Bhutan Journal of Animal Science (BJAS)
Volume 1, Issue 1, Page 28-33, March 2022

HONEY YIELD EVALUATION FROM THE TRADITIONAL AND MODERN MOVEABLE FRAME HIVES

PRASAD BHUJEL*, THINLEY WANGCHUK, SONAM CHOKI, KABIRAJ GURUNG, KINGA DORJI, VIJAY RAIKA AND SONAM WANGCHUK

National Highland Research and Development Centre, Department of Livestock, Bumthang, Bhutan

***Author for correspondence: pbhujel@moaf.gov.bt

ABSTRACT: The study was conducted to evaluate the honey yield from *Apis cerana* bees reared in traditional and modern moveable frame hives managed by the beekeeping farmers in Samtse, Chukha, Sarpang, Dagana and Tsirang districts. In total 70 beekeeping households owning 200 bee colonies - 100 traditional and 100 modern moveable frame hives were identified for the qualitative and quantitative data collection. Out of 200 identified hives 100 colonies had absconded from the hives while the remaining 100 colonies comprising of 50 traditional and 50 modern moveable frame hives were available for data collection. A structured questionnaire was used for household data collection. The data for the honey yield from the identified hives were measured and recorded by the field extension agents and farmers in the respective locations. The honey yield data were collected for two seasons - autumn in 2019 and spring in 2020. The mean annual honey yield from modern moveable frame hives were significantly higher (6.2 ± 1.3 kg) than from the traditional hives (4.6 ± 1.3 kg). Annual honey yield is significantly affected by the interactions of hive types (p = 0.000) and the locations (p = 0.049). There was a significant interaction effect (p = 0.034) of the type of hive, place and season on annual honey yield in the study areas. The study concluded that modern moveable frame hives yield more honey than the traditional hive under Bhutanese conditions. Thus, beekeeping, using modern moveable frame hives has the potential to be promoted across the country to increase honey yields and enhance rural livelihoods.

Keywords: *Apis cerana*; honey yield; modern moveable frame hive; traditional hive.

1. INTRODUCTION

Honeybees provide direct hive products such as honey, royal jelly, pollen and bee wax. It also plays vital roles in the food production system to enhance the quantity and quality of crop production through their pollination services (Klein et al. 2006). Agriculture is the backbone of the rural economy employing about 1,45,691 (43.9%) of the active working population in Bhutan (NSB 2018). Livestock is the integral part of the Bhutanese mixed farming system contributing about Nu.7,463.7 (4.46%) million to the total Gross Domestic Product (GDP) of the country (DoL 2020). Honeybee is a minor livestock commodity in Bhutan for which its full potential is yet to be explored. From the seven honeybee species found in the Hindu-Kush Himalayan (HKH) regions, six of them are found in Bhutan. They include *Apis cerana*, *Trigona iridipennis*, *Apis laboriosa*, *Apis dorsata*, *Apis florea* and *Apis mellifera*. In the Hindu Kush Himalayan countries, commercial beekeeping started from the 1970s with the introduction of imported species like *Apis mellifera* (Gurung et al. 2012). However, in Bhutan bee keeping in Langstroth hive started in 1986 when *Apis mellifera* was sourced from India and successfully managed in Bumthang (Maurer, *personal communication* 2020). The management of local honeybees (*Apis cerana)* in modern movable frame hive was started from the southern part of the country in 2007 whereby, the traditional beekeeping farmers were trained and supplied with the basic modern tools and equipment to take up commercial beekeeping (Tamang 2007). While introducing the modern beekeeping technology, its adoption was deterred by the socio-economic problems because of the limited knowledge and skills about the technology. Some of the common challenges hindering the acceptance of modern beekeeping technology in developing countries are the inadequacy of scientific knowledge and skills,

poor access to tools and equipment which are the main requirements for its successful adoption (Mujuni et al. 2012; Gebiso 2015). In the existing state of rural beekeeping, the modern moveable frame hive for *Apis cerana* are well adopted especially in the southern part of the country. The farmers also keep traditional hives (log and wall hives) to rear *Apis cerana* for honey production alongside modern hives. Several comparative studies on honey yield from traditional and modern hives have been done previously because of its importance to improve honey production. In Bhutan, no study has been carried out to compare the honey yield from *Apis cerana* (local honeybees) reared in traditional and modern moveable frame hives. Thus, the study was conducted with the main objective to assess the honey yield of *Apis cerana* reared under traditional management practices to those reared under modern moveable frame hive conditions in two different seasons and five locations in the country. It also aims to understand the basic demographic status of local beekeepers in the study areas.

