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Pre-Extension Demonstration and Evaluation of Modern Hive Technology in Borana Zone, Southern Oromia, Ethiopia

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Abstract **Original Research Article**

Beekeeping is an important component of rural development in many African countries. Though the country has favorable environmental conditions for beekeeping, there are significant constraints that impede and keep this sector from realizing its potential for honey and beeswax production, earning foreign exchange, and providing income to smallholder beekeepers. Also, there is limited study conducted on beekeeping technology demonstration. The main objective of this study was to demonstrate and evaluate productivity of modern hive. The study was conducted at Gomole and Elwaye districts. A total of 14 modern bee hives were used for demonstration, comparison with traditional hives. Both quantitative and qualitative data were used. The data was analyzed using descriptive and inferential statistics. The result revealed that modern hives consistently show a higher mean value than traditional hives at both Buya (8.98kg/hive) and Kobo (11.58kg/hive) kebeles. Moreover, modern hive provides a 72.77% yield advantage over the traditional hive under beekeepers' condition. It was concluded that modern hives offer significantly higher honey productivity and demonstrate a superior financial return, making a compelling case for investment in modern beekeeping technology and associated capacity building and knowledge improvement initiatives among beekeepers. Therefore, it was recommended for further scaling up in Borana zone.

Keywords: Beekeeping, Borana, Evaluation, Modern hive, Productivity.

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INTRODUCTION

Beekeeping is an important component of rural development in many African countries (Bunde and Kibet, 2016). In Ethiopia, it accounts for 1.3% of agricultural gross domestic product – generating and diversifying the income of subsistence farmers, especially small land holders and the landless; it is eco-friendly, does not compete for scarce land resources and provides off-farm income-generating opportunity, food and medicine (Abebe, 2011; Onwubuya, *et al.*, 2013; Wakjira, 2016). Ethiopia has great potential for apiculture in its varied ecology and climatic conditions, endowed with over 10 million bee colonies and about 2 million smallholder beekeepers (Kidane, 2014). Currently, the country's potential for honey and beeswax production is expected to be 500,000,000 and 50,000,000 kg per year, respectively (Apimondia, 2018).

It is a common activity among smallholder farmers and landless people since it does not require cultivated land, involves little investment, and yields immediate financial returns (Dekebo *et al.*, 2019). This sector has the potential to produce jobs for smallholders in both rural and urban parts of the country, by government strategy. It was reported that beekeeping employs two million Ethiopians (Kassa and Regasa, 2020). As a result, the development of beekeeping techniques is now widely recognized as one of the best ways to improve society's livelihood.

Therefore, Ethiopian government is strengthening the sector as a mechanism for poverty reduction and improving the livelihood of many people including the unemployment youths, jobless women and adults, elder peoples, carpenters for beehive construction and equipment preparation, living both in rural and urban areas (CSA, 2013). The importance of the sector also extends to initiate youth groups to contribute to social, economic and ecological aspects (Alebachew and Eshetie, 2020).

The volume of honey and beeswax produced in the country was reported by FAO (2017), where honey and beeswax output reached 53782 and 5,742 tons, respectively. In the same report, from the 187 tons of

honey exported about a 133 million Ethiopian Birr Per year was earned at a national level. Furthermore, beekeepers are estimated to earn around 360-480 million Birr per year from the total honey produced in the country (Amsalu *et al.*,, 2020). Much honey has traditionally been fermented in Ethiopia to make 'Tej.' According to Sahle *et al.,* (2018), 85% of the total honey estimated to be brought for the market is used for 'Tej' manufacture, with 15% of the total honey consumed at home.

Even though the country has favorable environmental conditions for beekeeping, more opportunities, and a high potential for honey production, there are significant constraints that impede and keep this sector from realizing its potential for honey and beeswax production, earning foreign exchange, and providing income to smallholder beekeepers (Siraj and Abdi, 2021). According to these authors, the key issues influencing the promotion and development of honey production and marketing are reliance on traditional and low-technology input, poor pre- and post-harvest management, insufficient extension services, and a lack of marketing infrastructure. In addition, Guy and Legesse (2015) reported that introducing upgraded hives and working tools to the rural population is out of reach for most farmers and even for those who can afford it, it is not readily available.

