Journal of Natural Science Review

Vol. 3, No. 2, 2025
https://kujnsr.com
e-ISSN: 3006-7804

The Impact of Beekeeping on Small Holder Farmers' Household Income in Kandahar, Afghanistan

Shair Ahmad Hashmat[1], Qudratullah Ehsan[✉2], Sayed Mohammad Kabir Maien[3], Ali Reza Behzad[4]

[1,3,4]Department of Agricultural Economics, Faculty of Agricultural Economics and Extention, Afghanistan National Agricultural Sciences and Technology University (ANASTU), Kandahar, Afghanistan
[2]Department of Agronomy, Faculty of Plant Sciences, ANASTU, Kandahar, Afghanistan

✉E-mail: qudrat.ehsan@gmail.com, qudrat.ehsan@anastu.edu.af (corresponding author)

ABSTRACT

Beekeeping is a vital component of rural economies, significantly contributing to household income, particularly in agricultural regions. This study employed a cross-sectional survey design to analyze the impact of market outlet choices and related socioeconomic factors on beekeeping income in Kandahar, Afghanistan. A structured questionnaire was administered to 310 randomly selected beekeepers across five key districts known for honey production. The collected data were analyzed using descriptive statistics and multiple linear regression to identify significant predictors of income and assess the effectiveness of various market strategies. This study examines the relationship between beekeeping and the household income of smallholder farmers. Using a multiple regression model, data from 310 sample households distributed across four districts and Kandahar City were examined. The findings revealed a positive relationship between beekeepers' income and beekeeping factors, such as family size and work experience. The research suggests that governments, in collaboration with relevant NGOs, can encourage wholesale opportunities and strengthen ties between producers and customers to address the honey demand gap and boost beekeepers' incomes. Although this study primarily focuses on Afghanistan, its findings apply to other rural agricultural regions, demonstrating the potential of beekeeping to promote economic growth and alleviate poverty. These findings can inform programs and policies aimed at enhancing the economic resilience and sustainable livelihoods of rural populations worldwide.

ARTICLE INFO

Article history:
Received: February 8, 2025
Revised: June 04, 2025
Accepted: June 21, 2025

Keywords:

Afghanistan; Challenges; Livestock products; Opportunities; Self-sufficiency

To cite this article: Ehsan, Q., Hashmat, S. A., Maien, S. M. K., & Behzad, A. R. (2025). The Impact of Beekeeping on Small Holder Farmers' Household Income in Kandahar, Afghanistan. *Journal of Natural Science Review*, *3*(2), 76-93. https://doi.org/10.62810/jnsr.v3i2.231

Link to this article: https://kujnsr.com/JNSR/article/view/231

INTRODUCTION

Regarding the potential economic impact of beekeeping, it has been suggested that it is a non-farm, ecologically friendly commercial venture that significantly boosts both national and societal economies (Arnold et al., 1998). Afghanistan is one of the least developed

countries in the world, struggling to keep pace with the economic development of other countries. Currently, the majority of the country's population is experiencing poverty (CSO, 2009; Central Statistical Organization, 2014), with over 60-80% of the population dependent on livestock and agriculture (World Bank, 2023). Their primary sources of income, which remain unmodernized (IPC, 2019), hinder economic progress (Haidari et al., 2023; Ehsan et al., 2024). With the financial support and collaboration of international organizations and the community, the Afghan government has recently undertaken significant initiatives aimed at improving the standard of living in rural areas (Fishstein & Wilder, 2012). Beekeeping in Afghanistan is a crucial component of the country's economy (Yolchi, 2021). Beekeeping has been a long-standing tradition in Afghanistan, significantly contributing to the country's agricultural industry through honey production. Beekeeping is important for providing high-value honey as a nutritious food source and also aiding in pollination, which is essential for crop production (Khan, 2020).

Beekeeping is crucial for Afghanistan's economy as it offers financial opportunities for several rural households. Beekeepers generate honey through beekeeping, which is consumed locally and exported, earning both the beekeepers and the country money. Bees are vital for pollinating crops, which is necessary for agricultural productivity (Gul, 2023). The production and marketing processes present numerous challenges that hinder farmers' ability to generate profit. Farmers, particularly beekeepers, rely on various retailers to sell their honey products (Maletta, 2006). They sell directly from home, distribute honey to local shops, wholesalers, and contractors, and also engage in sales through branches in other provinces. To date, no research has been conducted on the value chain of honey production, nor is there clarity regarding the impact of market outlet choice in Kandahar province, despite its significance for income and rural development (Marsden, Banks, & Bristow, 2000). To this end, this research will clarify the impact of the beekeeping business and identify the optimal choices for honey market outlets that can maximize income for smallholder farmers and enhance rural development in Kandahar province(Chantawannakul & Ramsey, 2018).

The results of this research will assist the government and NGOs in addressing the market issue of produced honey, which has encountered challenges in getting and remaining unsold since last year. The findings will facilitate future research in the field to address similar difficulties concerning other items. This research focuses on economically disadvantaged rural populations to identify appropriate market outlets that can enhance their income levels. The government and NGOs have provided beekeepers with tools, training, and certain extension services. However, they engage less in marketing and assisting the recipients of their honey projects to maximize the benefits of these operations (FAO, 2022; UNHCR, 2024). In rare instances, certain beekeepers are merely dispatched to participate in agricultural shows in the capital, Kabul. It is also significant that the beekeeping sector has received limited academic attention regarding its challenges and issues (Martínez-López et al., 2022). This research addresses the optimal marketplace selection for honey production and initiates a novel trend in empirically examining local issues from an academic

perspective. In some districts, beekeeping constitutes a significant source of income (Department of Agriculture & Livestock, 2020).

Furthermore, many farmers in Kandahar have limited formal education, which may hinder their ability to make informed decisions about beekeeping and its marketing. Providing farmers with education and training in beekeeping techniques, marketing strategies, and financial management can enhance their capacity to address challenges that adversely affect their beekeeping income. The market for honey and associated items in Kandahar is highly competitive due to the extensive production by numerous beekeepers (Abidullah et al., 2023).

