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Research Article

Factors Affecting Adoption of Improved Modern Beehive Technology in West Hararghe Zone, Oromia National Regional State, Ethiopia

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Abstract

This study attempted to identify adoption status, factors affecting the adoption decision and intensity, and identify major constraints of beekeepers for modern beehive adoption. Agriculture is a backbone of country economy. Beekeeping is one of an agricultural subsector which is a sustainable and low-investment strategy for poverty reduction. Both qualitative and quantitative data collected from a sample of 180 beekeepers which collected from three districts of West Hararghe zone and analyzed using STATA software. Heckman two-stage model was employed for the analyses. In study area less than half of the beekeepers were adopters of modern beehive technology. Heckman two-stage model of first-stage results revealed that households' decision to adopt modern beehive were influenced by factors such as age of household head, education level, livestock owned (tlu) and number of extension contact. Furthermore, the second-stage results indicated that intensity of modern beehive adoption of households' was influenced by factors such as distance from FTC, access to accessory, livestock owned (tlu), access to training and number of extension contact. From policy perspective improving distribution of modern beehive with full package; encourage extension service, and focus on the deliverance of training are crucial for the adoption of beekeeping technologies and increasing honey production.

Keywords

Adoption, Beekeeping, Decision, Heckman Two-Stage Model, Modern Beehive

1. Introduction

In Ethiopia, agriculture is a heart of economic development strategy in which more than 80% of the population depends on for their livelihoods that means as their primary source of income and food. It accounts for about 33% of the gross domestic product (GDP) which is higher than the Sub-Saharan Africa which had 24% to GDP share, accounts for 76% of foreign earnings, employs 66% of the population, capital for investment and market, and major source of raw material [4].

Beekeeping is a livestock subsector which recognized as a sustainable and low-investment strategy to alleviate poverty in generating a stable income for rural populations. A country has diverse biological and climatic circumstances which favorable and can sustain millions of honeybees colonies. There are over 10 million bee colonies and 1.8 million beekeepers exist in the country [22]. The country has the potential of

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producing over 500,000 tons of honey per year. However, the annual production of honey and beeswax is low compared to its potential [20].

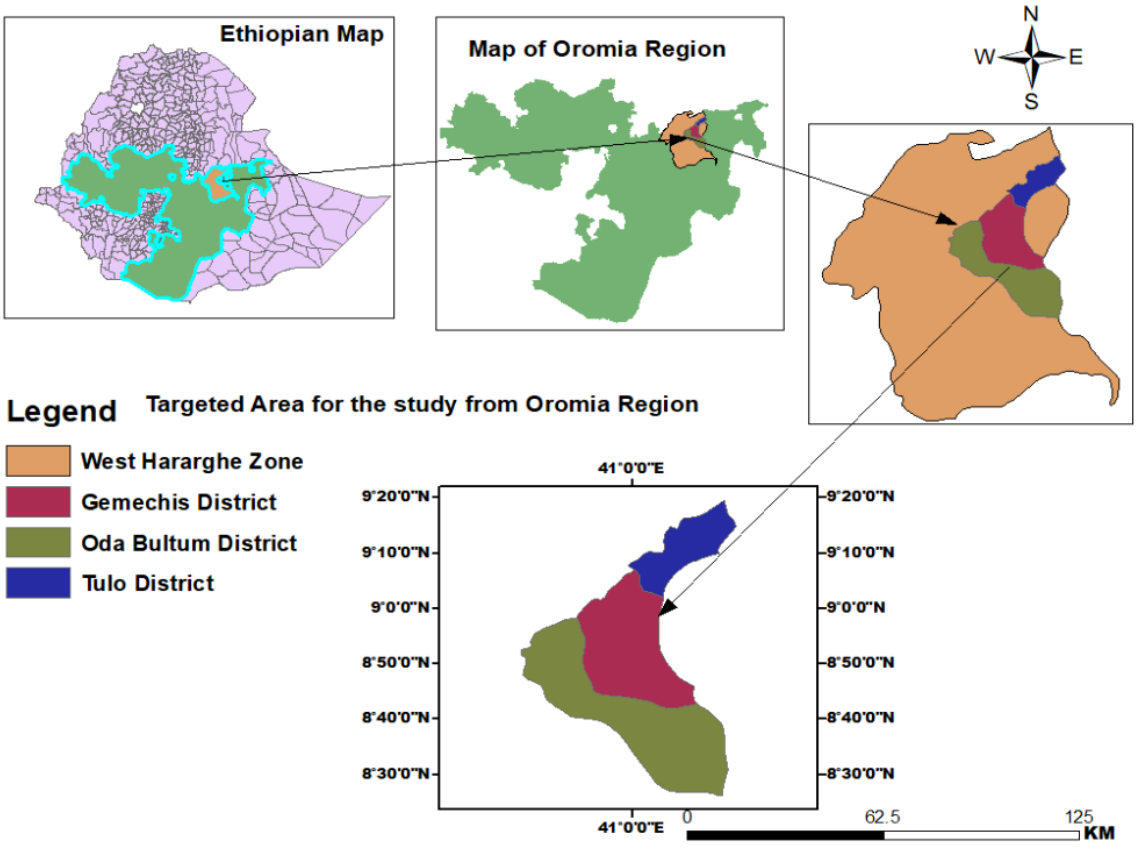
In rural and pastoral sedentary areas there are an estimated of about 5.98 million hives were found. Among beehives exist in country modern beehives estimated to 121,419 hives which is only 2.03% from the total hives [11]. As a result the yield of honey and other hive products have been constantly low over the past years. To boost production and productivity the backward cultivation practices should progressively be transformed into relatively modern methods [2]. Thus, this technology transfer interventions provide farmers as to access the technologies [26]. To encourage a sector Oromia National Regional State launched it as one strategic plan for regional development.

