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Full Length Research Paper

Assessment of Transitional and Contemporary Hives for Honey Production in Ethiopia's Mid-Rift Valley

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From September 2009 to June 2012, a study was carried out in the regions of Adami Tulu and Arsi Negelle to assess the productive performance of modern and transitional bee hives. Three representative sites—Asebo, Adami Tulu research station, and Ashoka Lepis site—were chosen for this investigation. For the path in each experimental farmer's backyard, a modern hive and a transitional hive constructed from locally accessible materials were utilized, depending on the farmers' capacity. Thirty beekeeping farmers at the chosen sites received both theoretical and practical instruction prior to the study's real start. Three years' worth of data were gathered, and the statistical analysis system (SAS) program's General Linear Model analysis variance process was used to analyze the data. At Asebo, Adami Tulu Research Station, and Ashoka Lepis location, the average annual honey yield from transitional hives was 13.88 kg, 13.21 kg, and 10.45 kg, respectively. The annual honey yield per hive from transitional hives varied ($p < 0.05$) between the Ashoka Lepis site and Adami Tulu Research station. However, there was no significant difference ($p>0.05$) in the mean honey yield from transitional at the Adami Tulu Research Center and Asebo location.At the Asebo and Ashoka Lepis sites, the transitional hive produced noticeably more and less honey, respectively. At the Adami Tulu Research Center, Asebo, and Ashoka Lepis sites, the modern hive produced an average of 23.18 kg, 21.61 kg, and 18.45 kg of honey annually, respectively. The three typical sites differed ($p < 0.05$) in the amount of honey produced annually by modern hives per hive. Comparing modern hives to transitional and traditional hives, the mean yield from the former was statistically higher at all study sites. At the Adami Tulu Research Center, Asebo, and Ashoka Lepis sites, the average honey yield per hive per year from traditional hives was 6.08 kg, 5.94 kg, and 4.94 kg, respectively. The honey yield from traditional hives did not differ ($P < 0.05$) across all research sites. In terms of honey yield per hive per year, there was, on average, a highly significant difference ($p < 0.05$) across the three types of hives. The study area's honey yield per hive was significantly impacted by the interplay between hive type and location. In contrast, the study area's honey yield per hive was not significantly impacted by the interaction between hive types and honey harvesting season. The use of better bee hives with better management techniques was found to increase honey yield and guarantee higher quality. Compared to transitional and traditional hives, modern hives require highly skilled workers and costly beekeeping equipment and accessories. Therefore, it is advised that government and non-governmental organizations concentrate on expanding and encouraging the use of transitional bee hives in order to increase farmers' incomes with minimal expenses and little expertise.

Key words: Bee colonies, Ethiopia, evaluation, honey, modern hives, transitional hives, yield.

INTRODUCTION

Common Ethiopia ranks among the top ten honey-producing nations worldwide and is the top producer in Africa. Ethiopia has some of Africa's most varied flora and fauna because of its extensive climatic and edaphic variability, which gives foraging bee colonies an abundance of nectar and pollen sources (Girma Deffar, 1998).More than 12 million honey bee colonies exist nationwide because to this (Gezahegn, 2001).Even though the country has a lot of bee colonies and a good agro-ecology for honey production, the level of productivity and honey output in the nation is still low. Traditional hives are one of the main causes of this low honey yield. About 98% of beekeepers in the mid-rift valley of Oromia still produce honey using traditional bee hives, per a 2007 study on bee hive distribution by Tesfaye Kebede and Tesfaye Lemma. Ethiopia could generate over 500,000 tons of honey and 50,000 tons of beeswax annually, however at the moment, only 43,000 tons of honey and 3,000 tons of beeswax are produced (MOARD, 2008). Due to inadequate bee colony management and conventional production methods, honey output in the mid-rift valley area has frequently been reported to be extremely low, as is the case in many beekeeping localities. The main financial obstacles for beekeepers are low productivity and subpar bee products (Nuru, 1999).

Beekeeping has been done for a very long time in Ethiopia, especially in the mid-rift valley of Oromia regional state in particular (Tesfaye, 2007). However, in comparison to the nation's bee colony resource base, this subsector plays a very small part in diversifying farmers' incomes. In impoverished nations where farmers have few other sources of income, beekeeping is crucial to diversifying their revenue streams. According to Nuru (2002), honey bees and their products give beekeepers a direct source of financial income, particularly in areas where other agricultural activities are challenging.

