RJOAS: Russian Journal of Agricultural and Socio-Economic Sciences
ISSN 2226-1184 (Online) | Issue 5(149), May 2024

UDC 332

SOCIO-ECONOMIC ANALYSIS OF TRADITIONAL AND MODERN BEEKEEPING IN GULMI, NEPAL

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ABSTRACT
The study was conducted to evaluate the socio-economic aspects of the traditional and the modern beekeeping methods comparing costs, returns, productivity, profitability, and identifying key constraints for both approaches. Ninety-six beekeepers, with equal representation from both modern and traditional beekeeping practices, were selected randomly from Resunga Municipality-10 and Musikot Municipality-6. Primary data were gathered through questionnaire surveys, key informant surveys, and focal group discussion. Secondary information was obtained from publications of relevant institutions. The collected data were analyzed using Microsoft Excel and SPSS software. The results show that modern beehives have 2.3 times higher honey productivity (6.49 kg/hive) compared to traditional hives (2.77 kg/hive). Despite higher total production costs for modern beekeepers (NRs. 2526.70) than traditional beekeepers (NRs. 1373.74), modern beekeeping generates greater income per hive (NRs. 7825.32 vs. NRs. 3025.73). Modern beekeepers also exhibit higher gross margin, net margin, and benefit-cost ratio (NRs. 6156.13/hive, NRs. 5298.61, and 3.09) than their traditional counterparts (NRs. 2012.90, NRs. 1651.99, and 2.21). Analysis of production constraints reveals that the modern beekeepers face issues of unavailability and inaccessibility of modern input materials (index value 0.77) and inadequate technical knowledge (index value 0.74). In contrast, traditional beekeepers encounter challenges of absconding and swarming (index value 0.89) and infestation of disease/pests (index value 0.83). Modern beekeeping in Gulmi, Nepal, exhibited greater productivity and profitability than traditional methods. The study highlights the necessity of addressing distinct challenges within each group to promote sustainable beekeeping practices in the region.

KEY WORDS
Apis cerana, absconding, honey; Nepal, wooden hives.

Nepal, a country noted for its rich agricultural tradition, is strongly reliant on agriculture, which accounts for 25.8% of the total Gross Domestic Product (GDP) and employs over 60.4% of the population (MOF, 2020). Among the various agricultural enterprises, apiculture has gained significant popularity in recent years due to the country's diverse agroclimatic conditions and abundant bee flora. Beekeeping is a lucrative agricultural activity highlighted in the Agricultural Perspective Plan and the Tenth Plan, despite contributing less than 1% to the Agricultural GDP (Devkota, 2020). Beekeeping offers dual economic benefits: income from honey and its by-products (beeswax, royal jelly, pollen, propolis, bee colonies, and bee venom), and gender-neutral employment opportunities (Miklyaev et al., 2014). Nepal stands out as the only country in the world capable of successfully producing honey across a wide range of altitudes, from tropical to temperate regions (Joshi, 2008). With four native honeybee species: *Apis cerana*, *Apis dorsata*, *Apis laboriosa*, and *Apis florea*, Nepal has enormous potential for beekeeping with a carrying capacity of up to one million bee colonies

(Pokhrel et al., 2014; Thapa et al, 2018). In addition to native species, *Apis mellifera,* the European honeybee, is reared in Nepal, predominantly in the Terai region, while *Apis cerana* is more commonly found in hilly areas. Compared to honey collected from *Apis mellifera*, honey produced by native honeybee species is regarded as organic honey (Sivaram, 2012).

Apis cerana, also known as the Asian hive bee can be found across the country up to 3500 masl. (Gurung et al., 2012) and is reared in different types of hives such as Newton, wall, and wooden hives (Thapa 2012). As per MOALD (2019), *Apis cerana* is the dominant species found in 80% of traditional hives in Nepal, and it comprises 78% of the beehives nationwide. Log hives are made from hollowed-out logs of locally available trees and are mostly used to rear *A. cerana* in hilly regions (Pudasaini,2018). Although modern beehives have been introduced since 1989, old log hives are still extensively employed (Devkota, 2020). Modern beekeeping technologies, such as improved beehives, are seen as a significant advancement in the sector, as they increase resource efficiency, beekeepers' earnings, and welfare (Kuboja et al., 2016).