In order to solve the mentioned problems, the government is currently promoting a self-governing basin development initiative that includes beekeeping. Modern, low-cost beehives are built using locally accessible materials, while an effort is made to organize farmers into groups and connect them with local carpenters who build modern hive. Recent public and private sector initiatives, as well as non-governmental organizations (NGOs), are pointing in the correct direction for developing the beekeeping sub-sector in order to maximize its potential and competitiveness.

So far, adaptation study has been conducted by Yabello Pastoral and Dryland Agriculture Research Center that aimed to realize well adapted/improved beekeeping technologies to benefit beekeepers in the locality. Specifically, technologies such as modern and transitional hives, honey processing, bee forages and honey badger protection methods were the outcome of the resent study in Borana zone. It was confirmed that modern hive was among improved technologies where it was convenient for keeping bees without harming the colony.

Despite the central contribution of modern bee hive in demand-driven and client-oriented technology generation, there is limited study conducted on beekeeping technology demonstration. Besides, there is insufficient documented information on modern beekeeping productivity. Therefore, this study was conducted with the main objective to demonstrate and evaluate productivity of modern bee hive

Objectives

- To evaluate honey productivity using modern hive under beekeepers' condition
- To create awareness through capacity building on modern beekeeping technology
- To improve knowledge of beekeepers on beekeeping management practices
- To analyze financial return from selling of honey product at local market

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in Elwaye and Gomole districts of Borana zone (Fig 1). Elwaye district represents the hot lowland, which is located at 04° 26' 47"E latitude, 37 ° 39' 55" N longitude, with an elevation of 1379 m.a.s.l. The mean annual rainfall is 500mm-800mm at short rain (Hagaya) and 700mm-800mm at main rain season (Ganna). The mean temperature ranges from 25°to 35°c. The district is located 27km and 580km from Yabello town and Addis Ababa (capital city of Ethiopia), respectively.

Gomole is located at 04°50' 00"E latitude and 38° 30' 10"N longitude, with an elevation of 1741 m.a.s.l. Gomole district is located at 535km from Addis Ababa in south direction and it is 40km away from capital town of Borana zone, Yabello, in Northern direction. The annual temperature ranges from 16 to 28°C.The mean annual rainfall is 1300mm and agro-climatic condition of the area is semi-arid and arid. There are two rainy seasons in the area, 'ganna'(June-September), used for crop production, pasture and water harvest and the short rain, 'hagayya'(February-May) that mainly used for land preparation, planting of long cycle crops collected after the 'ganna' rains, small scale production, and improving water and pastures. Overall, the people in the area are rearing livestock as a major activity, based on the traditional pastoralist system.