In West Hararghe zone there were a total of 256,433; 32,507, and 6162 traditional, transitional and modern beehives, respectively with total honey production potential of 168 ton/year in 2012/13 EC in a zone [27]. On other hand, farmers constrained by serious land shortage. For this, beekeeping is very important an income generating and diversifying activity due to it does not need large land to practices. In a zone, beekeepers majorly (more than 96%) had traditional bee hives. However, there is a productivity difference between traditional, transitional and modern beehives. According to Benyam *et al*., the annual honey obtained from traditional beehive was very low (9 kg/hive) in quantity and quality as compared to the modern bee hives (22 kg/hive) [7].

Hence, for the improvements of honey production with its products, Mechara Agricultural Research Center was introduced, promoted and distributed modern beehives with its accessories for the beekeepers starting before 10 years. Besides, World vision, Red Cross Society, HABP and MSEs (IMX) offices were participated in its distribution in a zone. Despite distribution and efforts made so far, majority of beekeepers still use traditional beehives and similar study was also not conducted in a study area. Therefore, this study was attempted to investigate factors that affects adoption of modern beehive in a study area.

2. Objectives

1. To assess adoption status of modern beehives in study area
2. To identify the factors affecting the adoption decision and intensity of modern beehive
3. To identify and prioritize major constraints of modern beehive adoption of beekeepers



Source: Own design from ArcGIS data, 2023

Figure 1. *Map of the study area.*

3. Methodology

3.1. Description of Study Area

This study was conducted in three districts (Oda Bultum, Tulo and Gemechis) of West Hararghe Zone, Oromia, Ethiopia. Oda Bultum district is one of the 15th districts of West Hararghe zone. It is located at 363 km South-east of Addis Ababa and 37 km from Chiro, the zonal capital town of West Hararghe Zone. The district is found from 1040 to 2500 meters above sea level with the average altitude of 1770 m.a.s.l. The district has three agro-ecological zones. These are 4% high land, 34% midland, and the rest 62% lowland. The district obtained annual rainfalls 600 - 800 mm and temperature of 22 - 38 ℃ [23].

Tulo district is one of the 15 districts of West Hararghe Zone of Oromia National Regional State, Ethiopia. It is located at 368 km East of Addis Ababa and 42 km from Chiro, the zonal capital town of West Hararghe Zone. The district is found from 1631 to 2800 meters above sea level. The district has two agro-ecological zones: 43.33% high land and 56.67% midland. The district received mean yearly temperature of 26 ℃, whereas mean annual rainfalls of 1700 mm [21, 27].

Gemechis district is one of the 15 districts of West Hararghe Zone of Oromia National Regional State, Ethiopia. It is located at 343 km South-east of Addis Ababa and 17 km from Chiro, the zonal capital town of West Hararghe Zone. The district is found from 1300 to 3400 meters above sea level. The district has three agro-ecological zones. These are 26.9% high land, 35.5% midland, and the rest 37.6% lowland. The minimum and maximum annual rainfalls are 650 and 1200 mm with an average of 850 mm. The minimum and maximum temperature of 15 ℃ and 30 ℃ with the average temperature is 22 ℃ [14].

