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Adoption of Good Beekeeping Practices Among Beekeepers in Chitwan District, Nepal

Nishma Kriti SHARMA[1], Prabin KC*[2] and Binayak Prakash MISHRA[2]

[1]Purbanchal University, Nepal
[2] Agriculture and Forestry University, Chitwan, Nepal
Corresponding Author's Email*: pkc181755@gmail.com

ABSTRACT

The adoption of Good Beekeeping Practices is widely recognized as essential for enhancing productivity, sustainability, and commercial success in the beekeeping industry. In Nepal, despite the sector's strong potential to support rural livelihoods, its growth remains constrained by reliance on traditional methods. This study investigates the extent of Good Beekeeping Practices adoption and explores the socioeconomic factors influencing their use among beekeepers in Chitwan, one of the country's leading honey producing districts. A mixed-methods approach was employed, combining a survey of 57 randomly selected beekeepers with qualitative insights from focus group discussions and key informant interviews conducted within the Prime Minister Agriculture Modernization Project (PMAMP) area. Data were analyzed using descriptive statistics and a binary logit regression model. Findings reveal a 59.6% adoption rate of Good Beekeeping Practices. Core practices such as the use of protective gear, appropriate apiary site selection, and maintenance of colony handling (64.9%) and feeding honey-pollen mixture (52.6%) were less common. Regression results indicate that age and the number of beehives negatively influenced adoption, whereas annual income from beekeeping, off-farm income, and honey production were positive and significant. The study concludes that financial capacity and economic resilience are key to encouraging the adoption of better practices. It suggests that efforts to increase profitability and diversify income are essential for modernizing the sector.

Keywords: Age, colony, income, production, regression

INTRODUCTION

Beekeeping is a significant part of rural households' incomes and economies in Nepal (Devkota, 2020). Despite economic growth, bee keeping is also essential for raising agricultural productivity, and biodiversity via the pollination services (Gupta et al.,

2014). Nepal has the capacity to produce around 10,000 tons of honey every year (Bhattarai et al., 2021). Honey is the primary output of bee keeping. Along with honey, various bee products are royal jelly, propolis, bee bread, bee venom, beeswax can be obtained from bee industry (Aryal et al., 2015). Beekeeping is an economically viable, socially acceptable, and environmentally sound business. Beekeeping is associated with the cultural as well as the economic history of Nepal. Five economically important Apis species found in Nepal are *Apis cerana*, *Apis mellifera*, *Apis florea*, *Apis dorsata*, and *Apis laboriosa* (Shrestha & Shrestha, 2000). All four species except Apis mellifera, are indigenous to Nepal. In Nepal, Apis mellifera and A. cerana make up 22% and 78% of all domestic bee species respectively (Kafle, 2019). In the Terai region, Apis mellifera are raised extensively, although Apis cerana are more common in the hills. The government and non-governmental organizations have worked hard to promote this bee species to boost the production of honey (Taylor, 2014). Since Bee Keeping is a non-land-based business with multipurpose output, demand for it has been rising dramatically in Nepal (Bista & Shivakoti, 2001).

The problems associated with beekeeping in Nepal are a shortage of bee flora, pesticide poisoning, and no access to improved apian materials for keeping bees (Devkota et al., 2022). In beekeeping, good management practices constitute several techniques that enhance honey production, improve hive health, and ensure sustainability. An essential component of successful honey production is low-cost technology combined with appropriate feeding, mite, and other pest control (Bista et al., 2015). Those who wish to start a beekeeping business must manage artificial feeding during the harsh winter and rainy seasons and provide management as needed (Bista & Shivakoti, 2001). In off-season honey bee colony management, a low dosage of sugar syrup combined with 30g pollen was appropriate, since it also aids in a high rate of flight activity (Suroj, 2006). A study revealed that feeding bees banana syrup during the off-season can save the cost of sugar feeding by more than 50% (Neupane & Thapa, 2005). Good Management Practices (GMPs) in beekeeping operations are important for optimizing efficiency and productivity (Danieli et.al., 2023). GMPs thus play a critical role in the maintenance of the genetic quality of a bee colony and are also engaged in the control of diseases and pests, which will determine the sustainability of the undertaking in the long run (Oldroyd & Thompson, 2006). The adoption rate of GMPs, however, is not uniform and has varying factors. Generally, innovations in beekeeping are adopted in stages, with early adopters leading the way, to be followed by others as the benefits become more evident (Bhandari & Kattel, 2020). This speed of adoption is influenced by factors such as the availability of resources, financial constraints, and the level of education and training among the