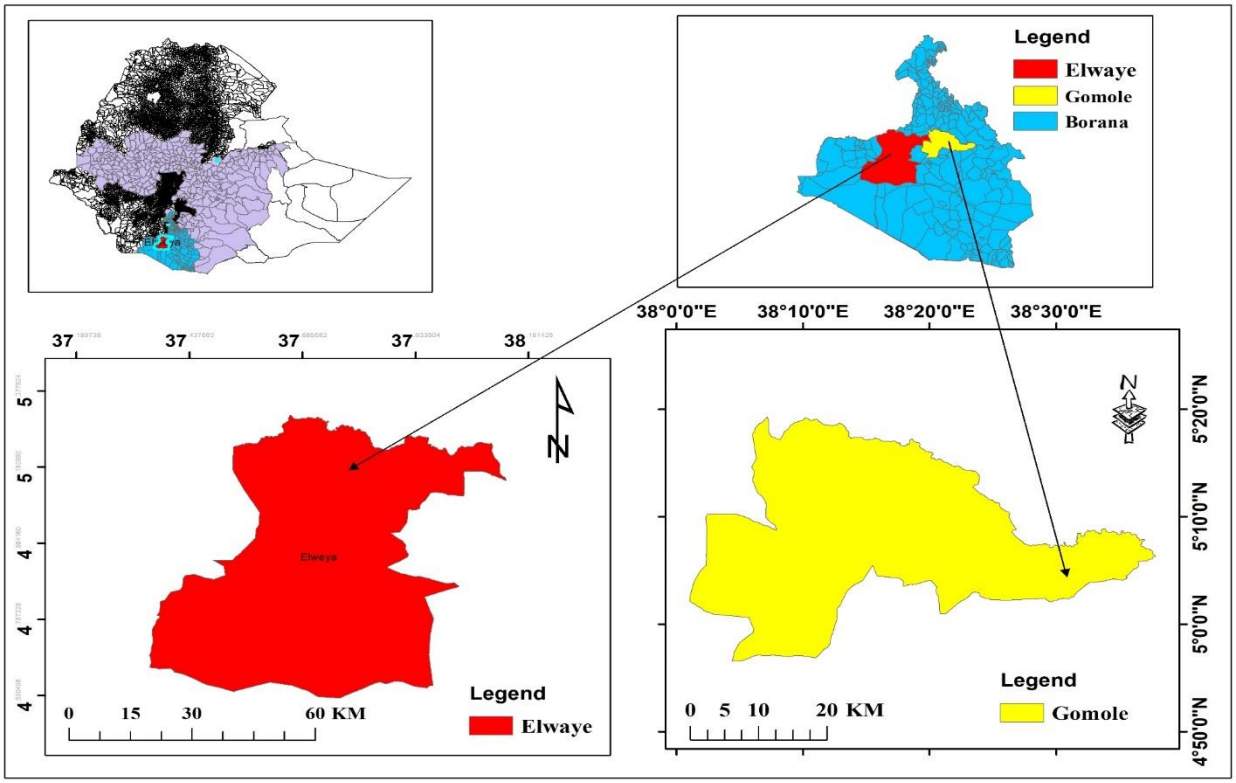


Fig. 1: Map of the study area
Source: Own sketch using ArcGIS version 10.4 (2026)

Site and Beekeepers Selection

This study was conducted in two selected districts: Elwaye and Gomole, which selected purposively on the basis of potentiality and conducive criteria. Similarly, two potential kebeles were selected through close consultation of the respective Agriculture Office and DAs in each district. Hence, Kobo kebele of Elweye and Buya kebele of Gomole were selected and apiary site was established at each kebele while it used as center of learning. These sites were accessible for demonstration purpose. One beekeepers research group (BRG) was established at each kebele. The beekeepers group at Buya kebele was consisting of 12 members while 14 members included at Kobo kebele. The selection criteria of individual beekeepers basically relied on willingness to participate in beekeepers' group, owner of bee colonies, experience of seasonal colony management and share experience for another beekeepers.

Technology Transfer Approaches

The study was conducted through participatory approach where pastoral beekeepers fully involved in beekeeping activity. A group of pastoralists, beekeepers research group (BRG) was established and different stakeholders such as District Agricultural Office, Kebele administrative, DAs, Experts, non-members of beekeepers were invited to share experience. The group of the beekeepers was composed of different age categories such as adult male and female, and youth. For these groups, YPDARC distributed modern hives for each group and empowered them to handle all beekeeping management activities. The mechanisms to transfer the technology were training of participants, demonstrating performance of the technology on field visit (Apiary site) which helps to share experience with other stakeholders.

Study Design

Participatory approach was used that involve pastoral beekeepers in beekeeping activity. The major tasks such as site selection and apiary establishment, bee colony transfer to modern hives, inspection and follow up, honey harvesting and processing were conducted. Two communal apiary site were used where colonies managed. In order to manage competing interest, community meeting was conducted to discuss about the significance of the action research on beekeeping as well as communal land use. Local elders decided the portion of land to use as demonstration site and BRG were the prime mover of the activity. The remaining community were convinced to share experience and knowledge on beekeeping management with those organized group. At Kobo kebele, eight experimental modern bee hives were used whereas 8 traditional bee hives used as control. Similarly, six modern and traditional (control) bee hives used at Buya kebele. A total of 14 bee colonies transferred to modern frame hives. Equipment such as cooking pan, plastic jars, staining cloths and honey extractor were used. Similarly, crude beeswax collected from different sources have been processed.

Training

Both theoretical and practical training was given for the selected beekeepers, DA's and experts basically on the overview to honey production, appropriate site selection and colony management, crude honey and wax processing, foundation sheet making, pre and post- harvest handling etc.

Data Types and Data Collection Methods

During the study period, both quantitative and qualitative data have been employed. Quantitative data was collected using simple survey and data sheet record from the amount of honey produced, input used, colony managed, knowledge test, number of participants on the training, price of honey in kilograms, net profit and income from honey sold and the likes. Similarly, qualitative data was collected through beekeeper's opinion, KII and personal observation.