2. MATERIALS AND METHODS

2.1 Study area

The study was conducted in five districts namely Dagana, Tsirang, Sarpang, Chuukha and Samtse from autumn 2019 to spring 2021. The study sites were selected purposively considering the large number of farmers rearing bees, experience of the beekeepers, presence of bee flora, access to motorable road, existence of intervention on bee farming development by the government and non-governmental organizations and adoption of both traditional and modern moveable frame hives for bee farming. These areas fall under humid sub-tropical and wet sub-tropical agro-ecological zones with altitudes ranging between 600 to 1200 meters above sea level. The mean annual rainfall and temperature ranges from 1200 mm to 5500 mm and 19.5 to 23.6°C, respectively (Pradhan and Chettri 2018). The areas are characterized by crop and livestock mixed farming system.

2.2 Sampling method

In total, 70 farmers were purposively sampled for this study. Farmers were selected based on their experience on traditional as well as modern method of beekeeping. Those beekeeping farmers who have received a formal training on modern method of beekeeping besides their traditional skills were chosen. The aims and objectives of the study were clearly explained to them through group discussions and individual dialogue to have a clear understanding of the study purpose and their roles in it. For quantitative data on honey yield measurement, a total of 200 colonies were selected. In each dzongkhag 40 colonized hives; 20 traditional hives (log or wall hive) and 20 modern moveable frame hives were identified. Before identification, the hives were opened and inspected to observe the hive strength based on the number of combs covered by bees. Only those hives which were covering an approximately equal number of combs and free from pest and disease were chosen.

2.3 Management of research hives

The selected hives were kept in a safe and suitable place to minimize absconding. The colonies were marked with permanent plastic hive tags with a unique identification number to avoid the mismatch of information during data collection. During the study period the colonies were not provided with any external feed supplement.

2.4 Data collection and analysis

The basic data from the beekeeping household were collected through interview using semi-structured questionnaire, and honey production was recorded by the respective livestock extension agents using standard format. Prior to the data collection, livestock extension agents were familiarized on the questionnaire and data recording format and procedures. The honey from the traditional hives was harvested using the common household items wherein honeycomb from the traditional hives were squeezed with hands and filtered using fine plastic sieve. Whereas, for the modern moveable frame hives the honey extractor was used to extract honey. As soon as the honey was harvested it was weighed using the common household balance and recorded its value in the recording sheet. Data collection process was monitored to ensure quality data.

The data was compiled in Microsoft Excel spreadsheet and taken to SPSS version 23 for the statistical analysis using General Liner Model

(GLM) analysis of variance. The three-way ANOVA was used to analyzed the data. Before conducting the test, the normality of the data was evaluated and determined that the outcome variable is normally distributed, W (200) = .990, p = .177. Furthermore, the assumptions of homogeneity of variances were tested and satisfied based on Levene's test (F (19,180) = 1.406, p = .128). The result was presented in descriptive statistics such as mean, minimum, maximum and standard deviation. The means were separated at the significance level of $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Identified colony behavior during study period

From the 200 identified colonies, 20% left the hive permanently between October and November 2019, before the first honey harvest. During the study period 60% of the identified colonies left the hive after honey harvest, between October 2019 to May 2021. However, 30% of the abandoned hives were recolonized with migratory bees during the nectar flow season in the study areas. Only 20% of the colonies stayed in the hives throughout the study period without leaving initially identified hives. At the end of the trial, honey yield data were available from 50% of the initially identified hives including the hives that were left and recolonized by the bees during the nectar flow season.

3.2 Demographic and socio-economic characteristics of respondents

As shown in Table 1, the average age of the respondents was 47.9 years with estimated standard deviation of 12.6 years. The data reveals that maximum of the respondents fall in the range of working age population in the country. The average household size was 3.4 individuals with estimated standard deviation of 1.4 individuals. The average age of beekeeping experience was 15.2 years with estimated standard deviation of 11.6 years. The data in beekeeping experience suggest that beekeeping is an old tradition in the study areas and young people are taking interest to take up this activity. The average number of hives per household was 7 with minimum of one and maximum of 35 hives. It implies that there are avenues for the livestock extension to reduce the hive holding gap among the trained beekeepers through extension service.

Table 1: Mean ± SD of sample respondents by demographic variables (n= 70)

Variables	Mean
Age	47.9 ± 12.6
Household size	3.4 ± 1.4
Beekeeping Experience	15.2 ± 11.6

3.3 Educational background and hive preferences

Irrespective of the qualification, all the respondents felt that both the traditional and modern hives are important for commercial beekeeping. However, the graph reveals that 8% and 6% of the respondents from the illiterate and primary level of education groups do not prefer modern hives for beekeeping. It implies that qualification influences choice of the hive types (Figure. 1). This could be due to the individual level of understanding about the modern beekeeping technology.

3.4 Trend of beekeeping

The trend of beekeeping was also studied in the areas. Of the total respondents, 83% affirmed that the beekeeping is increasing while 7% felt that it is declining over the last five years. The remaining respondent reported that they did not observed changes in the beekeeping household over the last five year.

