technologies can significantly improve productivity and rural incomes. The study recommends scaling up modern hive dissemination, integrating capacity-building programs, and ensuring institutional support to overcome adoption challenges and optimize the beekeeping sector’s contribution to sustainable livelihoods.*

**Key words**: Modern beekeeping; Technology adoption; Farmer training; Honey yield; Pest control.

#  Introduction and back ground

Beekeeping is likely to be the most profitable when improved beekeeping technology is used with its full packages (Berhe ***et al.,*** [2016](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). However, the traditional beekeeping system which results in low production, poor quality, and marketing efforts has kept beekeeping part of the subsistence sector (Meaza, [2010](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)).

Ethiopia has a potential for beekeeping as the climate is suitable for different vegetation and crops, which are a good source of nectar and pollen for honeybees (Chala *et al.,* [2013](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070); Teklu, [2016](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). Although the country has the potential of producing over 500,000 tons of honey per year, the annual production of honey and beeswax is low compared to its potential (Birhan et al., [2015](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). This is due to the reason that more than 95% of Ethiopian beekeepers use traditional hive management practices that affect yield and quality (CSA, [2017](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). The traditional production system poses many challenges that reduce the production and productivity of the subsector (Kalayu et al., [2018](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). Among these, poor management skills, shortage of honeybee forages, disease, and pests are the major ones (Chala et al., [2013](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070); Fikru, [2015](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). So far efforts have been made to tackle this problem such as modification and dissemination of beekeeping technology that increases production and productivity and maximizes benefit from beekeeping in line with sustainable natural resource conservation (Adgaba et al., [2014](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). The annual crude honey yield per traditional beehive is 5–7 kg. It is very low in quantity and quality as compared to the national average of improved box hives, which is 20–30 kg, respectively (Sebeho, [2015](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). Employing improved beekeeping technology with its full packages enables the beekeeper to produce surplus honey (Teklu, [2017](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)).

Beekeeping is one of the most important livestock subsectors that contribute to the improvement of the livelihoods of people in many countries (FAO, [2012](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)). It is also one of the major areas of intervention for poverty alleviation in many developing countries (Amulen et al., 2019). Beekeeping is providing nutritional, income-generating, and ecological security to rural communities at the household level. It also assists to increase crop production through honeybee pollination (Amulen et al., 2019; Tarekegn et al., 2017)

Beekeeping is likely to be the most profitable when improved beekeeping technology is used with its full packages (Berhe et al., 2016). However, the traditional beekeeping system which results in low production, poor quality, and marketing efforts has kept beekeeping part of the subsistence sector (Meaza, 2010).

Ethiopia has a potential for beekeeping as the climate is suitable for different vegetation and crops, which are a good source of nectar and pollen for honeybees (Chala et al., 2013; Teklu, 2016). This makes it conducive for the beekeeping business (Adgaba et al., 2001). Although the country has the potential of producing over 500,000 tons of honey per year, the annual production of honey and beeswax is low compared to its potential (Birhan et al., 2015). This is due to the reason that more than 95% of Ethiopian beekeepers use traditional hive management practices that affect yield and quality (CSA, [2017](https://www.tandfonline.com/doi/full/10.1080/23311932.2020.1814070)).

The traditional production system poses many challenges that reduce the production and productivity of the subsector (Kalayu et al., 2018). Among these, poor management skills, shortage of honeybee forages, disease, and pests are the major ones (Chala et al., 2013; Fikru, 2015). So far efforts have been made to tackle this problem such as modification and dissemination of beekeeping technology that increases production and productivity and maximizes benefit from beekeeping in line with sustainable natural resource conservation (Adgaba et al., 2014).

The annual crude honey yield per traditional beehive is 5–7 kg. It is very low in quantity and quality as compared to the national average of improved box hives, which is 20–30 kg, respectively (Sebeho, 2015). Employing improved beekeeping technology with its full packages enables the beekeeper to produce surplus honey (Teklu, 2017).