Based on their level of sophistication, Ethiopia produces honey from three different types of hives. These bee hives are classified as modern, transitional, and traditional (GDS, 2007).In Ethiopia, traditional bee hives are used for the majority of honey production. Over 95% of honey is generated in conventional bee hives. The management of honey bees for improved honey quality and quantity is more challenging with this method of honey production. According to Gezahegne (2001), the average annual production of crude honey from traditional hives in Ethiopia is estimated to be 5 kg per hive under management conditions. Kenya Top-bar hives, Tanzania Top-bar hives, and mud block hives are among the contemporary hive forms that have been promoted in the nation since 1978. One of these hives is the transitional hive. Among these, the Kenya Top-bar hive is well-known and frequently utilized throughout the nation (HBRC, 1997).Also referred to as an intermediate bee hive, it comes in two varieties: one is constructed from a wooden box, while the other is produced from locally accessible materials like bamboo (GDS, 2009). The main relative benefit of modern hives is their high productivity and other quality, as well as their ease of examination and harvesting. Under ideal circumstances, a top-bar hive can produce roughly 50 kg of honey annually; however, given Ethiopian conditions, the average annual production of crude honey would be 7-8 kg/hive (Gezahegne, 2001). Because of their relatively high honey yield and ease of colony status inspection, these hives have been regarded as superior to traditional ones. In order to assess the effectiveness of modern box hives and transitional hives constructed from locally accessible materials in the mid-rift valley of Oromia, Ethiopia, this study is crucial.

MATERIALS AND METHODS

Study Area

From September 2009 to June 2012, a study was carried out in the districts of Adami Tulu and Arsi Negelle to assess the productive performance of contemporary and transitional hives. At an elevation of 1500 to 2000 meters above sea level, the Adami Tulu district is located between latitudes 7° 19' N and 7° 40' N and 35° 38° 30' E and 38° 53' E (ATARC, 1998). The district is situated 160 kilometers south of Ethiopia's capital, Addis Ababa. With a total population of 177,492 and an area of 1403.3 km2 (140,330 hectares), approximately 79% of them reside in rural areas. 90% of the district is low terrain, with the remaining 10% being intermediate, making it an agro-ecological zone that is semi-arid and sub-humid. The average annual temperature is 25°C at the minimum and 28°C at the maximum, with an average rainfall of 750–1000 mm. The distribution of rainfall varies greatly from year to year and within years. According to the Arsi Negelle Agriculture and Rural Development Office (2013), the district of Arsi Negelle is located between latitudes 7o09' N and 7o41' N and 38o25' E and 38o54' E. Its elevation ranges from 1500 to 2300 meters above sea level. It is situated 225 kilometers south of Ethiopia's capital, Addis Ababa. The average rainfall falls between 800 and 1400 mm, while the average temperature varies between 15°C and 20°C. According to unpublished statistics from the Arsi Negelle Office of Agriculture and Rural Development, the rainy season is bimodal, with the longest rainy season coming from June to September and the shortest rainy season from March to April. The heaviest rainfall is typically recorded in July and August, respectively. Low, mid, and high altitudes are the three main climatic zones that make up the Arsi Negelle area. Both districts use a mixed crop-livestock strategy for agriculture.

Treatments

A total of 30 bee colonies with comparable strength were chosen and moved from traditional hives to transitional and contemporary hives throughout the active season in order to assess the productive performance of these hives in Ethiopia's mid-rift valley. Each experimental farmer used one traditional hive, one modern hive, and one transitional hive made from locally available materials for the trail, depending on their capacity. However, two farmers were grouped under one experimental group for farmers who did not have any of the three types of hives in the area. Throughout the trial period, traditional hives served as the control.

Farmers and Experimental Sites Selection

A large number of beekeepers' experience and interest, the potential area for beekeeping, the abundance of honey bee colonies in traditional hives, the availability of common bee forage, the areas' accessibility to transportation services, and the socioeconomic value of bee products were the criteria used to purposively select potential beekeeping sites for this study. As a result, Ashoka Lepis PA from Arsi Negelle district, Asebo PA from Adami Tulu district, and Adami Tulu research station were specifically chosen and utilized for this investigation.