Although Afghanistan is the primary focus of this study, its conclusions apply to other developing countries with similar rural and agricultural contexts. Beekeeping can serve as a viable alternative or supplementary source of income for smallholder farmers, particularly in regions such as Sub-Saharan Africa, Southeast Asia, and parts of Latin America, where agriculture forms the backbone of livelihoods. The successful application of these findings in other countries depends on the implementation of appropriate market structures that enable farmers to access fair and stable markets. Additionally, tailored training programs are crucial for equipping beekeepers with modern techniques, marketing skills, and financial management expertise. Furthermore, financial support systems such as microcredit, subsidies, or grants can facilitate Access to beekeeping equipment and inputs. By integrating these elements, rural economies can leverage beekeeping to enhance income diversification, improve food security, and promote sustainable development at both local and national levels.

Theoretical Framework

Multiple studies have shown that several countries, particularly wealthier ones, have successfully harnessed the economic and environmental benefits of profitable beekeeping and honey production. Beekeeping benefits farming communities worldwide by pollinating crops and enhancing yields of pollinator-dependent crops, thereby supporting agricultural production. Bees' pollination Globally, services are valued at USD 215 billion annually (Qazizada et al., 2021). Stakeholders do not sufficiently understand the benefits of bees and beekeeping; therefore, the potential of beekeeping in developing countries is often overlooked in development activities (Ahmad et al., 2017). For example, Moore and Kosut (2013) found that, in Africa, beekeeping serves as an additional source of income for households, just as it does in Europe. Given this, it would be reasonable to say that industrialized economies now prioritize development above poverty alone. Thus, these economies are capable of increasing apiculture investment, standardizing apiculture techniques, advancing agriculture to a scientific level, and diversifying honey products to realize the economic and environmental benefits of beekeeping fully. (Bingen et al., 2003). The field of agricultural economics has been keen on the connection between household income and beekeeping, particularly in developing countries where alternative income options may be limited (Čavlin et al., 2023).

Throughout the world, beekeeping has been recognized as a practical method of diversifying one's income source, helping farmers increase their earnings (Magesa et al., 2014). Another challenge caused by geography is the process of market integration. They encounter challenges in accessing foreign markets by establishing connections with lead enterprises, struggle to maintain vertical linkages and find interventions unsatisfactory. Additionally, several specific characteristics positively influence the quantity of marketable honey, which in turn affects beekeepers' income (Magesa et al., 2014). By pollinating crops not only does it increase crop production, but it also directly generates income through the sale of honey and other bee products. However, differing approaches and conflicting data in the literature have made it challenging to assess its precise effect on household income (Gul, 2023).

The dependent variable in this study is income, which represents the total earnings a beekeeper generates from their beekeeping activities, including honey production, sales, and other related ventures. Several factors influence income and serve as the primary outcome that the study aims to explain. The independent variables are the factors that potentially affect the income of beekeepers. Key factors influencing a beekeeper's income include honey quantity, investment in equipment and inputs, years of experience, Access to extension services, membership in associations, land and household size, education level, and the gender and age of the household head. These variables collectively affect productivity, decision-making, and Access to resources. The objectives of this study are:

- To investigate the influence of beekeeping on the income of smallholder farmers in Kandahar, Afghanistan.
- To support government and NGO initiatives in improving the marketing and economic impact of beekeeping projects.
- To evaluate the potential of beekeeping as a sustainable livelihood option in similar agricultural contexts in developing countries.
- To contribute to policy recommendations for strengthening rural economic resilience through beekeeping.

METHODS AND MATERIALS

The study was conducted in Kandahar province, Afghanistan, at an elevation of around 1,010 meters (3,314 feet) above sea level. The community is situated near the confluence of the Arghandab and Daman rivers, and the surrounding area is characterized by limited vegetation and semi-desert topography. Summers are scorching, and winters are pleasant in this dry climate. Geographical factors have significantly impacted the region's agricultural practices, particularly in the production of fruit crops, wheat, and corn. Poppy planting, which has historically been a significant agricultural activity in the area, has also gained significance.