available beekeepers. The Agricultural Development Strategy (ADS) 2015-2035 underscores the importance of advancing scientific beekeeping through the adoption of quality standards, promotion of modern technologies, strengthening of extension networks, enhancement of honey value chains, and assurance of food safety and competitiveness. Within this framework, beekeeping is identified as a key enterprise for commercialization, biodiversity conservation, and improved management practices to boost productivity, sustainability, and market access MoAD, (2016).

Chitwan district is recognized as one of Nepal's most promising regions for beekeeping, owing to its rich bee flora and abundant pasture resources among 30 districts nationwide (FNBK, 2012). The district's potential is significant, with beekeeping offering greater revenue opportunities compared to traditional crop farming (Bhattarai et al., 2021). However, productivity and the processing of hive products remain constrained by reliance on traditional methods. Against this backdrop, the present study was undertaken to assess the adoption of good beekeeping practices among beekeepers in Chitwan. By examining the extent of adoption and the socioeconomic factors influencing it, the study aims to inform targeted interventions that can strengthen beekeeping practices and unlock the district's full potential.

MATERIALS AND METHODS

Study area: The study was carried out in Rapti Municipality, located in the eastern part of Chitwan district, Nepal, in 2024. Research activities focused on beekeeping practices within the Prime Minister Agriculture Modernization Project (PMAMP) command area, covering wards 1-6 and 10-13 of the municipality.

Sampling technique and sample size: The target population comprised 151 registered beekeepers in the study area. Using Daniel (1999) sample size determination formula, a sample of 57 beekeepers was selected. Respondents were chosen through random sampling to reduce selection bias and ensure the findings could be generalized to the wider population.

Data collection: A mixed-methods approach was employed to collect both qualitative and quantitative information. Primary data were gathered using three instruments. First, household surveys with a semi-structured interview schedule were administered to the heads of 57 selected beekeeping households. Second, Focus Group Discussions (FGDs) were conducted with farmers to gain deeper insights into community-level practices and challenges. Third, Key Informant Interviews (KIIs) were held with officials from government institutions (including PMAMP and the Agricultural

Knowledge Centre), representatives of non-governmental organizations (NGOs), and members of farmers' groups and cooperatives. In addition, secondary data were obtained from institutional reports and scientific journal articles, which helped contextualize the study and refine the definition and review of Good Beekeeping Practices.

Variables and measurement: The adoption of Good Beekeeping Practices served as the dependent variable and was measured as a binary outcome. Beekeepers were classified as adopters (1) if their Good Beekeeping Practices was greater than or equal to the mean value, and as non-adopters (0) if their score fell below the mean. Ten independent variables were selected to examine their influence on Good Beekeeping Practices adoption. These included a combination of continuous and categorical (dummy) variables, as summarized in Table 1.