Methods of Data Analysis

Both descriptive and inferential statistics were used to analyze the data. Quantitative data was analyzed using descriptive statistics and partial budgeting for financial analysis. Knowledge test on modern beekeeping also analyzed using descriptive in percentage that indicated the change before and after the intervention. Whereas qualitative data was analyzed using narration method. Yield advantage of modern bee hive over traditional hive was analyzed as follow.

$$Yield\ Advantage = \frac{Yiled\ of\ modern\ hive - Yield\ of\ traditional\ hive}{Yield\ of\ traditional\ hive} * 100$$

RESULTS AND DISCUSSION

Training on Modern Beekeeping

Training for beekeepers is very crucial to introduce modern beekeeping practices. In history, pastoralist were characterized by nomadic as their livelihood more depends on livestock production. Other agricultural activities including beekeeping were currently introduced in Borana Lowland areas. Today, the area was known by crop, livestock and other livelihood diversities. Among others, experienced households rearing bees were selected purposefully. To enhance beekeeping sector in the area, this study employed modern beekeeping techniques through capacitating beekeepers group in some selected areas. In this regard, basic beekeeping training was provided by multidisciplinary team at Yabello Pastoral and Dryland Agricultural Research Center. The main topics of the training includes characteristics of beekeeping, seasonal colony management, crude honey and wax processing, pre and post harvesting methods etc.

The table 1 shows that stakeholders including DAs, experts and pastoral beekeepers were warmly participated in the training. DAs, who facilitate or support development initiatives, potentially acting as intermediaries between the training and the wider community. Their participation suggests a focus on disseminating knowledge or implementing programs. The inclusion of Development Agents suggests a broader objective beyond just individual beekeeper skill development, possibly aiming for community-level impact or program implementation. A substantial number of experts are involved, which can elevate the quality and depth of the training as well as subjected practical. Experts were likely contributing specialized knowledge or skills to the training. Their presence can enrich the content, provide advanced insights, and potentially act as trainers or mentors.

This indicated that one-fifth (under 20%) of beekeeper participants were female, which is not a significant proportion. However, there is a noticeable representation of female beekeepers, indicating that the intervention is reaching women in the beekeeping sector.

Table 1. Training Stakeholders on Beekeeping Technology

Stakeholders	Number of participants across the study kebeles						Grand Total
	Buya			Kobo			
	Male	Female	Sub-total	Male	Female	Sub-total	
Experts	2	1	3	2	1	3	6
DA's	1	1	2	2	1	3	5
Beekeepers	10	2	12	11	3	14	26
Others	2	1	3	1	1	2	5
Total	15	5	20	16	6	22	42

Source: Own data, 2025

Honey Yield Performance

The frequency of honey yield was twice in the main season of two consecutive years (2022/23-2024/25). The result in the table 2 presents the compared honey yields from two different hive types (Modern and Traditional) across two locations (Buya and Kobo). In both Buya and Kobo kebeles, modern hives consistently show a higher mean value than traditional hives. This suggests that Modern hive types are generally more productive at both locations. The mean honey yield at

Buya was 8.98 with SD of 2.21 (relatively high, indicating more variability in yields among modern hives in Buya kebele. Similarly, the mean yield at Kobo was 11.58 with SD of 0.71 (Very low, indicating high consistency in yields among modern hives in Kobo kebele). The independent sample t-value of 5.295 (0.008) at Buya and 24.35(0.068) at Kobo indicates a statistically significant difference between Modern and Traditional hives in both Buya and Kobo kebeles.

Traditional hives in Kobo (Mean 6.47) was slightly outperformed than traditional hives in Buya (Mean 5.42) (Table 2). This suggests that Kobo might be a more favorable environment overall for beekeeping, regardless of hive type. Beekeepers also managed their bees through cleaning apiary site, supply water near to the site and well fenced. Overall, Kobo kebele appears to be a better location for honey production, yielding higher means for both hive types and showing greater consistency (lower SDs) for modern hives compared to Buya. Whereas, traditional hives demonstrate remarkable consistency (low standard deviation) in their yields across both locations.

Table 2: Honey Yield Performance across Kebeles

locations	Hive type	N	Mean	SD	Min.	Max.	t-value(sig.)
Buya	Modern	6	8.98	2.21	5.75	13	5.295 (0.001) ***
	Traditional	6	5.42	0.75	4.15	6.72	
Kobo	Modern	8	11.58	0.71	10.5	12.6	
	Traditional	8	6.47	0.45	5.32	6.88	24.35(0.001) *

Source: Own data computation, 2025. ***, * indicates 1% and 10% significance level, respectively.

