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Research Article

Adoption and Impact of Modern Beehive on Household Income: The Case of Selected Districts of Horro Guduru Wollaga Zone, Oromia Region, Ethiopia

Gemechisa Yadeta*, Shelema Rafera, Dereje Tibebu

Bako Agricultural Engineering Research Centre, Oromia Agricultural Research Institute, Addis Ababa, Ethiopia

Abstract

This study was conducted to identify factors affecting adoption of modern beehive and to analyze the impact of modern beehive adoption on household income in selected districts (Horro and Jimma Genet) of Horro Guduru Wollaga zone. Three kebeles from each sampled districts (totally six kebeles) were selected purposely depend on potentiality of beekeeping production. A total of 155 sample respondents were selected randomly to provide information (58 with modern bee hive and 97 with traditional beekeeping production). Results indicated that an average yield harvested per hive per year from traditional and modern beehive was 3.21kg and 14.56 kg respectively. The results from the econometric model showed that income from traditional beehive production, the number of traditional beehives possessed by bee-keepers, attitudes towards perceptions of easiness of inspection of modern hive positively and significantly influence a beekeeper's adoption of modern beehive of households in the study area. In addition, average treatment effect of household income assessed and the average income of farmers with modern beehive was estimated to be 10014.15 birr which was greater than farmers with traditional beehive production. So, linking farmers training with FTC demonstration were expected during promotion of modern bee hive and providing adequate technical skill through training the easiness of modern beehive inspection and management is required.

Keywords

Beekeeping, Honey Production, Modern Bee Hive , Propensity Score Matching

1. Introduction

Beekeeping in Ethiopia holds a rich historical background and traditional beekeeping was started before 5000 years back and used as the source of honey [1]. Ethiopia, with its diverse biological and climatic circumstances, is one of Africa's leading honey producers [2]. The country has some of the most diverse flora and wildlife providing surplus nectar and pollen to foraging bees, and there are more than 10 million beehives, and around 2 million individuals involved in honey production [3].

Honey production is one of the major agricultural activities being upheld by the government program of poverty alleviation, generating income, creating job opportunities in both rural and urban areas [4]. Further beekeeping does not require fertile land; uncultivated area is suitable for beekeeping. So it is a common practice in every part of Ethiopia for landless farmers having apiary site is sufficient for engaging in the

*Corresponding author: gemechisaya@gmail.com (Gemechisa Yadeta)

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activity [5]. In addition, the sector does not compete for resources with other agricultural activities and does not disturb the ecological balances of an area [6].

The country has 95.73% traditional, 1.30% transitional and 3.33% modern hives [7]. To increase production and productivity of honey and bee wax, different improved technologies of beekeeping have been used in the last 7-10 years in Ethiopia. Some of the technologies are a transitional beehive, a modern beehive, a honey presser, a water sprayer, a smoker, gloves, a honey extractor, and a veil [8]. Especially, distribution of a modern bee box-hive has been conducted to the farmers through the offices of agriculture and different governmental and non-governmental organizations to improve the production and productivity of bees in the different parts of the country.

Yet, in Horro Guduru Wollaga zone it was observed that the adoption of modern beehive technologies by farmers were very limited as compared to traditional beehive and more research needed to be done to understand what factors affect the acceptance and use of modern beehive and its impact on household's income in the study area. Therefore, this research has been initiated with the objective of to identify factors affecting adoption of modern beehive and to analyze the impact of modern beehive adoption on household income in selected districts of Horro Guduru Wollaga zone.

2. Research Methodology

2.1. Methods of Data Collection

Four-stage probability sampling procedures was used for sample selection. Initially districts, secondly kebeles, thirdly households with beekeepers were stratified into farmers having modern hive (adopters) and farmers having only traditional hive (non-adopters). A total of 155 sample respondents were selected to provide information (58 with modern bee hive and 97 with traditional beekeeping production randomly.

2.2. Method of Data Analysis

Since household's adoption decision in modern beehive is dichotomous (binary), it takes a value of 1 if the household has adopted and zero otherwise. The logit model that assesses the farm household's adoption decision of modern beehive was used for data analysis. The propensity scores matching was used to analysis household income.