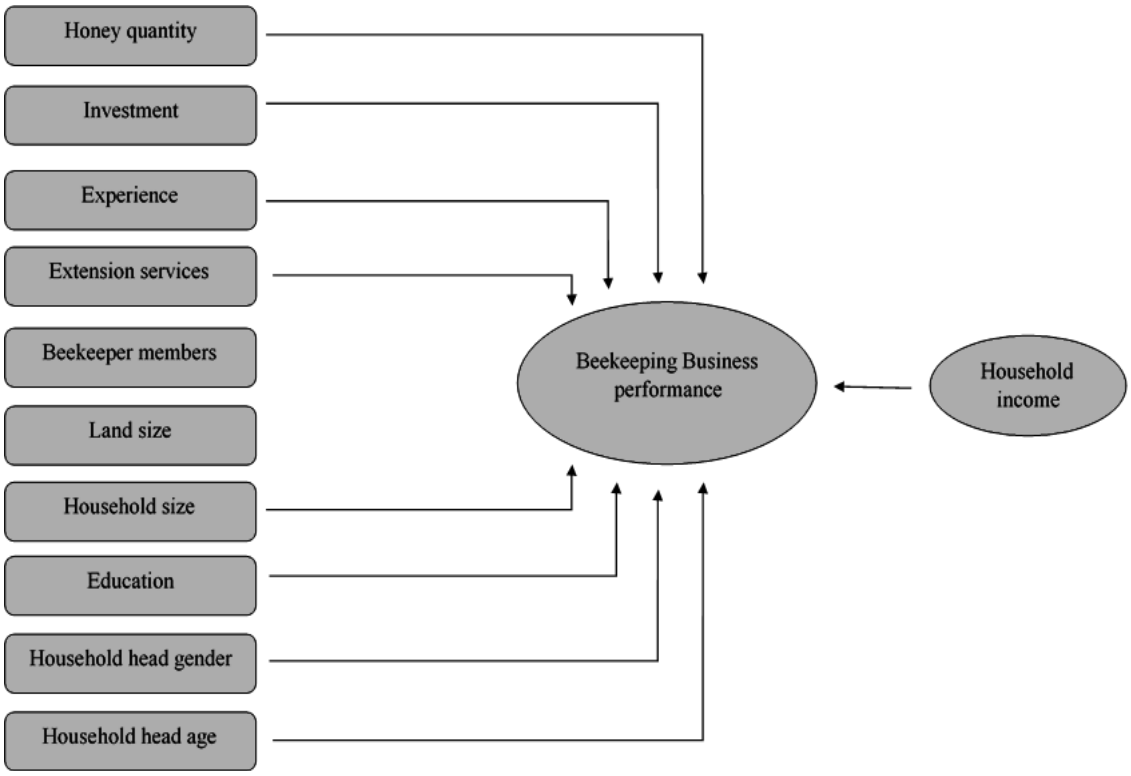

Figure 1. *Conceptual Framework*

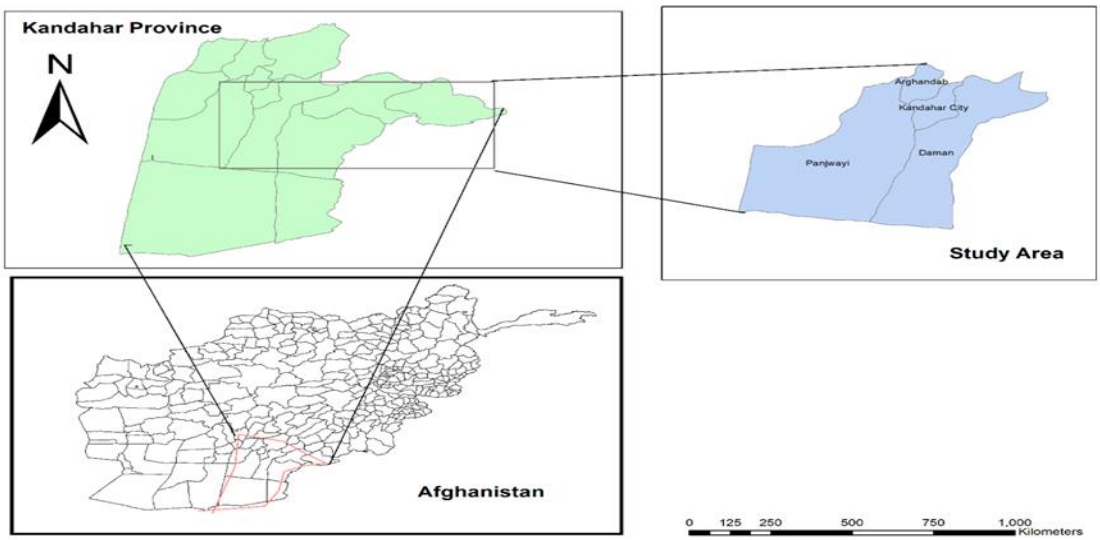

Figure 2. *Study Area Map*

This study primarily relies on initial quantitative data. The collected data consists of measurable variables related to household income, family size, beekeeping experience, and market accessibility. These data types are suitable for statistical analysis, especially for the multiple regression models applied in the research. Since the focus is on investigating the influence of beekeeping on smallholder farmers' income, the data is numeric and derived directly from the field rather than secondary sources. Data was directly collected from respondents using structured questionnaires, and the information collected is numerical, making it suitable for regression analysis and other statistical tools.

Data Sources

The source of data for this study is smallholder beekeepers in Kandahar province, Afghanistan, specifically in areas known for high honey production. The province has 17 districts, of which approximately eight are considered suitable for honey production (Haidari et al., 2022). Based on expert judgment and regional importance, four districts and Kandahar city were selected for sampling: Kandahar city and the four districts of Dand, Daman, Panjwai, and Arghandab. These regions collectively contribute to more than 50% of Kandahar's honey production, making them a representative sample for the study. To determine the number of respondents, the Yamane (1967) formula was used for sample size calculation: $N = \frac{N}{1+N(e^2)}$

Where: n = required sample size, N = total beekeeper population in the study area (1500), and e = desired level of precision (0.05)

The sample size was approximately finalized at 310 respondents, accounting for any missing or improperly completed questionnaires.

Data Collection

The data collection process employed a multistage sampling method and utilized structured questionnaires to ensure consistency and relevance. The following steps were taken: District Selection: Out of the 17 districts in Kandahar, five regions were purposively selected based on their high involvement in honey production. Village Selection: Within each selected district, villages were randomly chosen to ensure fair representation and avoid selection bias. Respondent Selection: Individual beekeepers were selected from the sampled villages. The inclusion criteria focused on those actively involved in beekeeping during the study year (2022). Instrument Used: A structured questionnaire was designed to collect data on various aspects, including Household income from beekeeping, Beekeeping experience, Family size and labor availability, Access to markets, and extension services. Data Collection Period: The data was collected during August 2022, which aligns with the active beekeeping season in Kandahar. Data Quality Assurance: The sample size was slightly overestimated to 310 to account for potential issues such as non-response or improperly completed forms.