3.2. Sampling Procedure

In this study both purposive and random sampling techniques were employed. Firstly, 3 districts were selected from a zone purposively based on the intervention of improved modern beehive technology. Second, two kebeles were selected randomly from the potential kebeles in utilization of a technology. Then, beekeepers of the two kebeles were stratified into two categories: beekeepers that have modern beehive as adopters and the counterpart non-adopters. Finally, a total of 180 sample beekeepers were selected in a simple random sampling technique including adopters and non-adopters by considering probability proportional to population size. Therefore, the sample size was determined according to [19].

$$n = \frac{Z^2 pqN}{e^2(N-1)+Z^2 pq} = \frac{(1.937)^2(0.037)(0.963)(114{,}270)}{(0.0527)^2(114{,}270-1)+(1.937)^2(0.037)(0.963)} \approx 180 \quad (1)$$

Where n is the sample size for the study, N is the size of the total households in the districts the sample is drawn, Z is the selected critical value of desired confidence level (1.937), p is the estimated proportion of an attribute that is present in the population which is 0.037 in this study. q =1-p that is 0.963 and e is the desired level of precision which is 0.0527.

Table 1. *Number of sampled households in each kebele.*

Kebeles	Households of districts	Sample taken	
		Frequency	Percent
Gemechis	43,924	73	40.56
Oda Bultum	43,840	54	30.00
Tulo	26,506	53	29.44
Total	114,270	180	100

Source: Own computation, 2023

3.3. Data Types, Source and Method of Data Collection

Both qualitative and quantitative data were collected from primary and secondary data sources. The primary data were collected from the sampled beekeepers. It collected through personal interview using structured questionnaire. While, secondary data source were annual reports of respective district and zonal agricultural office.

3.4. Method of Data Analysis

The collected data were analyzed using STATA version 16.1. Both descriptive statistics (such as mean, standard deviation, frequency and percentage) and econometric model (Heckman two-step model) were employed to meet the specific objectives of the study. Before analyzing the determinants of modern beehive adoption decision, it is important to assess adoption intensity for each farm household. Accordingly, beekeepers who does not have at least one modern beehive that had bee colony in 2022/23 were considered as non-adopters, while beekeepers who were owning at least one modern beehive that have bee colony focusing on 2022/23 were considered as adopters. In this study, dependent variable of adoption intensity was calculated using the following formula:

$$Adoption\ \ intensity\ \ (proportion) = \frac{Numbers\ of\ \ modern\ beehive\ a\ \ farmer\ \ owned}{Total\ \ numbers\ of\ \ beehive\ a\ \ farmer\ \ owned} \quad (2)$$

Model Specification for This Study

Heckman selection model was tested for the analysis of the data. The inverse mill's ratio produced was significant indicating that there was selectivity bias and which reject the null hypothesis that state: there is no unobserved selection process which governs the participation equation. This means that the error terms of the decision and intensity of models are correlated. For this, a two stage model was employed for its advantage of selectivity bias correction [15]. Thus it also preferred for its exceptional efficiency of using the same or different explanatory variables in both the first stage (decision of adoption) and the second stage (intensity of adoption) of analysis.

Before the analysis, appropriateness of model was tested using the maximum likelihood method. The Wald chi-square of the model is significant (Wald chi^2 (12) = 174.47 Prob > chi^2 = 0.0000) indicating the model is adequate because coefficients are jointly significant. This is an indication that all the explanatory variables included in the model jointly influenced households' likelihood to participate in adoption of modern beehive. Besides, multicollinearity problem were tested using VIF (mean of VIF = 1.26) and Ramsey RESET test for omitted variables (F (3, 161) = 2.07 Prob > F = 0.1066).

The Heckman selection model considers the possibility of selection bias by allowing for possible dependence in the two parts of the model, decision to adopt and intensity of adoption [1, 13, 16, 17]. The two steps Heckman selection model specified as follows:

Let y_1 and y_2 denote decision and intensity of adoption, respectively. y_1 is a dummy variable that takes the value 1 if the farmer adopts the modern beehive and 0 otherwise. While y_2 is a continuous variable that takes a value of the proportion of modern beehive to the total beehive a household owned. In Heckman selection model an outcome (adoption intensity) is observed if $y_1 > 0$ and $y_1 \neq y_2$. The two-equation model comprises a selection equation for where,

$$y_1 = \begin{cases} 1 & if\ y^* > 0 \\ 0 & otherwise \end{cases} \quad (3)$$

The outcome equation for y_2,

$$y_2 = \begin{cases} y_2^* & if\ y_1^* > 0 \\ 0 & otherwise \end{cases} \quad (4)$$

The latent variable y_2 is only observable when $y_1^* > 0$ and not observable when $y_1^* \leq 0$. Therefore,

$$y_1^* = x_{1i}\beta_1 + u_i \quad (5)$$

$$y_2^* = x_{2i}\beta_2 + v_i \quad (6)$$

Where, u_i and v_i possibly correlated; the Heckman probit model provides consistent, asymptotically efficient estimates for all parameters.