Gulmi district in Nepal has high potential for beekeeping but traditional practices limit productivity and processing of hive products. Productivity of honey in Gulmi is 2.2 kg/hive/year (AKC, 2019) which is disappointingly low compared to the national average of 16.45 kg/hive (MOALD, 2019). Adoption of modern beekeeping practices is limited due to lack of information on profitability and productivity (Al-Ghamdi, 2010). In Nepal, many farmers use both traditional and modern beehives, but it's unclear if the increased investment cost of modern beehives leads to higher returns. An empirical study is essential to compare the productivity of traditional and modern beehives and determine if the gains for beekeepers justify the investment costs. However, such a study has not been conducted in Nepal, and this research aims to fill that gap by comparing the economic performance of traditional and modern beehives among small-scale beekeepers using household survey data from Gulmi. In addition, it also analyzes the socio-demographic characteristics of beekeepers and the challenges associated with both types of beekeeping practices. The study can provide insights to improve productivity and raise awareness among beekeepers and authorities about the limitations in the industry, ultimately benefiting Nepal's beekeeping industry.

METHODS OF RESEARCH

The research was conducted in the Gulmi district, located in the mid-hill regions of Lumbini province in Nepal. It was specifically carried out in the Resunga and Musikot municipalities (Figure 1), deliberately selected due to their promising honey production prospects. The study took place from February to July 2021.

The sampling frame for this study comprised registered beekeepers at the Agriculture Knowledge Centre in Gulmi. To prevent biased representation, a simple random sampling method was used. A total of 96 beekeepers from two municipalities were selected with an equal representation of modern and traditional beekeepers.

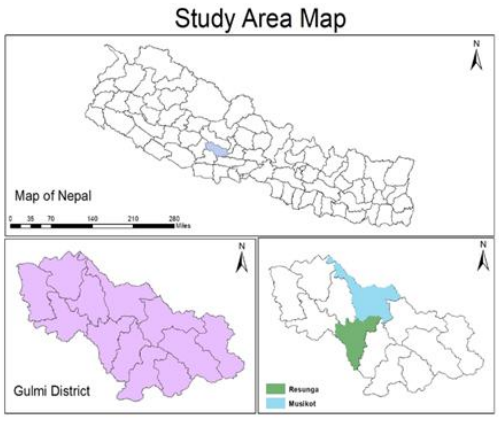

Figure 1 – Map showing research area

Primary data were gathered through methods such as questionnaire surveys, key informant surveys (KIS), and focal group discussions (FGD) and field observations. Questionnaire adjustments were made based on a pre-test with 10 households, while secondary data were sourced from articles, journals, documents, and publications from relevant organizations. The study analyzed socio-demographic and economic variables, including age, gender, household size, productivity, profitability, cost, benefit-cost ratio, gross margin, net margin, and production issues. Descriptive analysis was conducted using MS-Excel 2010 and SPSS 26.0.

Economic analysis was done using given formulae:

Total cost of production = Total variable cost + Total fixed cost

Total fixed cost = Depreciation on cost of (bee colony +beehive + hive stand + hive tool + uncapping knife + bee veil + wax box + smoker + honey extractor + harvesting net+ queen cage)

The fixed cost was calculated by dividing their original cost by the number of years of life expectancy of the equipment.

Table 1 – Life expectancy of equipment used in beekeeping

S.N.	Equipment	Durability (in years)
1	Bee hive	10
2	Bee colony	10
3	Stand	10
4	Hive tool	5
5	Smoker	10
6	Honey extractor	5
7	Uncapping Knife	5
8	Bee veil	3

Note. Adapted from Devkota (2006).

Total variable cost = C. labor+ C. feeding+ C. drugs+ C. comb+ C. repair and maintenance + comb foundation

Where: C. labor = Cost on human labor used (NRs/hive); C. feeding = Cost on supplementary feeding (Sugar + pollen + honey) used (NRs/hive); C. drugs = Cost on drugs (NRs/hive); C. comb = Cost on comb foundation (NRs/hive); C. repair and maintenance = Cost of repair and maintenance of beehive (NRs/hive).

Total returns = Total Revenue from honey+ Total revenue from wax + Total revenue from sale of bee colonies

Gross Margin= Gross Revenue - Variable Cost

Net Margin = Gross Return - Total Cost

Benefit Cost Ratio (B: C) = Gross Revenue/ Total Cost

Problems for the production of the honey were identified with the help of forced ranking technique. The formula given below was used to find the index for intensity of production problems faced by modern and traditional beekeepers.

$$I_{imp} = \sum (Si\ Fi)/N$$

Where: I_{imp} = index of importance; $\sum$ = summation; Si = i^{th} scale value; Fi = frequency of i^{th} importance given by the respondents; N = total number of respondents.