## JUSTIFICATION

Beekeeping in the Somali region is underdeveloped and traditional. To increase the Productivity of bee products in quantity and quality, transferring improved beekeeping Technologies (like modern beehives) to beekeepers as well as enhancing improved Beekeeping knowledge/skill of beekeepers through training and demonstration is very important. district has high potential of honey bee colonies, and the district also has high potential of bee flora. But, majority of beekeepers use traditional bee hives and productivity is low. In the district, improved and/or modern beehives are not introduced and unavailable.

The project aims to pre scaling to familiarize modern hives and enhance the productivity of beekeepers by providing them with practical training on modern beekeeping technologies. By pre scaling improved bee hive technologies and evaluating their productivity through a participatory approach, the project seeks to empower stakeholders and boost the overall performance of the beekeeping sector in the region.

## OBJECTIVES

* To demonstrate modern beehive technology for the agro-pastoral areas
* To enhance awareness of the agro-pastoralists on utilization of the modern beehives.
* To improve the income of agro-pastoralists and evaluate their perceptions of the technology.

#  Expected output

Modern hive technology was implemented and assessed within pastoral settings. The knowledge of agro-pastoralists regarding contemporary beehive technology was enhanced. The income levels of agro-pastoralists increased, and their attitudes toward the technology were examined.

# Methodology

## Description of the target project area

This project was carried out in Lowanaje Kebele, located within Dambal district of Sitti zone in the Somali region. Specifically, Lowanaje Kebele is known for its honey bee production. However, most beekeepers in the area predominantly practice traditional beekeeping methods, which likely result in lower production yields.

## Establishment of PAPREG

A total of twenty-five agro-pastoralist individuals were selected based on their interest, experience in beekeeping, and the abundance of honey bee colonies in traditional hives. These individuals were grouped into two PAPREGs. Among the 25 agro-pastoralists, 20 were males and 5 were females, particularly those from households headed by women

## Experimental Design and Data Collection

The site was purposively selected considering the availability of common bee forage, ease of access for transportation, and the socioeconomic value of bee products. The Dambal district (specifically Lowanaje Kebele) pastoral association was chosen based on issues identified by the agro-pastoralists during the needs assessment. Fifteen Modern hives were purchased and distributed to the PAPREG groups, with receiving fifteen traditional hives containing colonies. Colony transfer and all management activities were carried out by Kebele development agents and PAPREG members as well as researchers.

## Roles of each actor

During the delivery of the modern hive to the PAPREG, a multidisciplinary research approach was employed, involving a team of researchers, extension workers, and pastoralists working together to address specific topics based on the needs of the pastoralist. The researcher’s role was to provide adapted, improved, and profitable technology, as well as to deliver training to the beekeeper. Extension workers supported the formation of the PAPREG and provided ongoing support throughout the implementation process, supervised follow-up activities, and facilitated data collection through collaboration with development agents. These agents gathered important information, supported activities among pastoralists and agro-pastoralists, and linked them with other beekeepers. A group of pastoralists organized together participated in activities such as apiary site selection, hive construction, and transferring colonies from traditional to modern hives. The LLRP program purchased and provided modern beehives to support the pastoral and agro-pastoralist beekeepers

## Training of PAPREG

Following the formation of the PAPREG, theoretical and practical training sessions were conducted for the beekeeper and development agents at the project site, as modern hives were new to the district’s beekeepers. The training covered topics including bee biology, beekeeping systems, routine colony management and inspection, transferring colonies from traditional to modern hives, honey harvesting, post-harvest handling, marketing of bee products, and the benefits of modern hives. The project introduced several proven and recommended beekeeping technologies to enhance production and improve the livelihoods of the beekeeper. Inputs provided during demonstrations included wax casting molds, queen excluders, smokers, water sprayers, hive chisels, bee brushes, honey sieves, 15 modern hives with frames, protective clothing, and honey extractors.