Table 2. *Summary of explanatory variables used in the model.*

Variables	Measurement	Expected sign	
		Decision	Intensity
Dependent variable			
Adoption decision	Dummy		
Proportion of modern beehive	Continuous		
Explanatory variables			
Age of household head (years)	Continuous	+	+
Education level	Continuous	+	+
Land holding size (timad)	Continuous	+	
Livestock owned (tlu)	Continuous	+	+
Household size (numbers)	Continuous		+
Extension contact (Frequency)	Continuous	+	+

Variables	Measurement	Expected sign	
		Decision	Intensity
Participation on demonstration/ field days	Dummy	+	
Distance from FTC (Minutes)	Continuous	-	-
Access to credit	Dummy	+	+
Access to training	Dummy	+	+
Land allocated for bee forage (timad)	Continuous		+
Beekeeping experience (years)	Continuous	+	+
Access to accessory	Dummy		+
Supplementary feed	Dummy		+
Sex	Dummy	+	+
Membership for beekeeping association	Dummy	+	

Source: Empirical studies reviewed, 2020

4. Results and Discussions

4.1. Adoption of Status Beekeepers for Modern Beehive Technology

According to the survey results, out of 180 interviewed beekeepers only 52 (28.89%) were adopters of modern beehives and the remaining 128 (71.11%) were non-adopters. Besides, among the three selected potential modern beehives user districts, Oda bultum district had more percentage of adopters than Gemechis and Tulo districts. While in reverse large percentage of non-adopters were found in Tulo district followed by Gemechis district.

Table 3. *Adoption status of beekeepers across districts.*

District	Adopters		Non adopters		Total (in frequency)
	Frequency	%	Frequency	%	
Gemechis	22	30.14	51	69.86	73
Oda Bultum	17	31.48	37	68.52	54
Tulo	13	24.53	40	75.47	53
Total	52		128		180

Source: Survey result, 2023

4.2. The Results of Descriptive Analysis

Education has direct and positively importance in increasing ability to adopt modern beehive technology. The mean education level of sampled households was 4 grade completed. The mean education of adopter farmers was around grade 5 complete while the mean education of non-adopter was around grade 4 complete. The t-test showed that there was statistical significant difference between adopters and non-adopters of modern beehive technology in the study area at 5% significance level (Table 4).

The average livestock owned of households in the study area was less than three tropical livestock unit which is 2.74. Average livestock owned of adopter groups of modern beehive were 3.45 tlu with 2.09 standard deviations; while 2.44 average livestock owned of non-adopters with 1.76 standard deviations. There was significant difference between the two

groups (adopters and non-adopters) in livestock owned at 1% significance level. It is similar with report of Central Statistical Agency which reported that 72.79% of households owned less than equal to 4 head of cattle [10].

Sampled beekeepers on average walked 23.4 minutes (A person walks 1 km in 10 minutes) to reach respective kebele FTC. On average adopter of modern beehive walked 17.51 minutes with 16.09 standard deviations; while non-adopters walked 25.62 minutes with 25.44 standard deviations. There was significant difference between the two groups (adopters and non-adopters) in amount of minutes they walked to reach FTC at 5% significance level.

The average land owned of households in the study area was 2.5 timad (8 timad equal to 1 hectare) (Table 4). Average land owned of adopter groups of modern hive were 4.21 timad with 3.18 standard deviations; while 3.52 timad average lands owned of non-adopters with 2.07 standard deviations. There was significant difference between the two groups (adopters and non-adopters) in land owned at 10% significance level. This average landholding of household is lower than the regional average landholding of a household which is 1.10 ha/household [9].

Frequency of extension contact has positive impact on adoption of improved technology. The study results indicated that beekeepers on average contacted with extension agents 0.8 which is less than one in study area. That means some beekeepers hadn't any contacts with extension agents in 2022/23 fiscal year. Adopters of modern hive were contacted with extension agents on average 1.71 times with 2.30 standard deviations; while 0.38 average number of extension contacts of non-adopters with 1.01 standard deviations. There were significant differences between adopters and non-adopters in frequency of extension contact.