RESULTS AND DISCUSSION

The average age of the respondents was 50.43 years, with modern beekeepers being significantly younger (45.98 years) than traditional beekeepers (54.87 years). Additionally, the average family size in the area was 5.45, and modern beekeepers had a smaller family size (5.14) than traditional beekeepers (5.77), with a 1% level of statistical significance. The differences in age and family size suggest that modern beekeeping may be attracting a younger population and/or those with smaller families.

Furthermore, traditional beekeepers had considerably more beekeeping experience (17.10 years) compared to modern beekeepers (4.04 years) at a 1% level of significance. This difference in experience may result in distinct approaches to beekeeping, with traditional beekeepers relying on their expertise in traditional techniques, while modern beekeepers may lean more on technology.

Table 2 – Socio-economic and demographic characteristics (continuous variables) of the respondents in the study area in 2021

Variables	Modern (n=48)	Traditional (n=48)	Overall (n=96)	Mean Difference	T-value
Age	45.98(12.85)	54.88(7.88)	50.43(11.51)	-8.89	-4.09***
Family size	5.14(0.99)	5.77(0.95)	5.65(1.19)	-0.63	-3.16***
Economically active members	2.66(0.86)	2.70(1.05)	2.55(0.95)	-0.04	-0.19
Dependent family members	2.47(0.82)	3.06(0.93)	2.77(.923)	-0.58	-3.25
Years of beekeeping	4.04(2.77)	17.10(8.08)	10.57(8.89)	-13.06	-10.59***

*Note: Figures in parenthesis indicate standard deviation (SD). *** and ** indicate 1% and 5% level of significance respectively.*

The majority (83.3%) of the respondents in the study were male. Traditional beekeepers had a higher percentage of male respondents (87.5%) compared to modern beekeepers (79.2%). Despite the potential for beekeeping to empower rural women and reinforce their role in agriculture, it is currently dominated by men. However, it can be adapted to serve as an additional income source for them (Poccol & McDonough, 2015).

Table 3 – Socio-economic and demographic characteristics (categorical variables) of the respondents in the study area in 2021

Variables	Modern (n=48)	Traditional (n=48)	Overall (n=96)	Chi-square	P value
Gender of respondent					
Male	38 (79.2)	42 (87.5)	80 (83.3)	1.2	0.27
Female	10 (20.8)	6 (12.5)	16 (16.7)		
Primary Occupation					
Agriculture	36(75)	41(85.4)	77(80.2)	4.76*	0.09
Service	10(20.8)	3(6.3)	13(13.5)		
Business	2(4.2)	1(8.3)	6(6.3)		
Education Status					
Only read and write	8(16.7)	23 (47.9)	31(32.3)	25.86***	0
Primary Education	14(29.2)	21 (43.8)	35(36.5)		
Secondary Education	16(33.3)	4(8.3)	20(20.8)		
Higher Secondary	7(14.6)	0(0)	7(7.3)		
University	3(6.3)	0(0)	3(3.1)		
Ethnicity					
Brahmin	18(37.5)	18(37.5)	36(37.5)	1.44	0.7
Chhetri	13(27.1)	10(20.8)	23(24)		
Adibasi/Janajati	16(33.3)	17(35.4)	33(34.4)		
Dalit	1(2.1)	3(6.3)	4(4.2)		

*Note: Figures in parenthesis indicate SD. *** and ** indicate 1% and 5% level of significance respectively.*

Agriculture was the main occupation of the respondents, with 80.2% of household heads involved in it. 75% of modern beekeepers and 85.4% of traditional beekeepers had agriculture as their primary occupation. This suggests that beekeeping is often seen as a complementary activity to agriculture and may serve as an additional source of income for

those engaged in farming (Dolores-Mijangos et al., 2017). It also highlights the potential for beekeeping to contribute to rural livelihoods and the overall agricultural sector. Education level influenced the decision to use modern hives, with modern hive owners having higher levels of education (Al-Ghamdi et al., 2017). 32.3% of respondents could only read and write, with a higher percentage of traditional beekeepers (47.9%) falling into this category compared to modern beekeepers (16.7%). Brahmins were the dominant group in society, comprising 37.5% of households, followed by Adibasi/Janajati (34.4%).