Yield Advantage of the Hives

Modern hive provides a 72.77% yield advantage over the traditional hive under beekeepers' condition. In simpler terms, if a traditional hive produces 100 units of yield, a modern hive would produce 172 units. This suggests that the modern hive is significantly more efficient or productive in terms of yield.

$$Yield\ Advantage = \frac{10.28 - 5.95}{5.95} * 100 = 72.77\%$$

Knowledge Test on Modern Beekeeping

Based on the training and experience developed throughout the lifespan of the intervention, beekeepers' knowledge was assessed using checklist questions. It was intended to analyze the change in knowledge after intervention as relative to existed knowledge. Before the intervention, the majority of participants (80.8% to 100%) reported a lack of knowledge in these modern techniques. Following the intervention, these figures were almost entirely reversed, with 80.8% to 100% of participants now reporting improved knowledge on beekeeping technology (Table 3).

The majority of respondents (ranging from 80.8% to 100%) said "yes" that modern beekeeping has led to improvements in various aspects, including application of bee hive technology, colony management, honey harvesting and processing knowledge, pre and post-harvest management. A significant knowledge improvement was justified by the fact that both theoretical and practical training, efforts and active participation in the demonstration. This result is consistent with the finding of Desiso and Asefa (2023). Therefore, this study concludes beekeepers have a very positive attitude of modern beekeeping, believing it significantly improves technology and other aspects. The only area with some reservation is the direct impact of modern hives on the price of honey, although this does not negate the overall perceived improvement in income. A brief summary of the result was discussed as follow.

Honey Processing Knowledge: This area saw the most absolute improvement. It moved from 0% (no one had improved knowledge) to 100% after the intervention.

Application of Modern Technology: There was an 84.6 percentage point increase in positive responses. Knowledge jumped from only 7.7% of participants to 92.3%.

Pre and Post-Harvest Management: Knowledge in this area improved significantly, rising from 11.5% to 88.5%, showing that the training effectively covered the complete lifecycle of honey production.

Knowledge of Honey Harvesting: Positive responses increased from 15.4% to 84.6%, indicating that participants learned more efficient or safer ways to harvest.

Colony Transfer & Management: While this started with the highest baseline knowledge (19.2%), it still saw a massive jump to 80.8% post-intervention.

Overall, the data demonstrates that the intervention was highly effective. It successfully bridged a significant knowledge gap, transforming a group that was largely unfamiliar with modern beekeeping into one where the vast majority are now proficient in key technical areas. The total reversal of "Yes" and "No" percentages across almost all categories suggests the training was comprehensive and well-received.

Table 3: Knowledge Test on Modern Beekeeping before and after Intervention (N=26)

Description	Before				After			
	yes	%	no	%	yes	%	no	%
Application of modern beekeeping technology improved	2	7.7	24	92.3	24	92.3	2	7.7
Colony transfer & management improved	5	19.2	21	80.8	21	80.8	5	19.2
Knowledge of honey harvesting improved	4	15.4	22	84.6	22	84.6	4	15.4
Knowledge on pre and post-harvest management improved	3	11.5	23	88.5	23	88.5	3	11.5
Honey processing knowledge improved	0	0	26	100	26	100	0	0

Source: Own checklist result, 2025

Financial Analysis

The price per kilogram of honey is also higher for modern hive produce compared to traditional hive produce in both locations. This could be due to perceived quality differences, better processing, or marketing strategies associated with modern beekeeping. Consequently, the total revenue generated by modern hives is substantially higher than traditional hives in both locations, largely driven by both increased yield and higher price per kilogram.

Despite the higher initial investment and operational costs, modern hives are generating a better return for every unit of cost invested compared to traditional hives. This suggests that the increased revenue from modern hives more than compensates for their higher costs.

The data strongly suggests that modern beehives are financially more attractive than traditional beehives in both Elwaye and Gomole, based on these parameters. While modern hives entail significantly higher costs (hive and labor), their superior yields and higher honey prices lead to substantially greater total revenue, gross margins, and ultimately, a better profit. The financial costs and profits of the improved frame hives across two demonstration sites as the calculation used 800birr/kilogram at farm gate (Table 4). All costs and incomes were calculated in Ethiopian Birr. Therefore, the profit gained from modern hives were 3,414 and 1,334 ETB at Kobo and Buya kebeles, respectively.