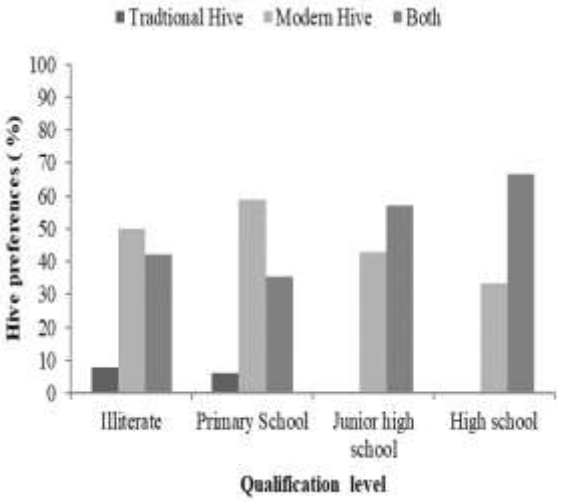

Figure. 1. Level of qualification and bee hive preference

3.5 Honey yield from tradition and modern hives

The mean honey yield harvested per hive per year from traditional and modern hives were evaluated in five different districts for two years. The mean honey yield obtained from the traditional hive was 4 kg, 5 kg, 4.9 kg, 4 kg, 4.5 kg in Samtse, Chukha, Sarpang, Dagana and Tsirang respectively, with overall mean yield of 4.6 kg (Table 3). A significant difference in the annual honey yield for the traditional hive was observed between Chukha and Dagana districts ($p<0.05$). The mean honey yield from the traditional hive recorded in this study was higher than the yield reported by the Department of Agriculture Marketing and Cooperatives [DAMC] 2017 and AI-Ghamdi et al. (2017). The annual yield per traditional hive reported was 2.5 kg and 3.7 kg. However, the average annual honey yield recorded in this study was close to findings reported by Beyene et al. (2015) and Taguiling et al. (2015) of 5.6 kg and 5 kg, respectively. The difference in honey yield reported may be attributed to the availability of flora, the inherent ability of bee colonies to collect nectar and the management practices of the farmers. The mean annual honey yield recorded per modern hive in this study was 6.4 kg, 6.5 kg, 5.8 kg, 6 kg, and 6.4 kg in Samtse, Chukha, Sarpang, Dagana and Tsirang, respectively. There were significant differences in the mean annual honey yield obtained from the traditional and modern hives ($p<0.05$). The mean honey yield obtained from the modern hives in the study areas are lower than the quantity of 6.6 kg and 10 kg per hive recorded by AI-Ghamdi et al. (2017) and International Centre for Integrated Mountain Development [ICIMOD] (2017), respectively. But the annual honey yield recorded in this study was higher than 5.5 kg per hive reported by DAMC (2017). Absence of significant difference in the mean honey yield from modern moveable hive in different places may be ascribed to similar knowledge and skills imparted to the management of standard modern moveable frame hives through capacity building.

Table 3: The mean annual honey yield ± SD from traditional and modern hive

Locations	Mean yield (kg)	
	Traditional hive	Modern hive
Samtse	4 ±1.5	6.4 ±1.2
Chukha	5 ±1.5*	6.5 ±1.3
Sarpang	4.9 ±0.7	5.8 ±1.3
Dagana	4 ±1.9*	6 ±1.1
Tsirang	4.5 ±1	6.4 ±1.2
Overall mean	4.6 ±1.3*	6.2 ±1.3*

*The mean in the table with * are shown statistically significant at $p < 0.05$*

3.6 Main effect and interaction effects

A three-way factorial ANOVA was conducted to compare the main effects of hive, place and season (Independent variables) as well as their interaction effects on average annual honey yield (dependent variables). Hive and place effects were statistically significant at $p<0.05$. The main effect of hive yielded an effect size of 0.319, indicating that 31.9% of the variance in the annual honey yield was explained by hive ($F(1, 180) = 84.275$, $p = 0.000$). The main effect of place yielded an effect size of 0. 051, showing

Table 2: Effect of hive types, places and seasons on honey yield

Source of variance	SS	df	MS	F	Sig.	PES
Hive	133.444	1	133.444	84.275	0.000	0.319
Place	15.411	4	3.853	2.433	0.049	0.051
Season	4.319	1	4.319	2.728	0.100	0.015
Hive * Place	11.539	4	2.885	1.822	0.127	0.039
Hive * Season	0.205	1	0.205	0.129	0.719	0.001
Place * Season	7.261	4	1.815	1.146	0.336	0.025
Hive * Place * Season	16.873	4	4.218	2.664	0.034	0.056
Error	285.018	180	1.583			
Total	6305.69	200				
Corrected Total	474.77	199				

a R Squared = .400 (Adjusted R Squared = .336)

that 5.1% of the variance in the annual honey yield was explained by place (F (4, 180) = 2.433, p = 0.049). The interaction effects were statistically significant with p = 0.034. The interaction effects of hive, place and season yielded an effect size of 0.056 indicating that 5.6 % of the variance in the annual honey yield was explained by the interaction effects of hive, place and season. The findings are similar to that of (Yirga and Teferi 2010; Haftom and Awet 2013; Beyene et al. 2015) which could be due to the differences in hive management practices and availability of bee flora.