3. Results and Discussion

3.1. Socio-economic Profiles of Beekeepers

The average age of the household head was 41 years for the adopter, which had been involved in beekeeping experience for about 5.8 years while the average age of non-adopter was 40 years with experience of 10.3 years. The average year's education of sampled households for adopter and non-adopter was 8.7 and 8.4 years respectively. The average income obtained from modern bee hive was 17,140.8 birr per years and from traditional bee hive was 7,302.9 birr per year. It was statistically significant relationship between adopter and non-adopter of the technology in the study area. The statistical significance of the variables was tested for continuous variables using t-tests (Table 1).

Table 1. *Mean Difference of Household Characteristics by Farmer Type.*

No	Variable	Adopter		Non adopter		aggregate	T test
		Mean	Std.dev	mean	Std.dev	Mean	
1	Age (years)	41.43	10.49	40.18	10.50	40.66	0.70
2	Education	8.7	2.7	8.4	7.8	8.5	0.25
3	Experience	5.8	6.4	10.3	5.5	9.7	0.36
4	Total income	17140.8	13376	7302.9	6163.2	11008.12	6.20***

***indicates significant at 1%
Source: Own computation survey data of 2016

3.2. Household Having of Improved Beekeeping Technology

Modern beekeeping technologies were defined as any beekeeping technologies (modern box hives, transitional hives, and the accessories) other than traditional hive [8].

Table 2. Status of Improved Beekeeping Technology.

No	Type of technology	Household having technology	
		Frequency	%
1	Only transitional beehive box	6	10
2	Modern and transitional boxes	19	33
3	Only modern beehive boxes	33	57
4	Who have access to accessories	32	55

Source: Own computation survey data of 2016

Identify of improved beekeeping technology in household in the study area was appropriate for more future interventions. Based on this definition, out of the total beekeepers interviewed 39 (26%) were adopters of modern beekeeping technologies and the remaining 116 (74%) of them were non adopters. From interviewed households only 10% have transitional beehive box, 33% have modern and transitional boxes, 57% have modern beehive boxes and 55% were households having access of accessories. Out of the total adopter interviewed 32 (55%) households' accesses to modern beehive accessories such as frames, smoker, bee suit, gloves and like which are essential for hive management and beekeeping operations (Table 2).

3.3. Honey Bee Colony Holdings of the Respondents and Its Yield

The average bee colonies possessed by the beekeepers, an average frequency honey harvest per year and price of different product per different beehive were assessed in the study area (Table 3). According to this table, in the study area the average numbers of bee colonies per beekeeper was for traditional bee hive was 10.18 whereas 4.5 for modern bee hive with bee colony. Furthermore, an average frequency honey harvest per year of respondents was accessed, and it was conducted 1.5 times for traditional and 2 times for modern beehive in the study area. However, the frequency of harvesting honey were conducted three times a year from frame (modern) hives was possible in Jimma and Illubabor Zone of Oromia Regional state [9] and buire district [10].

According to the result showed in the able 3, an average yield harvested per hive per year from traditional and modern beehive was 3.21kg and 14.56 kg respectively. The result of the yield in the study area was below the range of national yield of the country, which was 5–8 kg of honey can be expected from traditional hives, the average honey yield from modern hives ranges from 15 to 20 kg [11]. On the hand, the farmers in the study area harvest crude honey and they have a chance to harvest more quality (pure) of honey from modern hive which have a good price in the market to increase their income by adjusting time of harvest. According to [12], a modern hive has advantages over traditional hives because of its suitability for internal inspection of the honey harvesting type.

Table 3. Honeybee Colony Holdings and Its Yield.

No	Bee hive	Type of bee hive	
		Traditional	Modern
1	Beehive with honey colony of sampled house hold have	10.18	4.5
2	Frequency harvest honey per year	1.5	2
3	Type of honey yield per year (kg)		
3.1	Pure	13.96	28.74
3.2	Crude	19.79	36.91
3.3	Total	33.78	65.65
3.4	Yield per hive (kg) per year	3.21	14.56
4	Mean price of honey		
4.1	pure	358	406
4.2	Crude	246	294
4.3	wax	466	669

Source: Own computation survey data of 2016

3.4. Placement of Honeybee Colonies and Colony Inspections

The majority of the respondents were keeping their bee hive in in separate shade constructed for bee colonies and hanging on trees near homestead which accounts for 53.9% and 27.6%, respectively. So, in the study area, majority of respondent delivering attention for their apiary by constricting shade separately which was relatively better management than

other area stated by another researchers. For instance, the result contradicts with scholar, hanging on trees and backyard beekeeping were the most popular in the west part of the country [13]. In addition, according to [6] many households Keeping honeybee colonies under the roof of the outside part of house wall which was there are disturbance with other domestic animals around homestead.