In the Gulmi district, beekeeping is a popular activity among farmers. The study categorized motivating factors for beekeeping into four categories. It was found that a significant percentage of traditional beekeepers (87.5%) and modern farmers (36.4%) were driven by tradition. Moreover, 65.4% of modern farmers and 79.2% of traditional farmers perceived beekeeping as easier than other occupations. Additionally, 75.1% of modern and 36.1% of traditional beekeepers were motivated by the higher returns compared to other crops. Lastly, 12.7% of all respondents, encompassing both traditional and modern beekeepers, continued beekeeping due to technical support from various I/NGOs. The details are presented in figure 2.

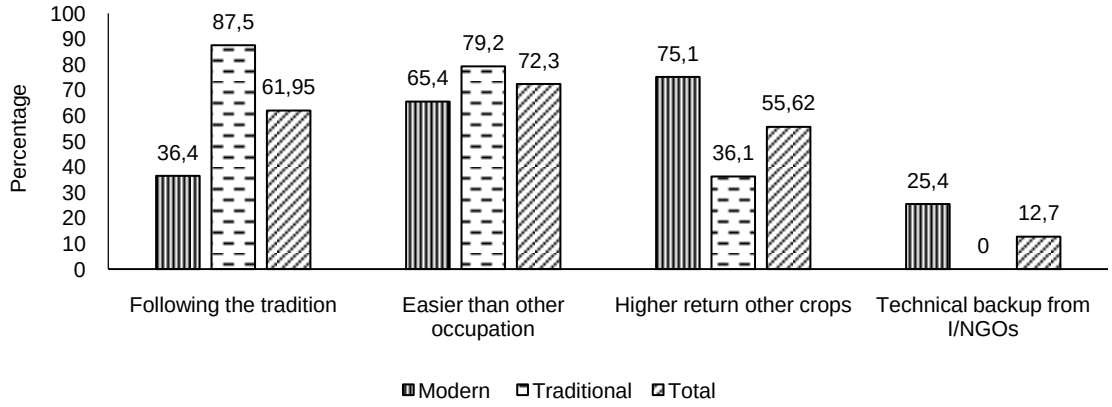

Figure 2 – Reasons for beekeeping in the study area in 2021

Effective management practices contribute to increased returns and the efficient operation of beekeeping enterprises. In the study area, both modern and traditional beekeepers adopted practices such as requeening, diseases and pest management, and planting bee-friendly flora. Modern beekeepers exclusively implemented additional practices like artificial feeding, artificial queen production, and the use of comb foundation. However, neither group practiced hive migration nor bee insurance, which is shown in the Figure 3.

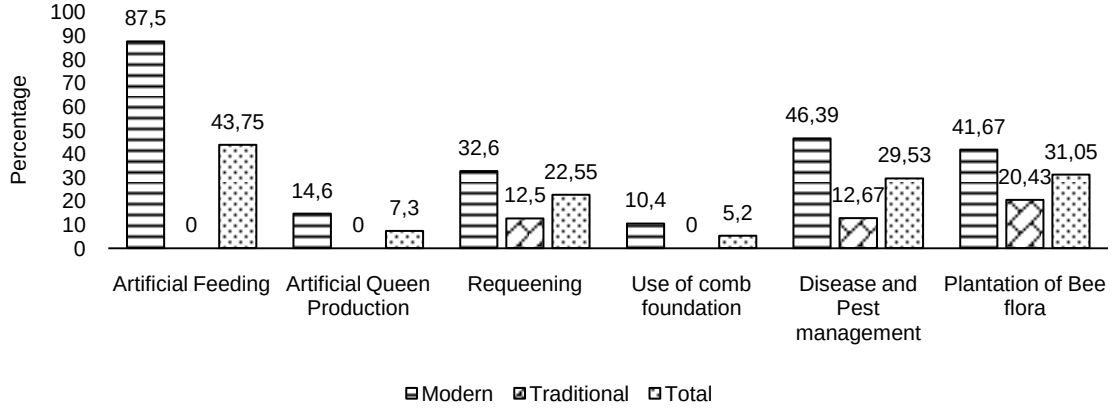

Figure 3 – Management practices in beekeeping in the study area in 2021

Out of total respondents, 32 % of the modern beekeepers were found to receive training and extension services related to beekeeping through GOs and NGOs (Figure 5) whereas none of the traditional beekeepers were found to have received the service (Figure 4). The result reveals the importance of extension services for promotion of modern apiculture enterprises in the study area.