Table 4: Financial Analysis of Honey Yield

Location	Kobo		Buya	
Hive types	Traditional	Modern	Traditional	Modern
Yield/kg/hive (x)	6.47	11.58	5.4	8.98
Price/kg(y)	500	800	500	800
Total revenue=TR= x*y	3235	9264	2700	7184
Variable costs				
Hive cost	1500	2500	1500	2500
Wax purchase cost	0	350	0	350
Labor cost	1200	3000	1200	3000
Total variable cost (TVC)	2700	5850	2700	5850
Fixed cost (TFC)	0	0	0	0
Total cost (TC=TVC+TFC)	2700	5850	2700	5850
Gross Margin (GM=TR-TVC)	535	3414	0	1334
Profit = GM-TFC	535	3414	0	1334

Source: Own data computation, 2025

Beekeepers' Feedback

Honey production is very important role as a source of increasing rural income in sustainable development in the study districts. But key informants explained that beekeeping sector faced many problems as quality, shortage of equipment, suit, predators (honey badger), inflation, drought, shortage of forages and water in the locality. It was ideal that beekeepers prefer modern hive and its accessories with the exception of its operational costs. This is due to the improved income from modern hive as compared to traditional. Keeping the knowledge obtained as opportunity, the members in BRG also argued that shortage of accessory is the most challenge in modern beekeeping. In addition, it was observed that the environment at Gomole district is more degraded which induced the limited bee forages. The information generated from group discussions at both locations explained that the behavior of lowland bees was very difficult as they seasonally migrate frequently. It was observed that the modern beekeeping was likely manageable so that reduced migration. The frequency of honey harvesting was also reduced to once per year.

CONCLUSION AND RECOMMENDATIONS

This study overwhelmingly indicates a highly successful intervention in terms of improving knowledge, enhancing beekeeping practices, increasing honey yields, and ultimately boosting beekeepers'

income through the application of modern beekeeping technology. Key successes include universal agreement on improved knowledge of modern beehive use, honey processing, and enhanced income, as well as near-universal agreement on higher yields and better application of technology.

The results also successfully demonstrate significantly higher honey productivity from modern hives compared to traditional hives in both Elwaye and Gomole districts, which represent pastoralist conditions. Modern hives yielded 11.58 kg and 8.98 kg in Elwaye and Gomole respectively, substantially outperforming traditional hives (6.47 kg and 5.4 kg). This provides clear evidence that modern hives can enhance honey production in these settings.

The evaluation of modern hives under pastoralist condition was strongly supports its adoption. Modern hives offer significantly higher honey productivity and demonstrate a superior financial return, making a compelling case for investment in modern beekeeping technology and associated capacity building and knowledge improvement initiatives among beekeepers. The financial metrics indicate that the higher initial and operational costs of modern hives are well compensated by increased revenue and profitability.

The result shows higher yields, improved income, and better returns on investment. Therefore, it was recommended that develop accessible programs for providing or subsidizing modern beehives, especially considering their higher initial cost, which could be a barrier to entry. There is a need to prioritize and actively promote the transition from traditional to modern beehives among beekeepers. This transition should be supported by targeted programs that address potential barriers to adoption, such as the initial cost of modern hives.

As the results indicate high agreement on improved knowledge across various aspects, it is better to continue and enhance comprehensive capacity-building initiatives focusing on modern beekeeping technology and management practices. It requires an action on designed training modules that cover: modern beehive use and management, colony management, pre and post-harvest management, and honey processing. Better market analysis needed to conduct a deeper analysis of local honey markets to understand price determinants, demand, and existing value chains for honey from modern hives.

Better to establish a robust monitoring and evaluation framework to continuously track productivity, income, knowledge adoption, and market prices. In doing so action on regularly conduct follow-up, inspection, financial assessments to gauge the long-term sustainability and impact of modern beekeeping interventions.

Develop and disseminate comprehensive training and capacity-building initiatives focusing on the optimal management practices required for modern beehives to ensure beekeepers yield advantage.

Finally, the future investigation can maximize the benefits of modern beekeeping technology, ensuring sustainable income generation and improved livelihoods for pastoralist communities. Therefore, it was suggested that future investigation could emphasis to further scale up the intervention in the pastoral area.

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