## Data analysis

The collected was analyzed using descriptive statistics such as percentages, frequencies, means, minimum, maximum, and standard deviations of SPSS 20 computer software, and t-tests were used for data analysis. The qualitative data was also analyzed through the explanation of the idea, opinion, and concept explanation method

## Data Collection and Analysis

During the project, data were collected on honey yields from various hive types (modern and traditional) and farmers' attitudes toward improved beekeeping technologies, which were then analyzed using descriptive statistic

# Result and accomplishment of the project

##  Training and capacity building

Capacity building of the PAPREG members is one of the important components to conduct research in the PAPREG approach. It is a tool which PAPREG, researchers and DAs use frequently to introduce new technology, sensitize to important issues and capacitate pastoral and Agro pastorals observation, recording, analyzing of knowledge and skills gained from demonstration of modern bee hives.

The training effectively increased awareness of the benefits and challenges associated with modern hive technology, fostering better adoption and implementation. Participant feedback indicates a positive reception, with suggestions for improving future training sessions to enhance practical skills and community engagement. The inclusion of discussions with local authorities facilitates smoother coordination and sustainability of interventions.

A total of 25 PAPERG members, 12 non-PAPREG members, 2 DA’s and 7 local authorities were trained on participatory research approach, how to enhance honey production and productivity to know and understand the modern beehive installations, bee management and the advantages and disadvantages of modern bee hive technologies. Beside this, discussion was conducted with PAPREG members, DAs, and kebele administrators for smooth implementation of the planned activities in the project. Finally, researchers collected the comments and suggestions on the organized training and discussion for future improvement.

**Table.1Training and capacity building**

|  |  |  |
| --- | --- | --- |
| Participated The Field Day | Frequency | Percentage |
| PAPREG members  | Male  | 20 | 80 |
| Female | 5 | 20 |
| Non PAPREG members  | Male  | 10 | 83.3 |
| Female | 2 | 16.7 |
| Das  | Male  | 2 | 100 |
| Female | 0 | 0 |
| Woreda administrators  | Male  | 5 | 71.4 |
| Female | 2 | 28.6 |
|  |

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##  Honey of yields of hive types

The average honey yield per hive per year was 7 kg for traditional hives and 17.9 kg for modern hives. There was a significant variation in honey yield across different hive types, with minor differences observed between seasons. The findings of this study exceeded the national average yields of 5 kg for traditional hives and 15-20 kg for modern hives, indicating the strong potential for beekeeping production in the study areas.

|  |  |  |  |
| --- | --- | --- | --- |
| **Hive type** | **Average yield per hive per season** |   **overall** | **Average yield /year (kg)** |
|  | **season 1** | **season 2** | **Mean** | **Total yield per hive** |
| Traditional | 3+0.65 | 4+0.57 | 5.5+0.65 | 7 |
| Modern | 7+0.65 | 10.9+0.53 | 8.45+0.5 | 17.9 |
|  |  |  |   |  |

Table 2: Average honey yield production year from different hive types

#  Cost-benefit analysis

The cost-benefit analysis presented in Table3 compares honey production outcomes between modern hives and traditional hives, highlighting differences in costs, yields, and profitability.

## Initial Investment Costs:

The cost of establishing 15 modern hives is significantly higher (52,500 ETB) compared to traditional hives (22,500 ETB). This reflects the higher unit price of modern hives (3,500 ETB) versus traditional ones (1,500 ETB). Such an investment aligns with literature emphasizing the higher initial costs associated with modern beekeeping equipment (Abebe & Tesfaye, 2018). Operational Costs:

Load and unloading costs are incurred only for modern hives (3,000 ETB), possibly due to transportation or handling complexities. Transportation costs for modern hives are 9,000 ETB, whereas no transportation costs are recorded for traditional hives, perhaps indicating local or less expensive transportation methods (Gebremedhin et al., 2019). Labour costs are higher for traditional hives (4,000 ETB) because of potentially more manual handling or less efficient practices, whereas modern hive management costs are lower (2,000 ETB). This aligns with studies indicating that modern hive systems often require less labour per unit of honey produced (Sileshi et al., 2020). Variable Costs and Total Costs:

Total variable costs are higher for modern hives (42,000 ETB) compared to traditional hives (11,000 ETB), primarily due to higher initial investments and transportation. The lower variable costs per unit of honey for modern hives suggest better efficiency. Honey Yield and Production:

Honey yield per hive is substantially higher in the modern hive system (7 kg per hive) than in traditional hives (3 kg per hive). Consequently, total honey production is also higher (105 kg vs. 45 kg), resulting in a total income of 105,000 ETB for modern hives compared to 45,000 ETB for traditional hives. Literature supports that modern hive technology generally improves honey yields due to better hive management, disease control, and colony health (Tadesse et al., 2017). Net Returns:

The net return (profit) for modern hive beekeepers is approximately 2,696 ETB, more than double the 1,100 ETB for traditional hives. This indicates that despite higher initial and operational costs, modern hives yield higher profitability (Yilma & Kebede, 2019). Conclude that while modern hive systems require higher capital investment, the increased honey production and income justify the costs over time.

Table 3 Cost-benefit analysis of honey production

|  |  |  |
| --- | --- | --- |
|   |  Modern Hive   | Traditional Hives |
| list item | Unit | Quantity | Unit Price | Total Price | Unit | Quantity | Unit Price | Total Price |
|  |  |  |  |  |  |  |  |  |
| number hive used | No | 15 | 3500 | 52500 |   | 15 | 1500 | 22500 |
| load unloading cost  | ETB | 15 | 100 | 3000 | ETB | 0 | 0 | 0 |
| Beehive colony  | No. | 15 | 500 | 7500 | No | 15 | 500 | 7500 |
| Transportation cost | Birr | 1 | 9000 | 13004 | -  | -  | -  | -  |
| labour Cost | #person | 15 | 400 | 2000 | person | 15 | 400 | 4000 |
| variable cost | ETB |  - | -  | 42000 | ETB |   |   | 11000 |
| Honey yield in kg | Kg | 7 | 1000 | 7000 | Kg  | 3 | 1000 | 3000 |
| Total honey production  | Kg | 105 | 1000 | 105000 | Kg  | 45 | 1000 | 45000 |
| Total income | ETB |   |   | 105000 | ETB |   |   | 45000 |
| Net return  | ETB |   |   | 2696 | ETB |   |   | 1100 |
|  |  |  |  |  |  |  |  |  |

# Pastoralist agro-pastoralist perception of the technology

Pastoralist agro-pastoralist perception of the technology after the demonstration of frame beehive technologies, the feedback obtained from the PAPREG members indicated that frame hive was deserved for ease of management, honey yield, on the quality of honey. In addition to this frame hives are very easy to handle by women compared to traditional hives. Based on the results indicated in Table 5 the high honey yield, quality honey, and ease of management make the frame hive is more preferable to the old ones

Understanding the perceived advantages and disadvantages of improved beekeeping technology is crucial for assessing beekeepers' attitudes and implementing appropriate interventions. Most PAPREGs and indirect beneficiaries noted the primary benefits of improved beekeeping technology as Increased Yield (59.5%), Ease of Management (24.3%), Easy of honey extraction (10.8) and ease of Pest control (5.4%). Conversely, they also identified significant drawbacks, including high costs (64.9%), the necessity for advanced skills man power (24.3%), and the requirement for additional complexity (10.8%) (Table 4). Overall, these findings suggest that beekeepers view improved beekeeping technology positively, presenting a valuable opportunity for beekeeping extension initiatives.