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Farmers Research Group (FRG) Approach Followed

Since transitional and modern hives were unfamiliar to beekeepers in both districts, a theoretical and practical training session was conducted for 30 beekeeper farmers, district honey experts, and development agents at research sites after locations and farmers were chosen. The training covered topics such as bee biology, beekeeping systems, regular management and inspection of honey bee colonies, the process of moving bee colonies from traditional hives to transitional and modern hives, post-harvest handling of honey, bee product marketing, and the significance of transitional and modern hives. During the training session, a single transitional bee hive was built at each study location using locally accessible materials, and it was shown to all participants. Following training, each farmer built two more transitional bee hives (Kenya Top-bar) on their own using materials

that were readily available in the area. Technical assistance and input supplies, including queen excluders, contemporary hives, and refined beeswax for farmers, were given to the initiative. Additionally, established, high-performing FRG members were invited to share their experiences at the Holeta Bee Research Center with farmers. This was done prior to the colony of honey bees moving to modern and transitional hives.

Honey Bee Colony Management Practices
Bee Colony Transferring

With the help of researchers, technical support, and farmers at each study location, bee colonies were moved from traditional hives to transitional and modern hives when there was an abundance of bee fodder in the area. External colony feeding with sugar syrup and bean flour (shiro) was carried out at each experimental site for colonies lacking honey, pollen, and brood. During colony transfer, all materials, including honey, pollen, and bee brood, were attached to top bars and frames and placed for the newly transferred bee colonies for maintenance and to minimize colony absconding.

Bee Colony Feeding and Watering

Normally, bee colonies get their pollen, nectar, and water from a variety of plant species and natural water sources. However, during the dearth period (both in wet and dry seasons), the study region experiences a shortage of pollen, plant nectar, and water. At each study site, different supplemental feeds, including water, sugar syrup, and bean flour (shiro), were implemented to reduce bee colony absconding and maintain during the dearth season.

Bee Colony Inspection

Modern and transitional bee hives, in contrast to traditional ones, feature moveable combs that make it simple for beekeepers to access their hives and conduct inspections in order to monitor bee populations. In order to monitor the status of the bee colonies, check the condition of the brood, check the food store, attach the top bar to the hive wall, check for honey ripeness, check for pest and predator attacks, and look for signs of disease, researchers, technical assistants, and farmers routinely inspected the hives at each study site.

Honey Harvesting and Processing

When the combs are sealed with a thin layer of wax, the honey is deemed ripe. Honey quality is low in conventional beekeeping systems because unripe honey is harvested, excessive smoking materials are used during the honey harvesting process, and honey is mixed with propolis, pollen, beeswax, and bee brood. First, a knife was used to uncap the thin coating of wax. This was the initial stage of processing honey. The honey from modern hives was extracted and strained using a honey extractor, then stored in sealed containers and kept dry until it was sold. In contrast, the honey from transitional hives was squeezed or pressed from the combs and strained/filtered as soon as it was harvested using a fine sieve and cloth. Using a delicate balancing scale, farmers at each study location were asked to measure the amount of honey harvested per transitional, traditional, and modern hives during all honey harvesting seasons.

Method of Data Collection and Analysis
Data Collection

For every study site, the researchers created checklists and data collection forms at the team level. Three years' worth of data on honey output per hive were gathered (2009-2012).Soon after, the yield of honey was measured and noted on honey collection sheets.
Statistical Analysis of Data.

The General Linear Model (GLM) analysis of variance procedure of the statistical analysis system (SAS) was used to statistically evaluate the gathered data (SAS Institute Inc., 2006). When a mean was statistically significant at $p < 0.05$, it was separated using the least square significant difference (LSD).

RESULTS AND DISCUSSIONS

The Mean Honey Yield from Transitional, Traditional and Modern Hives

For three years, transitional and modern hives were assessed at three different locations. The average yield per hive each year is displayed in Table 1. According to the study's findings, the average annual honey yield from transitional hives at Asebo, Adami Tulu Research Station, and Ashoka Lepis site was 13.88 kg, 13.21 kg, and 10.45 kg, respectively. The honey yield per hive/year from transitional hives differed ($p <0.05$) between Ashoka Lepis and Asebo, as well as between the Ashoka Lepis location and Adami Tulu Research Center.