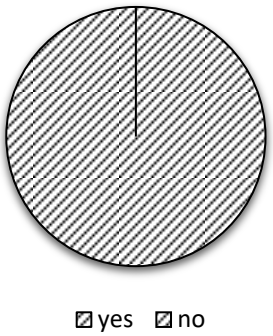

Figure 4 – Status of training on beekeeping among traditional beekeepers

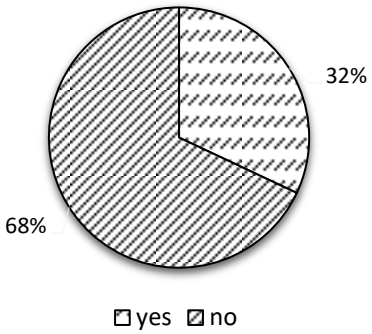

Figure 5 – Status of training on beekeeping among modern beekeepers

Out of total respondents, 77.1% of the modern beekeepers (Figure 6) and 43.75% of the traditional beekeepers were members of some agricultural cooperatives (Figure 7). The involvement of modern beekeepers in cooperatives was found higher in comparison. This shows that these cooperatives may influence in adoption of modern hives.

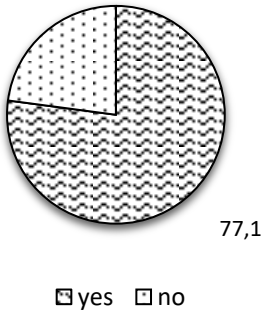

Figure 6 – Status of membership in agricultural cooperatives of modern beekeepers

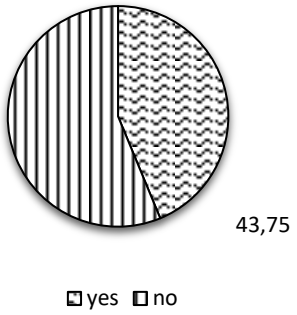

Figure 7 – Status of membership in agricultural cooperatives of traditional beekeepers

The average number of harvestings of honey in the study area was found to be 2.24. The number harvestings by modern beekeepers (2.67) were found to be significantly higher as compared to traditional beekeepers (1.81) at 1% level which is shown in Table 4.

Table 4 – Number of harvestings of honey per year in the study area in 2021

Variables	Modern (n=48)	Traditional (n=48)	Overall (n=96)	Mean difference	t-value	P-value
No. of Harvesting	2.67 (0.52)	1.81 (0.62)	2.24 (0.70)	0.85	7.41	5.42E-11

Note: figures in the parentheses indicate standard deviation to the total.

In sampled household, honey was found to be the main product of beekeeping, while other products such as wax, pollen, royal jelly, and propolis were almost non-existent due to the belief among farmers that collecting them reduces honey production. Only a few modern beekeepers engaged in colony division and sale. The average number of beehives per respondent was 8.7 for modern beekeepers and 7.7 for traditional beekeepers.

The study found that modern beehives yielded an average of 6.49 kg of honey per hive annually, while traditional hives produced only 2.77 kg, making modern hives 2.3 times more

productive. In a similar study in Uganda, enhanced top-bar hives produced 50% more honey than traditional hives (Dathine, 2012). Nonetheless, the average productivity of Apis cerana in the study area was significantly lower than the reported annual range of 8-15 kg/hive according to Devkota (2020). Another study in Nepal noted an average honey production of 6.12 kg per hive per year from Apis cerana in the Dang District (Yogi et al., 2020).

For the calculation of total cost incurred in apiculture, total fixed cost and total variable cost invested were analyzed. The results showed that that the annual cost for modern beekeeping was NRs. 2526.701 per hive, whereas traditional beekeeping incurred NRs. 1373.74 per hive. Modern beekeeping had a higher annual fixed cost of NRs. 857.5 compared to traditional beekeeping at NRs. 360.91, primarily due to modern beekeepers investing in bee colonies while traditional bee keepers collected the bee swarm baiting wild colonies in the forest and in pastures on cliffs using lure. Additionally, the modern approach had a greater annual variable cost of NRs. 1669.18 compared to traditional beekeeping at NRs. 1012.82, as modern beekeepers invested in artificial feeding, comb foundation, and drugs. Labor, repair, maintenance, marketing, and other expenses were also notably higher for modern beekeeping.