As indicated by [14] beekeepers inspect their bee colony for different purposes like to prevent the loss of honey product due to pest attack, to check if the hive was occupied with bees or honey, against bee enemies, to clean the areas around the box beehives and to put ash under the hives to avoid small ant and ant like insects. In this survey the house hold perception for inspection of modern hive was conducted, majority of respondents (54.4%) reply as it was easy to inspect their hive (Table 4).

Table 4. Bee Hive Placement and Colony Inspections.

No	Hive placements and inspection	Frequency	percent
1	Hive placements		
1.1	Backyard	24	15.8
1.2	Hanging on the tree	42	27.6
1.3	Under the shade	82	53.9
1.4	On open space	4	2.6
2	Colony inspection of modern beehive		
2.1	Easy	54	54.4
2.2	Difficult	49	47.6

Source: Own computation survey data of 2016

3.5. Major Constraints of Modern Hive Beekeeping Production in the Study Area

These constraints were identified by interview and they ranked according to their importance (Table 5). Accordingly, the problem of thief was ranked first and followed by lack of queen excluder, lack of wax and bee colony absconding ranked third and fourth respectively was selected as modern hive beekeeping production constraints in the study area. Research from South Africa conducted by the study [15] to struggled with the problem of theft, the farmers proposed beekeeping cooperatives as the solution.

Table 5. Major Constraints Modern Hive Beekeeping Production.

No	Modern hive Constraints Variables	Rank
1	Lack skill managing modern hive	6
2	The wideness of size bee entrance /exit	5
3	Hated by bee/ bee absconding from hive	4
4	Increases bee disease result in decline bee population	7
5	Lack of wax	3
6	Queen excluder problem	2
7	Thief problem	1

Source: Own computation survey data of 2016

3.6. Results of the Econometric Model

Farmers' decisions about the adoption of agricultural innovation can be influenced by factors, such as economic, institutional, demographic, and physical aspects. Table 6 presented the results of the logit regression model obtained from the interviewed data. The model sufficiently fitted the data at 1% significance level (LR $\chi 2$ (9) = 25.49; Prob > $\chi 2$ = 0.0028). Income from traditional beehive, numbers of traditional beehive, training through participation FTC and perception to inspection of modern bee hive were the major determinant factors of adoption of modern bee hive beekeeping.

Table 6. Results of the Logit Regression Model.

Categories	Coef.	Std. Err	z	P>|z|
Age	-.0386	.03455	-1.12	0.263
Education	.0432	0.0505	0.86	0.391
Experience	-.9883	.5004095	1.98	0.048
No. of traditional beehive	2.947	0.977	3.02	.003***
Training through FTC parti	2.85	1.045	2.73	0.006***
Members of beekeeping cooperative	-0.396	1.24	-0.31	0.753
Perception inspection	1.1235	.7760	1.45	0.148**
Income from traditional beehive	0.003	0.001	2.87	0.000***
Distance from FTC	-0.002	0.007	0.033	.742
Cons	-1.648	2.489	-0.66	0.508

Source: Own computation survey data of 2016

The results from the econometric model showed (Table 6)

that income from traditional beehive production have a significant and positive relation with adoption of technology in the study area. The result was similar with the research conducted by the study [16]. The number of traditional beehives possessed by bee-keepers has positive effect of the probability of adoption decision. The result was similar with the investigation of [17]. Farther, attitudes towards perceptions of easiness of inspection of modern hive greatly influence a bee-keeper's decision to adopt enhanced modern beehive and significantly increase adoption of households. The reason behind the farmer's response that modern hive bee-keeping is more difficult to implement as compared to the traditional one was due to lack of technical skills of modern bee hive [18]. The proximity of the households to the training through demonstration of farmer training center was one of institutional characteristics of the sampled households affects the adoption positively and significantly at 1%. This may be due to that beekeepers who participate in in training through demonstrations of improved beehive technology get the chance to exchanges knowledge and experience which motivates them towards adopting the technology. This result finding was similar with [12].