A total of 310 questionnaires were randomly collected and fully utilized for analysis. The distribution of respondents across the sampled areas is as follows: Kandahar City – 61 respondents, Dand – 62 respondents, Panjwai – 62 respondents, Daman – 62 respondents, and Arghandab – 63 respondents, totaling 310 respondents. These districts are well known for their beekeeping activities in Kandahar Province. Beekeepers, producers, and government employees were surveyed using both structured and semi-structured questionnaires to gather the primary data. Key informant interviews and concentrated group discussions with traders have been conducted to gather additional supporting data and information during the preparation of the questionnaire. Officials and producers were consulted to enhance the credibility of the questionnaire. The interviewees' socioeconomic and demographic details, as well as the factors that influence beekeeping, were recorded

using a standardized questionnaire. To get the most accurate data from the field while streamlining and expediting the procedure, we have chosen data collectors from the citizens of the aforementioned districts.

Model Specification and Estimation Techniques

To achieve the goals of this study, a multiple regression model and correlation test were developed, followed by a thorough analysis and interpretation of the results. The purpose of this is to minimize the sum of squared errors or deviations between the actual observation and the expected observation. Consequently, this will decrease the disparity between the observed regression line and the estimated regression line. The collected data will undergo analysis utilizing both descriptive statistics and econometric analytic methods. The data was analyzed using STATA version 13, employing the descriptive statistics approach. Descriptive statistics are employed to examine the data gathered, utilizing charts, percentages, and frequencies.

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\cdots+\beta_kX_k+\epsilon \quad \ldots\ldots 2$$

Where: Y is the dependent variable (predict).

β_0 is the intercept term.

$\beta_1, \beta_2, \beta_3, \beta_k$ are the coefficients for each independent variable.

$X_1, X_2, X_3 \ldots, X_k$ are the independent variables.

ϵ is the error term (residuals).

FINDINGS

This section is divided into two parts to present the empirical findings of the study. Initially, the descriptive statistics are presented, followed by the results of the Multiple Regression Model. To begin with, the descriptive statistics for the variables are presented in Table 1. As is clear, the table shows the mean, standard deviation, minimum, and maximum values for each variable. Refer to Table 1 for further details.

Table 1: *Descriptive Statistics of Variables Used in Analysis*

Variables	Obs	Mean	Std. Dev.	Min	Max
Honey Quantity	310	630.9806	62.60411	450	800
Investment	310	4473.829	547.7102	3400	6500
Experience	310	20.00645	2.335866	10	38
Extensions service	310	1.229032	0.4208894	1	2
Beekeeper member	310	2.180645	0.3853459	2	3
Land size	310	19.33548	1.86182	12	25
Households size	310	7.616129	1.565526	4	12
Education	310	2.26129	0.8161705	1	4
Hhh, gender	310	1.009677	.098055	1	2
Hhh, age	310	45.23871	8.763401	19	65

Source: Field survey

Table 1 above demonstrates the utilization of 10 variables in this study. The dependent variable is the performance of the beekeeping business. In contrast, the independent factors include Quantity of honey, Investment, Experience, Extension services, Number of beekeepers, Land area, Household size, educational attainment, Gender of the household, and Age of the household. The study examines the impact of these factors on the performance of beekeeping businesses in Kandahar province.

Table 2 categorizes household sizes as 4–6 people, 7–10 people, and more than 10 people, and income ranges as $2,001–$ 3,000, $3,001–$ 4,000, and above $4,001.

***Table 2**: Beekeeping income in different household size Crosstabulation*

		Household Size Category						Total	
		4 - 6		7 - 10		Above 10			
		N	%	N	%	N	%	N	%
Household Income Category	2001 USD - 3000 USD	3	3.9	16	6.9	0	0.0	19	6.1
	3001 USD - 4000 USD	36	46.8	63	27.2	0	0.0	99	31.9
	Above 4001 USD	38	49.4	153	65.9	1	100.0	192	61.9
Total		77	100.0	232	100.0	1	100.0	310	100.0

Source: Field survey

Among households with 4–6 members, the majority (49.4%) earn above $4,001. Similarly, in households with 7–10 members, 65.9% fall into the highest income bracket. These figures suggest a positive relationship between household size and income level, with larger households generally earning more.

Table 3 below describes beekeeping income in different land sizes in the research area, with varying incomes.

***Table 3:** Annual income in different land sizes in different districts crosstabulation*

		Household Size Category						Total	
		4 - 6		7 - 10		Above 10			
		N	%	N	%	N	%	N	%
Annual Income Category	2001 USD - 3000 USD	3	3.9	16	6.9	0	0.0	19	6.1
	3001 USD - 4000 USD	36	46.8	63	27.2	0	0.0	99	31.9
	Above 4001 USD	38	49.4	153	65.9	1	100.0	192	61.9
Total		77	100.0	232	100.0	1	100.0	310	100.0

Source: Field survey

Land size category size is 1-10, 11-20.21-30, 31-40; the first category is just one household that has 10 acres which the household income is 2000 USD; the second category households who are 183 income annually is 2000USD to 3000USD, the third category households the number is 94 households' income annually is 3000USD to 4000 USD the fourth category household which the number is four households the income is above 4000 USD.

Table 4 below describes the annual income at the districts level.

Table 4: *District name * Annual Income Category Crosstabulation*

		Annual Income Category						Total	
		2001 - 3000 USD		3001 - 4000 USD		Above 4001			
		N	%	N	%	N	%	N	%
District Name	City	4	21.1	30	30.3	27	14.1	61	19.7
	Dand	7	36.8	31	31.3	24	12.5	62	20.0
	Daman	6	31.6	27	27.3	29	15.1	62	20.0
	Panjwai	2	10.5	8	8.1	52	27.1	62	20.0
	Arghandab	0	0.0	3	3.0	60	31.3	63	20.3
Total		19	100.0	99	100.0	192	100.0	310	100.0

Source: Field survey

The Kandahar city beekeeper's household income respondent's sample size is 61, with household incomes ranging from 2000 to 3000 USD. The second district is Dand, and the respondent's sample size is 62. The beekeeper's household income annually is 3000USD to 4000USD the third district is Daman, the respondent's number sample size is 62 beekeeper's household income is 3000USD to 4000USD from beekeeping the fourth district is Panjwai the respondent's number sample size is 62 the household income annually is from 3000 to 4000USD the fifth district is Arghandab the respondent's number sample size is 63 whose annual income was above 4000 USD.