Table 5 – Cost for bee keeping per hive under different headings among modern and traditional beekeepers in the study area in 2021

Particulars	Modern (NRs.)	Traditional (NRs.)
Depreciation on beehive	337.91	320.2
Depreciation on bee colony	432.19	
Depreciation on other hive equipment (hive stand, hive tools, bee veil, gloves etc.)	87.42	40.71
Total Depreciation on Fixed cost/hive	857.5	360.91
Labor cost/hive	606.73	446.55
Comb Foundation	97.69	0
Feeding cost	314.98	0
Transportation cost	129.46	176.15
Baiting	0	140.83
Marketing Cost	117.32	49.7
Cost on Drugs	83.67	0
Repair and maintenance	237.8	64.62
Miscellaneous cost	81.59	20.49
Total Operating cost/hive	1669.18	1012.82
Total cost/hive	2526.701	1373.74

The average annual gross return was calculated including the gross returns from honey and the sale of colonies. The beekeepers generated an average of NRs. 7825.32 per hive per year for modern beekeeping and NRs. 3025.73 per hive per year for traditional beekeeping (Table 6). In the study area, traditional beekeepers solely relied on honey sales, while only modern beekeepers engaged in colony sales. Colony sales contributed 4.86% to the overall income, with only 20.8% of modern beekeepers participating in this aspect.

Table 6 – Returns from bee keeping per hive from different products among modern and traditional beekeepers in the study area in 2021

Particulars	Modern beekeepers (NRs.)	Traditional beekeepers (NRs.)
Annual Gross return/ hive from honey	7444.55	3025.73
Annual Gross return/hive from sale of colonies	380.77	0
Total	7825.32	3025.73

The analysis of Gross Margin, Net Margin, and B:C ratio showed that beekeepers using modern hives benefitted more compared to traditional hives. The average gross margin per hive per year was NRs. 6156.14 for modern hives and NRs. 2012.91 for traditional hives. The average net margin per hive per year for modern hives was NRs. 5298.61, while for traditional hives it was NRs. 1651.99. The B:C ratio for modern beekeeping was 3.09, significantly higher than the B:C ratio of 2.21 for traditional beekeeping. These analyses indicated that despite the higher costs, modern beekeeping was more profitable than traditional beekeeping.

Table 7 – Gross Margin, Net Margin and B:C ratio of Beekeeping among modern and traditional beekeepers in the study area in 2021

Variables	Types of hive	Mean	Standard Deviation	Mean Difference	T-value	P-value
Gross margin/hive	modern	6156.14	1972.18	4143.23	13.36***	0
	traditional	2012.91	853.15			
Net margin/hive	modern	5298.61	2007.71	3646.63	11.58***	0
	traditional	1651.99	852.11			
B:C Ratio	modern	3.09	0.71	0.87	6.50***	0
	traditional	2.21	0.61			

*Note: *** indicates 1% level of significance.*

In the study area, the farmers were facing several problems related to apiculture. Based on the perception of farmers, the scaling technique (indexing) was used to rank the problems. The production problem for modern and traditional beekeepers were separately studied and analyzed.

Among the modern beekeeper, the unavailability and inaccessibility of modern input material (I= 0.77) was identified as the major constraint followed by problem of inadequate technical knowledge (I= 0.74), absconding and swarming (I= 0.69), lack of capital (I= 0.65), disease and pest infestation (I= 0.50), death of bees from pesticide poisoning and forest fire (I=0.33) and low availability of foraging area (I= 0.33). The study shows necessity of extension services and training facility in order to mitigate the associated problems and promote the adoption of the modern beekeeping practices.