4. CONCLUSIONS & RECOMMENDATIONS

The study concludes that majority of the respondents, (83%) reported that beekeeping activities are increasing in the country. In terms of adoption of improved hives, level of education influences choice of the hive types with illiterate and primary level education groups having reservation to adopt modern hives. To improve the honey yield from *Apis cerana*, modern moveable frame hives are found to be better than the traditional hives as there was significant difference between the annual honey yield from traditional and modern hives. Approximately 32 %, of the honey yield differences between traditional and modern hives were determined by the hive type with modern hive at the higher end. It may be useful to promote the modern hive with basic infrastructure and accessories in place to upscale local honey production. *Apis cerana* beekeeping with modern movable frame hives were recently introduced in Bhutan and its adoption have to be expanded to the rest of the population as an alternative source of income and employment opportunity to the growing youth population of Bhutan.

Acknowledgements

The authors would like to thank Department of Livestock, Ministry of Agriculture and Forests for providing the fund support to carry out this study. Similarly, all the gewog extension agents, beekeeping Chairmen and farmers who have contributed to this study are equally acknowledged. The study would not have been possible without their dedicated support. Lastly, the team would like to thank Research and Management Committee of National Highland Research and Development Centre, Bumthang for giving their valuable comments to improve this work and office administration for rendering the necessary field support to complete this study successfully.

REFERENCES

AI-Ghamdi AA, Adgaba N, Herab AH and Ansari MJ. (2017). Comparative analysis of profitability of honey production using traditional and box hives. Saudi journal of biological sciences, 24(5): 1075-1080.

Beyene TD, Abi D, Chalchissa G and Tsadik MW. (2015). Evaluation of transitional and modern hives for honey production in mid rift valley of Ethiopia. Global Journal of Animal Scientific Research, 3: 48-56.

DAMC. (2017). Final report, Lot 1: Honey value chain analysis. http://www.agrimarket.gov.bt/public/news/download/id/300

DoL. (2020). Annual report 2019-2020, Department of Livestock, Ministry of Agriculture and Forests. Thimphu; Bhutan.

Gebiso T. (2015). Adoption of modern bee hive in Arsi zone of Oromia region: Determinants and financial benefits. Agricultural sciences, 6:382-396. doi: http://dx.doi.org/10.4236/as.2015.63038

Gurung MB, Partap U, Shrestha NCTD, Sharma HK, Islam N and Tamang NB. (2012). Beekeeping training for farmers in the Himalayas – Resource manual for trainers. Kathmandu: ICIMOD

Haftom G and Awet E. (2013). On farm evaluation of Kenyan top bar hive (KTBH) for honey production in Tigray Region, Northern Ethiopia. Livestock Research for Rural Development, 25. doi: http://www.lrrd.org/lrrd25/5/haft25086.htm

ICIMOD. (2017). Pro-poor value chain development for *Apis cerana* honey. International Centre for Integrated Mountain Development, Kathmandu: Nepal.

Klein AM, Dewenter IS, Tscharntke T, Vaissiere BE, Cane JH, Cunningham SA and Kremen C. (2006). Importance of pollinators in changing landscapes for world crops. Proceedings of the Royal Society B. pp 303-313.

Mujuni A, Natukunda K and Kugonza DR. (2012). Factors affecting the adoption of beekeeping and associated technologies in Bushenyi District, Western Uganda.Livestock Research for Rural Development, 24(08).

NSB. (2018). Population and housing census 2017. National Statistics Bureau, Thimphu, Bhutan.

Pradhan K and Chettri GB. (2018). Bhutan future smart food. pp 111-122 United Nations. doi: https://doi.org/10.18356/cfea5590-en

Taguiling NK, Buyucan MN and Taguiling ML. (2015). Comparative analysis of traditional and commercial apiculture. International Journal of Scientific and Research Publications, 5:1-7.

Tamang NB. (2007). "Honeybees in Himalayas: Promoting partnerships with rural development organizations and networks in HKH region''. Final report on beekeeping activities in Bhutan (July 2006 – June 2007).

Yirga G and Teferi M. (2010). Participatory technology and constraints assessment to improve the livelihood of beekeepers in Tigray Region, northern Ethiopia. Momona Ethiopian Journal of Science, 2: 76-92.