Table 5 below present's data indicating that nearly all initial investments in the beekeeping business, approximately $3,500, exhibit minor variation and lack significant outliers.

Table 5: *Initial investment cash in the beekeeping business*

N	310
Missing value	0
Mean	3615.16
Std. Error of Mean	7.662
Median	3500.00
Mode	3500
Std. Deviation	134.907
Variance	18199.812
Skewness	.345
Std. Error of Skewness	.138
Kurtosis	-1.833
Std. Error of Kurtosis	.276
Range	300
Minimum	3500
Maximum	3800
Sum	1120700

Source: Field survey

The standard error of the mean is low ($7.662), suggesting that the sample mean is a reliable estimate of the population mean. The median investment is $3,500, slightly lower than the

mean, indicating a right-skewed distribution. The mode is also $3,500, making it the most frequently occurring investment amount. The standard deviation of $134.91 reflects low variability, suggesting that most investment amounts are close to the average. The variance, calculated at $18,199.81, indicates the dispersion of the data in squared units. A skewness value of 0.345 confirms a mild right skew, while a kurtosis value of -1.833 signifies a platykurtic distribution—characterized by lighter tails and a flatter peak—indicating reduced susceptibility to outliers. Overall, the data demonstrates a stable and consistent range of initial investments, predominantly clustered between $3,500 and $3,800. The total investment across the 310 enterprises amounts to $1,120,700, highlighting the substantial capital involvement in this sector.

Table 6 summarizes beekeeping activities and financial results for 310 participants.

Table 6: *Beekeeping activities and financial outcomes*

	Sold kg ($)	In 2023 harvested honey	Harvested per beehive per season (2023)	Harvested this season (2023)	Annual cost beekeeping ($)	Annual income from beekeeping ($)
Mean	16.75	3.46	18	406.48	2684.18	4709.01
Std. Error of Mean	0.213	0.035	0.139	3.48	412.433	74.523
Median	20	3	20	415	1900	4300
Mode	20	3	20	430	1500	6300
Std. Deviation	3.745	0.615	2.453	61.28	7261.628	1312.105
Variance	14.04	0.379	6.019	375	527	1314
Skewness	-0.357	0.316	-0.41	0.466	10.862	0.686
Std. Error of Skewness	0.138	0.138	0.138	0.138	0.138	0.138
Kurtosis	-1.785	-0.227	-1.844	0.705	127.429	0.198
Std. Error of Kurtosis	0.276	0.276	0.276	0.276	0.276	0.276
Range	8	3	5	370	99500	7650
Minimum	12	2	15	230	500	2250
Maximum	20	5	20	600	100000	9900
Sum	5194	1073	5580	126010	832095	1459793

Source: Field survey

The data indicates that the majority of beekeepers are effective and prolific; however, the median is lower than the mean in several areas, suggesting that a small number of high-performing beekeepers increase the average. The mean yearly expense was $2,684.18, with a range from $500 to $100,000. This diverse range suggests that the majority of beekeepers experience minimal operating costs, whereas a minority may face elevated expenses owing to expansion, equipment acquisition, or unforeseen losses (Table 6). The disparity between the mean annual revenue and the mean expenditure indicates that beekeeping is often profitable for the average participant.

Table 7: *Correlation Matrix of coefficients of variables*

Income	Pearson Correlation	1	.755**	.472**	.548**	.589**	.413**	.855**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000
	N	310	310	310	310	310	310	310
investment	Pearson Correlation	.755**	1	.546**	.481**	.436**	.469**	.677**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000
	N	310	310	310	310	310	310	310
extensions service	Pearson Correlation	.472**	.546**	1	.241**	.275**	.318**	.445**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000
	N	310	310	310	310	310	310	310
Land size	Pearson Correlation	.548**	.481**	.241**	1	.422**	.367**	.481**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000
	N	310	310	310	310	310	310	310
Experience	Pearson Correlation	.589**	.436**	.275**	.422**	1	.270**	.555**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000
	N	310	310	310	310	310	310	310
Age	Pearson Correlation	.413**	.469**	.318**	.367**	.270**	1	.341**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000
	N	310	310	310	310	310	310	310
Honey quantity	Pearson Correlation	.855**	.677**	.445**	.481**	.555**	.341**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	
	N	310	310	310	310	310	310	310
Beekeeper members		.755**	1	.546**	.481**	.436**	.469**	.677**
Pearson Correlation		.000		.000	.000	.000	.000	.000
Sig. (2-tailed)		310	310	310	310	310	310	310
Households size		.413**	.469**	.318**	.367**	.270**	1	.687**
Pearson Correlation		.000	.000	.000	.000	.000	310	.000
Sig. (2-tailed)		310	310	310	310	310		310
Education		.313**	.489**	.418**	.387**	.370**		.467**
Pearson Correlation		.000	.000	.000	.000	.000	1	.000
Sig. (2-tailed)		310	310	310	310	310	310	310
hhhgender		.589**	.469**	.318**	.367**	.270**	.467**	.270**
Pearson Correlation		.000	.000	.000	.000	.000	.000	.000
Sig. (2-tailed)		310	310	310	310	310	310	310
hhhage		.370**	.489**	.318**	.367**	.418**		
Pearson Correlation		.000	.000	.000	.000	.000		
Sig. (2-tailed)		310	310	310	310	310		

**. Correlation is significant at the 0.01 level (2-tailed).

The matrix shows the relationships between important elements that affect honey production, including land size, experience, investment, and income, all of which have strong positive correlates with income (Table 7). The connections indicate that economic resources and beekeeping skill are significant factors in honey production outcomes.