Data analysis: The data were examined using both descriptive and inferential statistical techniques. Descriptive statistics, including the mean and standard deviation (SD), were applied to summarize and present the characteristics of the study variables. To identify the factors influencing the adoption of Good Beekeeping Practices, a binary logit regression model was employed. This approach allowed for the assessment of how socioeconomic and management variables affected the likelihood of adoption among beekeepers. The logit model is expressed as;

$$Zi = \ln [Pi/(1-Pi)] = a+b_1X_1+b_2X_2+b_3X_3+b_4X_4+b_5X_5 +b_6X_6+ b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10}+U$$

Where: Pi = Probability of adoption and non-adoption of Good Beekeeping Practices.
Pi = 1 indicates adoption
Pi = 0 indicates non-adoption
Dependent variable:
Zi = Probability of adoption of Good Beekeeping Practices

Independent variables:
X_1 = Age (Continuous); X_2 = Gender (Dummy); X_3 = Education (Dummy); X_4 =Farming experience (Continuous); X_5 = Beehives (Continuous); X_6 = Production (Continuous); X_7 = Pollination services (Dummy); X_8 = Off-farm income (Dummy); X_9 = Annual income (Continuous); X_{10} = Training (Dummy)
a = Intercept
b_1 to b_{10}= Regression coefficients of the dependent variables
U = Error term

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RESULTS AND DISCUSSION

Descriptive statistics: The descriptive statistics of variables is presented in Table 1. Results revealed that 59.6% of respondents have adopted Good Beekeeping Practices, equal to or higher than mean. The average age of respondents is 47.12 years. Among sampled respondents, 94.7% were men and 5.3% were women in the surveyed area. Only 24.6% of respondents have higher education. On average, respondents have 9.6 years of beekeeping experience. The average number of beehives owned is 68.05. The average annual honey production is 1838.1 kg. Approximately 80.7% of respondents provide pollination services. About 73.6% of households have on-farm income sources. The average annual income from beekeeping is NPR 441,105.3. Approximately 77.1% of respondents have received training in beekeeping.

Adoption status of good beekeeping practices: The survey of 57 beekeepers indicates a widespread adoption of Good Beekeeping Practices. A majority of respondents (84.2%) preferred apiary sites that were clean, open, and dry, while 80.7% selected locations that were free from pollutants yet easily accessible. Fresh running water near the apiary was considered important by 73.7% of beekeepers, and 82.5% valued the presence of windbreaks and early sunlight exposure. Similarly, 80.7% favored sites with abundant floral resources.

Proper spacing between rows and hive boxes was maintained by 73.7% of respondents, and 78.9% reported adopting general hygiene measures and conducting periodic colony inspections.84.2% people checked the colonies periodically for any abnormalities or changes in the behavior of bees. The use of smokers and protective gear was common (85.9%), although only 64.9% practiced gentle colony handling. Isolation of diseased colonies was reported by 75.4% of beekeepers. Feeding practices varied: 52.6% used honey-pollen mixtures, while 59.6% relied on sugar syrup. Artificial food was fed by 38.6% people. The use of stainless steel of food-grade plastic tools was noted among 73.7% of respondents. Migration of colonies during non-flowering periods was adopted by 70.2% and 68.4% closed hive entrance gates in the evening.

The same proportion (68.4%) managed weak colonies and avoided pesticide use during critical periods. 66.7% people managed the colonies to prevent swarming and extracted honey frequently during the season. Overall, the findings suggest a strong commitment to effective beekeeping practices, though areas such as gentle handling and specific feeding methods present opportunities for further improvement.

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Table 1. Descriptive statistics of the variables

Variable	Description	Mean	SD
Dependent variable			
Adoption	=1 if respondent adopt Good Beekeeping Practices equal to or higher than mean, 0 otherwise	0.596	0.4946
Independent variable			
Age	Age of the respondent (year)	47.12	9.70
Gender	Gender of the respondent (=1 if male, 0 female)	0.947	0.225
Education	=1 if respondent has higher education (grade 12 above), 0 otherwise	0.246	0.434
Experience	Beekeeping experience of the respondent (years)	9.61	6.67
Number of beehives	Number of beehives by the respondent	68.05	101.60
Annual production	Annual production of honey (kgs)	1838.1	3468.77
Pollination services	=1 if respondent provides pollination services ,0 otherwise	0.807	0.398
Off-farm income	=1 if household receive off-farm income,0 otherwise	0.736	0.442
Income	Annual income from beekeeping (NPR)	441105.3	709939.8
Training	=1 if respondent has received training ,0 otherwise	0.771	0.423