3.7. Estimating Results of Propensity Scores

In the propensity score matching the two outcome variables were No and Yes, (No means these individuals that have not received modern beehive and Yes means these individuals that received). The propensity score matching calculate the probability of individuals to be selected in the treatment group on the bases of different characteristics. These characteristics were age, education level, training through FTC demonstration, beekeeping experience production of sampled household were important variables that determine farmers' propensity to modern bee hive. The results were showed in (Table 7).

Table 7. *Covariate Balance Matching Using Kernel Matching.*

No	Variable	Mean			t-test		V(T)/V(C)
		Treated	Control	%bias	t	p>|t|	
1	Age of HHs	41.474	41.628	-1.5	-0.11	0.915	0.91
2	Education of HHs	8.359	6.9103	24.4	1.44	0.151	6.74
3	Experience in beekeeping	9.6282	9.2308	7.0	0.59	0.558	1.18
4	No of traditional beehive	.02564	.02564	0.0	0.00	1.000	.
5	Inspection modern beehive	2.475	2.3846	15.0	0.81	0.421	1.40
6	Training through FTC demo	.23404	.75362	-114.5	-6.37	0.000	.
7	Cooperatives of beekeepers	.01754	.32051	-124.2	-4.73	0.000	.

Source: Own computation survey data of 2016

3.7.1. Household Income of Unmatched and ATE Groups

Table 8 displays the disparity in overall household income between the matched treated and control groups prior to and following the matching process. The unmatched treated sample group has 7071 birr and matched treated group has a collective household income of 7272.18 Ethiopian Birr. Conversely, the control group of the average treatment effect (ATE) calculation had an income of 10681.16 ETB (Table 8).

Table 8. *ATT Estimation Results in Total Household Income.*

Variable	Sample	Treated	Controls	Difference	S.E	T-stat
Income	unmatched	7071.88	17664.26	-10592.38	1702.69	-6.22
	ATE	7272.18	10681.16	-3408.97	2754.39	-1.24

Source: Own computation survey data of 2016

3.7.2. Household Income of Average Treatment Effect

The propensity score for a given household was estimated using logit model where the dependent variable is adoption status and taking different covariates as independent variables. The result showed in Table 9. The average income of farmers with modern beehive was estimated to be 10014.15 birr greater than farmers with traditional beehive production.

Table 9. ATE of Income of Household.

Total output	Coefficients	Std. Err.	Z	P>z	[95% Conf.	Interval]
ATE	10014.15	1643.9	6.09	0.000	13236.3	6791.9

Source: Own computation survey data of 2016

4. Conclusion and Recommendation

Beekeeping in Ethiopia holds a rich historical background and traditional beekeeping was started before 5000 years back and used as the source of honey and beeswax. However, still in all parts of the country, several million colonies of bees are managed using traditional beekeeping methods with result in low output. This study identifies factors affecting adoption of modern beehive in selected districts of Horro Guduru Wollaga zone. Income from traditional beehive production, traditional beehive numbers, training through participation FTC and perception to inspection of modern bee hive was the major determinant factors of adoption of modern beekeeping. Income from traditional beehive production and traditional beehive numbers has a significant and positive influence on adoption households. Further attitudes towards perceptions of easiness of inspection of modern hive and training through participation in the demonstration in FTC of improved beehive technology had a positive effect on the decision to adopt it and significant at 1% in the study area. The result obtained from the propensity score also shows that the adopters of improved beehive obtained more income as compared to counterparts. The average income of farmers with modern beehive was estimated to be 10014.15 birr greater than farmers with traditional beehive production. Thus, it was recommend that concerned body should be formulated to take advantage of the factors influencing farmer's adoption.

The farmers in the study area have a chance to harvest more quality (pure) honey than crude from modern beehive by adjusting time of harvest because of easiness to inspect.

Linking farmers training with FTC demonstration were expected during promotion of modern bee hive, introducing the technology to these household having high numbers of traditional bee hive was advisable, providing adequate technical skill through training the easiness of modern beehive inspection and management. In addition, the production/yield per hive per year of either traditional or/and modern beehive was below the range of national level. So, the major duty expected from concerned body in the selected area.

Abbreviations

FTC	Farmers Research Center
ATE	Average Treatment Effect
ETB	Ethiopian Birr

Conflicts of Interest

The authors declare no conflicts of interest.

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