Table 8: *Multiple Regression Model*

Source	SS	df	MS	Number of obs	= 310
				F (10, 299)	= 87.59
Model	402894339	10	40289433.9	Prob > F	= 0.0000
Residual	137532032	299	459973.351	R-squared	= 0.7455
				Adj R-squared	= 0.7370
Total	5404426371	309	1748952.66	Root MSE	= 678.21
Income	Coefficient	Std. Err.	t	P> |t|	
Honey quantity	16.71564	0.85	19.66	0.000	
Investment	0.0720079	0.07	9.93	0.000	
Experience	54.43795	20.99	2.59	0.001	
Extension service	127.3617	164.43	12.77	0.000	
Beekeeper member	100.3991	169.51	17.59	0.000	
Land size	33.5167	25.63	16.31	0.000	
Household size	28.23309	26.16	13.08	0.000	
Education	49.6421	48.64	19.02	0.000	
Hhh gender	3.2311	397.05	17.33	0.000	
Hhh age	2.440552	5.16	14.47	0.000	
_cons	701.0036	825.95	16.85	0.000	

Source: Field survey

Beekeeper income is influenced by various independent factors in the regression study above. It is evident from Table 8. The model's 10 predictors include honey quantity, investment, experience, extension service, beekeeper membership, land size, family size, education, household head gender, and age. Honey production increases revenue with high confidence (p-value = 0.000), according to the coefficient for honey quantity (16.71564). Investment (coefficient = 0.0720079) also has a positive and substantial effect on income, indicating that financial input contributes to increased income. As shown by their considerable coefficients, experience, and extension services are also matters of concern, as the regression study reveals (54.43795 and 127.3617, respectively). Higher revenues are associated with beekeeping group membership (coefficient = 100.3991) and larger land area (coefficient = 33.5167), demonstrating the importance of communal efforts and resource availability. Household size (28.23309) and education (49.6421) also increase income, highlighting the importance of family labor and education. Demographic characteristics may also affect household head income, as gender (3.2311) and age (2.440552) have a significant impact on income. The model's R-squared value of 0.7455 indicates that these variables explain 74.55% of the variance in beekeepers' income, suggesting an excellent fit and highlighting their combined relevance to financial results (Table 8).

DISCUSSION

Beekeeping income is influenced by a range of factors, including honey yield, investment, experience, Access to extension services, cooperative membership, land size, household size, education, and various socioeconomic variables. These findings align with prior research on the determinants of agricultural income, particularly in beekeeping. For example, Taktakidze (2024) revealed that production and profitability in beekeeping improved with the adoption

of modern technology and better management practices. Similarly, Mosisa and Hordofa (2024) determined that investments in updated equipment significantly increased beekeepers' incomes, underscoring the critical role of financial capital in enhancing productivity.

Experience also emerged as a key factor. Studies by Shah et al. (2021) and Ehsan et al. (2017) demonstrated a positive correlation between agricultural productivity and experience, concluding that seasoned beekeepers adopt more efficient practices. Vercelli et al. (2021) supported this finding by demonstrating that experienced beekeepers managed challenges more effectively, resulting in better financial outcomes. Our results confirm these findings, highlighting that experience enhances operational productivity and, in turn, income potential.

In terms of extension services, Landaverde et al. (2023) established that educating beekeepers about pest control, advanced techniques, and marketing led to increased productivity. Their findings are reinforced by studies in Kenya, where extension programs enhanced crop yields and income (Landaverde et al., 2023). Consistently, our study shows that Access to extension services directly improves beekeeping practices, thereby increasing income. Participation in cooperatives also plays a crucial role. According to Abro et al. (2022) and Behzad et al. (2023), such memberships provide beekeepers with resources and market access. Khushwaha (2021) emphasized that collective marketing and shared resources through cooperatives enhanced farmers' earnings. Our findings revealed a positive and significant association between cooperative involvement and increased income, indicating that shared platforms amplify financial outcomes.

Land size was another critical variable. Landaverde et al. (2023) found that greater land access allowed for better forage sources and more colonies, thereby raising production. Helfand and Taylor (2021) also noted that land size correlates positively with agricultural productivity, although its impact can be context-dependent. Our study reinforces this view, demonstrating that larger landholdings are associated with higher beekeeping income.

Household size was also found to have a favorable influence. Giller et al. (2021) found that in farming households, larger families often contribute more labor, which in turn improves productivity. In alignment with our results, larger households can support labor-intensive beekeeping activities, resulting in increased output and earnings.

Education was also significant. Mulatu et al. (2021) revealed that more educated beekeepers are better equipped to apply modern techniques, resulting in higher incomes. Our findings supported this, showing that education improves both technical knowledge and financial decision-making, which in turn elevates income.

Demographic factors also showed some influence. Brannen and Wilson (2023) found that male-headed households typically had higher earnings, likely due to better Access to resources. Similarly, Kabeer (2021) concluded that older beekeepers earned more, presumably due to greater experience. Although our study confirmed these trends, the

relatively small coefficients for gender and age suggest that their effects are less pronounced than those of productivity-related factors, such as honey output and experience.

While our cross-sectional analysis provides meaningful insights, it has limitations. Establishing causality remains challenging. Longitudinal studies could help clarify how these variables impact income over time. Additionally, further research incorporating market access, climate variability, and technology adoption would offer a more comprehensive picture of the determinants of beekeeping income.

CONCLUSION

This study examined the impact of beekeeping on the household incomes of smallholder farmers in Kandahar, Afghanistan, with a focus on four districts and Kandahar City—areas characterized by favorable conditions for honey production. The research revealed that beekeeping is a viable pathway for promoting sustainable livelihoods in rural regions. While the findings are specific to Kandahar, they offer valuable insights that can be applied to other regions with similar socioeconomic and agricultural conditions.

The analysis revealed that several key socioeconomic variables have a significant impact on the success of beekeeping and its contribution to household income. These include family size, investment in beekeeping, beekeeping experience, Access to extension services, education levels, and institutional support from government and NGOs. The statistical significance of these factors (p-value < 0.000) underscores their importance in designing effective beekeeping interventions.