Table 8 – Constraints of production for modern beekeepers in the study area in 2021

Problems	1.00	0.86	0.71	0.57	0.43	0.29	0.14	Weightage	Index	Rank
Lack of technical knowledge	11	14	10	5	4	2	2	35.57	0.74	II
Unavailability and inaccessibility of modern input material	15	15	2	10	4	0	2	37.02	0.77	I
Pesticide poisoning and forest fire	0	0	5	4	10	11	18	15.84	0.33	VI
Absconding and swarming	15	3	13	5	4	5	3	33.25	0.69	III
Lack of capital	8	9	12	2	11	0	6	30.97	0.65	IV
Disease and pests	0	7	4	14	8	10	5	23.88	0.50	V
Lack of foraging area	0	0	0	10	6	20	12	15.76	0.33	VII

Table 9 – Constraints of production for traditional beekeepers in the study area in 2021

Problems	1.00	0.86	0.71	0.57	0.43	0.29	0.14	Weightage	Index	Rank
Inadequate technical knowledge	10	0	12	8	10	8	0	29.70	0.62	III
Unavailability and inaccessibility of modern input material	0	7	4	0	14	12	11	19.84	0.41	V
Pesticide poisoning and forest fire	0	0	5	11	14	10	8	18.69	0.39	VI
Absconding and swarming	22	16	10	0	0	0	0	42.85	0.89	I
Lack of capital	4	0	9	10	3	8	14	21.70	0.45	IV
Disease and pests	12	25	4	5	2	0	0	39.99	0.83	II
Lack of foraging area	0	0	4	13	4	10	17	17.27	0.36	VII

In contrary to this, among the traditional beekeeper absconding and swarming (I= 0.89) was noted as major constraint followed by the problem of disease and pest infestation (I= 0.83), inadequate technical knowledge (I= 0.62), lack of capital (I= 0.44), unavailability and inaccessibility of modern input material (I= 0.41), death of bees from pesticide poisoning and forest fire (I=0.39) and low availability of foraging area (I= 0.36). Similar results were obtained in the study conducted by Pudasaini (2018) who reported absconding behavior of honeybees followed by insect pests (ants, lizards, vespa and wasps) infestation as the most serious problem of beekeeping with *A. cerana* in traditional hives. Bees under the traditional type of hive were found to be more affected by the diseases and pests followed by transitional and modern hives (Solomon et al., 2021). The reason for the problem of colony loss and disease/pest infestation to be more severe in traditional beekeeping as compared to modern beekeeping may be due to inadequate knowledge of management practices like disease pest management, supplement feeding, colony division and periodic requeening among traditional beekeepers in the study area.

CONCLUSION

Despite greater production costs, modern beekeeping proves more profitable based on metrics such as B:C ratio, Gross Margin, and Net Margin. Modern beekeepers encounter fewer issues with absconding and diseases/pests, but challenges like a lack of modern input materials and insufficient technical knowledge persist. Extension services play a crucial role in encouraging farmers to adopt and expand modern beekeeping businesses. Traditional beekeepers see beekeeping as a traditional practice, expressing concerns about the purity and health of honey from modern hives due to supplement feeding. This belief, particularly prevalent among the older generation and those with lower education levels, underscores the need for awareness programs in the study area.

Even though lower colony productivity is evident in the study area, beekeeping remains a profitable and less labor-intensive venture, providing valuable income and diversification for beekeepers. Engaging in value-added activities like bee pollen and royal jelly can further boost profits beyond traditional honey sales, presenting an opportunity for entrepreneurial farmers to scale up their earnings through apiculture. To facilitate this, the Government of Nepal and supporting agencies should prioritize the expansion of modern beekeeping for increased productivity and profitability through effective awareness campaigns and expanded extension services. Initiatives such as subsidies, training, material support, credit facilities, and insurance should be introduced to incentivize farmers to adopt modern beekeeping practices. Additionally, establishing a strong market system is vital for enhancing the marketing of products related to apiculture in the region.

ACKNOWLEDGEMENTS

The authors express their gratitude to Agriculture and Forestry University in Rampur, Chitwan, the Agriculture Knowledge Centre, and the local farmers of Gulmi for their support and cooperation throughout this study. Special thanks are extended to Assistant Professor Mr. Tulsi Parajuli for his continuous support. Additionally, the authors appreciate the valuable suggestions provided by Mr. Komal Shahi and Mr. Ganesh K.C, Agriculture Officer at the Project Implementation Unit, PMAMP, who served as the member supervisor.

CONFLICT OF INTERESTS

The authors confirm that there are no conflicts of interest related to the publication of this paper.

UNITS AND ABBREVIATIONS

One Nepalese Rupee = 0.0075 United States Dollar.
AKC: Agriculture Knowledge Center.
masl: meters above sea level.
MOALD: Ministry of Agriculture and Livestock Development.
MOF: Ministry of Finance.
NRs = Nepalese Rupee.

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