Source: Field Survey, 2024

Age: Age was found to have a negative and statistically significant effect on the adoption of Good Beekeeping Practices. With each additional year, the likelihood of adopting improved practices decreased by approximately 18%, indicating that older beekeepers are less inclined to embrace new management approaches. This trend may be attributed to resistance to change, reliance on established habits, and a preference for traditional methods over newer, evidence-based techniques. Furthermore, older individuals may have limited exposure to recent advancements or technologies that support modern beekeeping. Similar findings were reported by Serebrennikov et al. (2020). In this study, the average age of non-adopters was higher than that of adopters, reinforcing the observation that younger farmers are more likely to adopt innovative practices (Andaregie & Astatkie, 2021).

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Factors affecting the adoption of good beekeeping practices: Table 3 presents the factors influencing the adoption of Good Beekeeping Practices. The significant variables are discussed below:

Table 2. Good beekeeping practices among beekeepers

S.N.	Practices	Frequency (n=57)
1	Site at clean, open, dry place	48 (84.2)
2	Site away from the power station, brick kilns, highways, and train tracks but easily accessible road	46 (80.7)
3	Fresh running water available near an apiary	42 (73.7)
4	Windbreaks	47 (82.5)
5	Site receives early morning and afternoon sunshine	47 (82.5)
6	Site with rich flora nearby	46 (80.7)
7	Row to row and box to box distance is 10 and 3 feet, respectively	42 (73.7)
8	Adoption of the general colony and personal hygiene in an apiary	45 (78.9)
9	Check the colonies periodically for any abnormalities or changes in the behavior of bees	48 (84.2)
10	Use of smoker, protective dress and veil during inspection of colonies	49 (85.9)
11	Handling of colonies; gently, avoid jerks and crushing bees	37 (64.9)
12	Isolate diseased colonies from healthy ones and handle them separately	43 (75.4)
13	The mixture of honey and pollen with water to feed bees	30 (52.6)
14	Provide percent sugar syrup without mixing honey in ca lean shallow vessel and provide fresh water near a colony	34 (59.6)
15	Artificial food	22 (38.6)
16	Use of honey extractor, containers, and other tools/equipment made from stainless steel/ food grade plastic	42 (73.7)
17	Migration during non-availability of flora	40 (70.2)
18	Close the entrance gates in the evening	39 (68.4)
19	Unite weak worker colonies and control predatory wasps, ants, frogs, lizards, etc.	39 (68.4)
20	Manage the colonies to prevent swarming and extract honey frequently during the season	38 (66.7)
21	Avoid spraying of pesticides during the flowering of the crop and peak foraging time	39 (68.4)

Source: Field Survey, 2024

Note: Figure in the parentheses indicates percentage.

Number of beehives: The number of beehives showed a negative and marginally significant effect on the adoption of Good Beekeeping Practices. Each additional hive reduced the likelihood of adoption by approximately 1.7%. A larger number of hives may hinder the adoption of new practices due to resource constraints and management complexity. Beekeepers managing many colonies often prioritize maintaining existing operations rather than experimenting with innovative methods. Abeje et al. (2017) observed that older beekeepers, particularly those above 47 years, tend to maintain fewer modern hives, largely due to concerns about the challenges of colony management. This suggests that the perceived complexity of handling a greater number of hives may discourage the adoption of modern techniques. Moreover, applying time-consuming procedures across numerous colonies can be difficult, leading to slower uptake of improved management practices (Al-Ghamdi et al., 2017).