However, there was no discernible difference in the transitional yield between the Adami Tulu Research Center and the Asebo location ($p > 0.05$). At the Asebo site, a noticeably larger volume of honey output from transitional hives was observed. On the other hand, the Ashoka Lepis site had a reduced honey output from transitional hives. A Kenya top bar hive may produce roughly 50 kg of honey year under the right circumstances (FAO, 1990). The mean yield of transitional hives in this study area is higher than the national average yield of traditional hives by Jacobs et al. (2006) and Workneh et al. (2007), which are 5-6 kg and 5 kg per hive/year, respectively, but it is comparable to the report indicated by Workneh et al. (2008), which is 10-15 kg per hive per year. The mean honey yield from transitional hives in this study region, however, is less than the 14.07 kg per hive/year finding reported by Nebiyu and Messele (2013) in districts of Gamo Gofa designated zone southern Ethiopia. At the Ashoka Lepis site, Asebo, and Adami Tulu research station, the average honey yield per hive per year was 18.61 kg, 21.61 kg, and 23.18 kg, respectively. The honey yield per hive/year from modern hives varied ($p < 0.05$) among the three study sites. The average honey yield from modern hives in this study area is higher than the average yield from Tessega (2009) in Burie district of the Amhara region, which is 15.6 kg per hive/year, but it is comparable to the national average yield from Workneh et al. (2008) in Atsib Wonberta district of the Tigray region, which is 20–25 kg hive/year. At the Adami Tulu Research Center, Asebo, and Ashoka Lepis sites, the average annual honey yield from conventional hives was 6.08 kg, 5.94 kg, and 4.94 kg, respectively. At the Adami Tulu Research Station, the honey yield from both traditional and modern hives was noticeably higher (Table 2).

On the other hand, the Ashoka Lepis site showed a decreased honey output from both traditional and modern hives. In general, the three types of hives differed significantly ($p < 0.05$) in the amount of honey they produced annually.

A transitional hive is three times less expensive than a modern hive. Compared to modern hives, transitional hives produce more honey and don't require as many costly beekeeping supplies and accessories. The only expenses needed are those for training and hive design. The Kenya top-bar hive (KTBH) has been found to be the most appropriate due to its low cost and the fact that it is much simpler to use and much less expensive for beekeepers or local carpenters to construct (Tessega 2009; FAO, 1990). However, movable frames hives are advised for seasoned beekeepers who wish to maximize honey production.

The research area's honey yield per hive was significantly impacted by the location and type of hive contact. In contrast, the honey yield per hive at the research region was not significantly impacted by the type of hive or the harvesting season (Table 3 and 4).

Additionally, Gidey and Mekonen (2010) found that the interplay between hive type and location affects the amount of honey produced per hive. This is most likely caused by variations in the kind and accessibility of bee food, bee management techniques, and environmental elements like disease, pests, and predators as well as climate change (Gidey & Mekonen, 2010).

Honey Harvesting Season

According to the study's findings, honey was gathered twice in each district. The Adami Tulu district has a small honey harvesting season in May, but a large one from September to early November. In the Arsi Negelle district, January is the busiest time of year for honey harvesting, whereas June is the busiest time (Table 5, 6, 7).

CONCLUSIONS

According to the study's findings, modern and transitional bee hives outperformed traditional hives in the study area in terms of honey quantity and quality. At the Asebo and Adami Tulu study stations, respectively, transitional, modern, and traditional hives produced noticeably more honey. However, the Ashoka Lepis site showed a low honey output from all three hive types.

At Asebo, Adami Tulu Research Station, and Ashoka Lepis location, the average annual honey yield from transitional hives was 13.88 kg, 13.21 kg, and 10.45 kg, respectively. The honey yield per hive/year from transitional hives differed ($p < 0.05$) between the Ashoka Lepis location and Adami Tulu Research Center. However, there was no discernible difference in the transitional hive yield between the Adami Tulu Research Center and the Asebo location ($p > 0.05$). At the Adami Tulu Research Center, Asebo, and Ashoka Lepis sites, the modern hive produced an average of 23.18 kg of honey annually, 21.61 kg, and 18.45 kg, respectively. The amount of honey produced by modern hives each year varied ($p < 0.05$) among the three research locations. At $p < 0.05$, the average yield from the three hive types was statistically significant. The study area's honey yield per hive was significantly impacted by the interplay between hive type and location. In contrast, the study area's honey yield per hive was not significantly impacted by the interaction between hive type and honey harvesting season. According to the study's findings, modern hives require more expensive beekeeping supplies and accessories as well as skilled workers than traditional and transitional hives, but the average honey yield per hive per year was found to be lower in the former. A modern hive is three times more expensive than a transitional hive. Therefore, it is advised that government and non-governmental organizations concentrate on expanding and encouraging the use of transitional bee hives in order to increase farmers' incomes with minimal expenses and little expertise.

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