**Table 4: perception and attitude of beneficiaries toward the technologies**

|  |  |  |  |
| --- | --- | --- | --- |
| **Advantages of the Technologies** | **PAPREG members (25)** | **Non PAPREG members (12)** | **Overall (41)** |
|  Increased Yield  | 15(60%) | 7(58%) | 22(59.5%) |
| Ease of Management | 7(28%) |  2(17%) | 8(24.3%) |
| Better Honey Extraction:  | 2(8%) | 2(17%) | 4(10.8%) |
| Pest control  | 1(4%)  | 1(8%) |  2(5.4/%) |
|  Disadvantages of the technologies |   |   |   |
| Cost | 17(68%) | 7(45.45%) | 24(64.9%) |
| Require skill manpower | 5(20%) | 4(36.36) | 9(24.3%) |
|  Complexity | 3(12%) | 1(18.18%) | 4(10.8%) |

# Conclusion and Recommendation

The analysis demonstrates that adopting modern hive technology, despite higher initial and operational costs, results in significantly higher honey yields and net profitability. This aligns with existing literature emphasizing the benefits of modern beekeeping practices in improving productivity and income for agro-pastoralists. However, strategies to reduce initial costs, improve transportation, and provide access to credit could further enhance the adoption and benefits of modern hive technology.

Participatory approach was used to evaluate improved beekeeping technologies in the Danbal district. Participants expressed a positive perception of these technologies, viewing them as a viable option for income generation that positively impacts their livelihoods. The evaluation revealed that the improved beekeeping technologies and associated management practices significantly enhanced production and productivity within the sector in the areas demonstrated. As a result, these technologies are deemed feasible and strongly recommended for wider adoption and scaling up to maximize honey production and address the current issues related to the scarcity of advanced beekeeping technologies and inadequate management practices in the region. To ensure effective utilization of these technologies, short-term training sessions for beekeeping farmers, development agents, and experts are necessary to address the constraints affecting production at the project site. Additionally, promoting these technologies in areas where their use is currently high potential should be scaling out on a large scale in the potential production area with a full production package of the technology is highly recommended.

# Lessons Learned

Training, monitoring and evaluation, and field days play pivotal roles in creating awareness and demand-driven technology dissemination.

Participation of different stakeholders in collaboration in agricultural production and productivity improvement activities plays an important role in transferring innovative modern beekeeping technology to extension agents and farmers.

Understanding Local Needs: Successful technology transfer requires a deep understanding of local farming practices and environmental conditions to familiarize solutions effectively.

Training and Support: Providing adequate training and ongoing support is crucial for farmers to effectively adopt and utilize modern beekeeping technologies.

Collaboration with Farmers: Engaging farmers in the development and evaluation of new technologies fosters ownership and encourages adoption.

Economic Incentives: Signifying the economic benefits of modern hives, such as increased honey yield and pollination services, can motivate farmers to invest in new technologies.

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#  Future Focus

Integrated Farming Systems: Promoting the integration of beekeeping with other agricultural practices to enhance biodiversity and crop yields, benefiting both bees and farmers.

Smart Technologies Focusing on smart hive technologies, including sensors and data analytics, to improve hive management and productivity.

Community-Based Approaches: Developing community programs that facilitate knowledge sharing and collective investment in modern beekeeping technologies.

Sustainable Practices: Emphasizing sustainable practices that align with environmental conservation and support healthy ecosystems.

#  Challenges

Cultural Resistance: Overcoming traditional practices and resistance to change can be a significant barrier to technology adoption.

Access to Resources: Limited access to financial resources or affordable technology can hinder farmers from investing in modern hives.

Education Gaps: Variability in education levels among farmers may require tailored training approaches to ensure effective learning.

Pest and Disease Management: Addressing the challenges of pests and diseases, which can undermine the benefits of modern hives if not managed effectively.

# Opportunities

Increased Pollination Services Highlighting the role of bees in improving crop yields through effective pollination can drive interest in modern beekeeping among farmers.

Encouraging farmers to explore honey production as a supplemental income source can enhance their economic resilience.

Collaborate with universities and research institutions to develop innovative beekeeping technology that meet farmers' needs.

Market Expansion: Leveraging the growing demand for local, organic, and sustainably produced honey to create new market opportunities for farmers. By focusing on these lessons, challenges, and opportunities, the transfer of modern beekeeping technologies to farmers can lead to more sustainable and productive agricultural practices.

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