Despite its potential, the beekeeping sector in Kandahar faces multiple challenges that must be addressed through further research and structured support from the government and non-governmental organizations (NGOs). A deeper understanding of the beekeeping ecosystem, both locally and globally, is essential for crafting strategies that enhance the sustainability, productivity, and profitability of beekeeping enterprises. Such strategies can be adapted and implemented in similar rural contexts around the world, especially in areas affected by poverty, climate change, food insecurity, and limited Access to financial capital.

RECOMMENDATIONS

Based on the findings, several key recommendations are proposed to enhance beekeeping as a sustainable and profitable livelihood for smallholder farmers. First, capacity building should be prioritized through continuous training programs on modern practices, pest management, and post-harvest handling. Equally important is improving Access to modern beekeeping equipment and technology via subsidies, grants, or microfinance, which can enhance productivity and honey quality. Strengthening market access through cooperatives, producer associations, and partnerships with buyers is essential to ensure fair pricing and bridge the honey market gap. The role of government and NGOs is also critical in developing supportive policies, infrastructure, and targeted programs to address marketing and logistical constraints in the honey value chain.

Furthermore, localized research and innovation tailored to regional conditions can generate practical solutions for improving production. Financial inclusion initiatives, such as investment incentives, insurance, and Access to credit, can help mitigate risk for beekeepers during economic challenges. Community engagement through awareness campaigns and education can promote beekeeping as a viable income source. Lastly, promoting environmental conservation by planting bee-friendly flora and implementing reforestation efforts supports both ecological sustainability and honey production. Establishing robust monitoring and evaluation systems will ensure the effectiveness and continual improvement of beekeeping initiatives.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the Department of Agricultural Economics, Faculty of Agriculture, ANASTU University, for academic and institutional support. Sincere thanks go to the beekeepers of Kandahar Province, local authorities, and NGOs for their cooperation and valuable insights. Appreciation is extended to the reviewers of the Kabul University Journal of Natural Science Review for their constructive feedback, as well as to my family and colleagues for their ongoing support.

FUNDING INFORMATION

No funding is available for the manuscript.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

Abidullah, S., Rauf, A., Zaman, W., Ullah, F., Ayaz, A., Batool, F., & Saqib, S. (2023). Consumption of wild food plants among tribal communities of Pak-Afghan border, near Bajaur, Pakistan. *Acta Ecologica Sinica*, *43*(2), 254–270. https://doi.org/10.1016/j.chnaes.2021.08.002

Abro, Z., Kassie, M., Tiku, H. A., Taye, B., Ayele, Z. A., & Ayalew, W. (2022). The impact of beekeeping on household income: evidence from north-western Ethiopia. *Heliyon*, *8*(5). E- https://doi.org/10.1016/j.heliyon.2022.e09492

Ahmad, T., Shah, G. M., Ahmad, F., Partap, U., & Ahmad, S. (2017). Impact of Apiculture on the Household Income of Rural Poor in the Mountains of Chitral District, Pakistan. *Journal of Social Sciences (COES&RJ-JSS)*, *6*(3), 518-531. https://doi.org/10.25255/jss.2017.6.3.518.531

Arnold, J. E. M., & Ruiz Pérez, M. (1998). The role of non-timber forest products in

conservation and development. *Incomes from the forest: Methods for the development and conservation of forest products for local communities*, 17-42. https://doi.org/10.25255/jss.2017.6.3.518.531

Behzad, A. R., Baryalai, A., & Ehsan, Q. (2023). Assessment of Organic Household Wastes Management System and its Impact on the Improvement of Home Economics in Kandahar-Afghanistan. *International Journal of Advances in Agricultural Science and Technology*, *10*(7), 1-12. https://ijaast.org/index.php/ijaast/article/view/143

Bingen, J., Serrano, A., & Howard, J. (2003). Linking farmers to markets: different approaches to human capital development. *Food policy*, *28*(4), 405-419. https://doi.org/10.1016/S0306-9192(03)00063-0

Brannen, J., & Wilson, G. (Eds.). (2023). *Give and take in families: Studies in resource distribution*. Taylor & Francis. https://doi.org/10.4324/9781003409786

Čavlin, M., Prdić, N., Ignjatijević, S., Vapa Tankosić, J., Lekić, N., & Kostić, S. (2023). Research on the determination of the factors affecting business performance in beekeeping production. *Agriculture*, *13*(3), 686. https://doi.org/10.3390/agriculture13030686

Chantawannakul, P., & Ramsey, S. (2018). The overview of honey bee diversity and health status in Asia. *Asian beekeeping in the 21st century*, 1-39. https://doi.org/10.1007/978-981-10-8222-1_1

Ehsan, Q., Rana, D. S., & Choudhary, A. K. (2017). Effect of crop establishment methods and phosphorus nutrition on growth and productivity of mungbean (Vigna radiata L. Wilczek) in semi-arid Afghanistan. *Annals of Agricultural Research*, *38*(2). Link

Ehsan, Q., Amini, M. Y., Obaid, H., Zaryal, K., Nazir, R., Fazil, K., & Serat, W. A. (2024). Yield and economics response of two cultivars of mungbean (Vigna radiata L.) to different potassium levels. *ESRJ*, *1*(1), 164-177. https://esrj.edu.af/esrj/article/view/50

Ferris, S., Robbins, P., Best, R., Seville, D., Buxton, A., Shriver, J., & Wei, E. (2014). Linking smallholder farmers to markets and the implications for extension and advisory services. *MEAS Brief*, *4*(10), 13-14. Link

Fishstein, P., & Wilder, A. (2012). Winning hearts and minds? Examining the relationship between Aid and Security in Afghanistan. *Feinstein International Center, Tufts University, Medford, MA*, *50*. Link

Food and Agriculture Organization (FAO). (2022). *Beekeeping to diversify livelihoods*. Retrieved from . Link