Annual production: Annual honey production exhibited a positive and marginally significant effect on Good Beekeeping Practice adoption. Higher production levels slightly increased the probability of adopting improved practices. Greater honey yields reflect stronger resource availability and financial stability, enabling beekeepers to experiment with and implement new techniques. Beekeepers with more successful operations are often more willing to inset in innovations that enhance productivity. Evidence shows that increased honey yields among those following good management practices reinforce the link between improved practices and higher output (Tubene et al., 2023). Furthermore, a positive and substantial correlation between honey production and the use of modern hives supports the view that rising output encourages the adoption of better management techniques (Affognon et al., 2015).

Off-farm income: Having an off-farm source of income significantly increased the likelihood of adopting Good Beekeeping Practices by approximately 60.9%. Off-farm income provides a stable and reliable revenue stream, enabling farmers to invest in improved management techniques for their beekeeping operations. This additional financial support allows beekeepers to overcome resource constraints and implement practices that enhance productivity and sustainability (Teferi & Wassie, 2020).

Annual income from beekeeping: Annual income from beekeeping was positively and significantly associated with Good Beekeeping Practices adoption. For each increase in income, the probability of adopting improved management practices rose by about 97.3%. Higher annual income offers financial stability, allowing beekeepers to invest in new technologies and practices. This economic cushion supports experimentation and adoption without financial risk. The findings also highlight the

differences between beekeepers and non-beekeepers in terms of skills and resource endowments, suggesting that greater revenue from beekeeping encourages the uptake of better management techniques (Abro et al., 2022).

Table 3. Logit regression analysis on factors affecting the adoption of good beekeeping practices

Variables	Coef.	St. Err.	P value	Dy /dx	St. Er (dy /dx)
Age	-0.083**	0.041	0.046	-0.180	0.009
Gender	0.311	1.401	0.824	0.071	0.330
Education	-0.454	0.827	0.583	-0.102	0.190
Experience	0.226	0.062	0.7116	0.005	0.014
Number of beehives	-0.078*	0.043	0.073	-0.017	0.008
Annual production	0.002*	0.001	0.097	0.0004	0.0003
Pollination services	-2.461	1.496	0.100	-0.370	0.145
Source of income	2.831**	1.117	0.011	0.609	0.178
Income	4.475**	2.114	0.034	0.973	0.438
Training	-0.188	0.978	0.847	-0.040	0.204
Cons	-18.567	9.731	0.056		

Summary statistics: Number of obs. = 57; LR chi2 =22.72; Prob>chi2 =0.0118; Pseudo R2 =0.2955; Log likelihood = -27.081773
Note: *, ** indicate significant at 10%, 5%, level of significance, respectively.
Source: Field Survey (2024)

CONCLUSUION

This study examined the adoption of Good Beekeeping Practices in Chitwan, Nepal, revealing a sector in transition. Overall adoption was moderate at 59.6%, with strong uptake of basic practices such as the use of protective gear, site selection, and colony hygiene. However, more advanced techniques including gentle colony handling and supplemental feeding were adopted less consistently, highlighting a gap that must be addressed to improve colony health and productivity in the long term. Logit model underscored the importance of socioeconomic factors. Annual beekeeping income and off-farm income had a strong positive influence, demonstrating that financial capacity is a key driver of adoption. In contrast, age showed a significant negative effect, suggesting generational resistance to change and reliance on traditional methods. Similarly, the number of beehives was negatively associated with adoption, indicating that scalability and management complexity can hinder consistent application of Good Beekeeping Practices in larger operations. For policymakers and development practitioners, these findings emphasize the need for economically empowering and

demographically targeted interventions. Efforts to modernize Nepal's beekeeping sector, as outlined in the Agricultural Development Strategy, should prioritize profitability, financial resilience, and tailored extension services. Supporting diversified income streams and designing hand-on programs for older beekeepers and large-scale operators will be critical. By focusing on these strategies, Nepal can accelerate the transition toward a more productive, sustainable, and commercialized beekeeping industry.

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