Giller, K. E., Delaune, T., Silva, J. V., van Wijk, M., Hammond, J., Descheemaeker, K., ... & Andersson, J. A. (2021). Small farms and development in sub-Saharan Africa: Farming for food, for income or lack of better options? *Food Security*, *13*(6), 1431-1454. https://doi.org/10.1007/s12571-021-01209-0

Gul, S. (2023). Exploring the honey value chain among Afghan refugees in Pakistan. *Journal of Business and Management Research*, *2*(2), 828-859. Link

Haidari, A. J., Jamshid Furogh, M., Kunduzi, M. O., & Aanwari, G. (2023). Primary factors of lack of economic development in Afghanistan. *International Journal of Social Science Research and Review*, *6*(2), 1-12. https://doi.org/10.47814/ijssrr.v6i2.803

Helfand, S. M., & Taylor, M. P. (2021). The inverse relationship between farm size and productivity: Refocusing the debate. *Food Policy*, *99*, 101977. https://doi.org/10.1016/j.foodpol.2020.101977

Kabeer, N. (2021). Gender equality, inclusive growth, and labor markets. *Women's economic empowerment*, *44*, 13-48. https://doi.org/10.4324/9781003178231-2

Kata, W. (2019). *Estimating the Contribution of Beekeeping to Household Wellbeing and Conservation Motivations in the Tanzanian Miombo* (Doctoral dissertation, Bangor University (United Kingdom)). Link

Khan, K., & Ghramh, H. A. (2020). Beekeeping in Pakistan (history, potential, and current Status). *Preprints*, 2020070503. https://doi.org/10.20944/preprints202007.0503.v1

Khan, N., & Khan, W. (2018). Review of past literature of honey beekeeping and its production in rural areas of the world. *Food Science and Quality Management*, *74*(6), 18-23. Link

Khushwaha, R. Farmer Cooperatives and Collective Marketing. In *Agribusiness Management* (pp. 162-183). Routledge. https://doi.org/10.4324/9781003139843-11

Landaverde, R., Rodriguez, M. T., & Parrella, J. A. (2023). Honey production and climate change: Beekeepers' perceptions, farm adaptation strategies, and information needs. *Insects*, *14*(6), 493. https://doi.org/10.3390/insects14060493

Magesa, M. M., Michael, K., & Ko, J. (2014). Access to agricultural market information by rural farmers in Tanzania. https://doi.org/10.1002/j.1681-4835.2015.tb00473.x

Maletta, H. E. (2006). Sources of household income in rural Afghanistan. *Available at SSRN 899806*. https://doi.org/10.2139/ssrn.899806

Martínez-López, V., Ruiz, C., & De la Rúa, P. (2022). Migratory beekeeping and its influence on the prevalence and dispersal of pathogens to managed and wild bees. *International Journal for Parasitology: Parasites and Wildlife*, *18*, 184-193. https://doi.org/10.1016/j.ijppaw.2022.05.004

Meaza, G. B. (2010). *Socioeconomic analysis of market-oriented beekeeping in Atsbi Wemberta District of Eastern Zone, Tigray Region* (Doctoral dissertation, The Institute of Development Studies and Partner Organisations). Economic_Analysis_of_Market_Oriented_Beekeeping_in_Atsbi_Wemberta_District_of_Eastern_Zone_Tigray_Region/26443144/1/files/48091111.pdf

Moore, L. J., & Kosut, M. (2013). Buzz: Urban beekeeping and the power of the bee. In *Buzz*. New York University Press. https://doi.org/10.18574/nyu/9780814763070.001.0001

Mosisa, T. D., & Hordofa, D. F. (2024). The impact of improved beehive technology adoption on rural household income, consumption expenditure, and asset wealth in Wonchi districts, Ethiopia. *Discover Global Society*, *2*(1), 33. https://doi.org/10.1007/s44215-023-00036-1

Mulatu, A., Marisennayya, S., & Bojago, E. (2021). Adoption of Modern Hive Beekeeping Technology: The Case of Kacha-Birra Woreda, Kembata Tembaro Zone, Southern Ethiopia. *Advances in Agriculture*, *2021*(1), 4714020. https://doi.org/10.1155/2021/6694284

Qazizada, M. R., Maqsodi, A. M., Sahibzada, S. K., & Gouhari, S. (2021). Sustainable Management of Nonwood Forest Products for Rural Livelihoods in Afghanistan. *Nonwood and Livelihood: Sustainable Management of Nonwood Forest Products for Rural Livelihoods in South Asia. SAARC Agriculture Centre, SAARC, Dhaka, Bangladesh, 166p*, 19. Link

Shah, K. K., Modi, B., Pandey, H. P., Subedi, A., Aryal, G., Pandey, M., & Shrestha, J. (2021). Diversified crop rotation: an approach for sustainable agriculture production. *Advances in Agriculture*, *2021*(1), 8924087. https://doi.org/10.1155/2021/8924087

Taktakidze, V. (2024). Economic Effects of Introduction of Modern Technologies in Beekeeping. *Globalization and Business*, *9*(17), 120-128. https://doi.org/10.35945/gb.2024.17.011

UNHCR. (2024). *Harvesting honey in Afghanistan raises hopes for a sweeter future*. Retrieved from Link

Vercelli, M., Novelli, S., Ferrazzi, P., Lentini, G., & Ferracini, C. (2021). A qualitative analysis of beekeepers' perceptions and farm management adaptations to the impact of climate change on honey bees. *Insects*, *12*(3), 228. https://doi.org/10.3390/insects12030228

World Bank. (2023). *Employment in agriculture (% of total employment) – Afghanistan*. Retrieved from Link

Yolchi, J. (2021). The impact of market outlets choice on beekeepers' income in rural poor: a case study of Badakhshan Province. *Economics and Business Quarterly Reviews*, *4*(2). https://doi.org/10.31014/aior.1992.04.02.353