Table 4. *Demographic and socio-economic characteristics of sample respondents.*

Variable	Adopters (N=52)		Non-adopters (N=128)		Total Mean	t-test
	Mean	St. dev	Mean	St. dev		
Household size (numbers)	5.37	2.57	5.29	2.55	5.3	-.182
Age of households (year)	40.08	12.10	42.55	14.41	41.8	1.070
Education level (Grade)	4.9	4.05	3.56	3.77	4	-2.176**
Livestock owned (TLU)	3.45	2.09	2.44	1.76	2.74	- 3.296***
Land allocated for bee forage (timad)	.03	.14	.01	.06	.02	-1.393
Distance to FTC (minute)	17.51	16.09	25.62	25.44	23.4	2.129**
Beekeeping experience (years)	10.38	9.74	9.26	8. 64	9.6	-.764
Land owned (timad)	4.21	3.18	3.52	2.07	2.5	-1.717*
Frequency of extension contact (numbers)	1.71	2.30	.38	1.01	.8	-5.417***

Note: ***, and * indicate significance at $P \leq 0.01$ and $P \leq 0.1$, respectively.
Source: Survey result, 2023

Out of the sampled households, only 6.11% were membership for beekeeping association; the rests were not member for beekeeping association (Table 5). In between adopters and non-adopters there were statistical significance differences in membership for beekeeping association. Among adopters 17.31% were member for beekeeping association while only 1.56% of non-adopters were member for beekeeping association.

Table 5. *Chi^2-test for demographic and socio-economic characteristics for dummy variable.*

Variables	Characteristic	Adopters (%)	Non-adopters (%)	Overall (%)	Pearson chi^2
Sex	Male	76.92	67.97	70.56	1.427
	Female	23.08	32.03	29.44	
Membership for beekeeping	Yes	17.31	1.56	6.11	15.977***

Variables	Characteristic	Adopters (%)	Non-adopters (%)	Overall (%)	Pearson chi^2
association	No	82.69	98.44	93.89	
Access to accessory	Yes	26.92	4.69	11.11	18.511***
	No	73.08	95.31	88.89	
Supplementary feed	Yes	53.85	47.66	49.44	0.567
	No	46.15	52.34	50.56	
Participation on demonstration	Yes	21.15	7.81	11.67	6.387**
	No	78.85	92.19	88.33	
Access to credit	Yes	1.92	3.13	2.78	0.198
	No	98.08	96.88	97.22	
Access to training	Yes	30.77	10.16	16.11	11.625***
	No	69.23	89.84	83.89	

Note: ***, and ** indicate significance at $P \leq 0.01$ and $P \leq 0.05$, respectively.
Source: Survey result, 2023

Presences of accessory have a great role in adopting and usage of modern beehive. Table 5 depicted, out of 180 respondents only 11.11% were got access of accessory and the remains were not. According to the report of respective districts and zone governmental and NGOs participated in supplying of modern beehive were not supply its accessories except Mechara Agricultural research center. The results of chi-square test indicated that there is a statistical significance difference between adopters and non-adopters in access to accessory at 1% significance level.

Among beekeepers of study area, 30.77% of adopters were obtained access of training; while only 10.16% of non-adopters were obtained access of training. In other words, adopter households were more likelihood in getting training than non-adopters households. Access to training was statistically significant in between the two groups at 1% significance level. In study area Mechara agricultural Research center, Red + and Care Ethiopia were the sources of training for beekeepers.

4.3. Econometric Results

4.3.1. Factors Affecting Farmers' Decision to Adopt Modern Beehive

Education plays a significant role in influencing farmers' altitude towards new technology. Education level of household was positively and significantly affects beekeepers decision to adopt modern hives at 1% significance level. Results of the study indicated that as education level of a household increased by grade 1 decision to adopt modern hive increases by 2.63% keeping the other constant (Table 6). This finding is agreed with the findings [5, 8].

Livestock owned of a household is strongly significant and positively affect farmers' decision to adopt modern bee hive at 1% level of significance. The results of first step heckman model indicated that a unit increment of livestock owned (in tropical livestock unit) increases probability of adopting modern bee hive increased by 4.61% at ceteris paribus. The result is consistent with previous studies who claimed farmers those had more livestock owned has potential to use and adopt new technology [5].

Households those got access to training are more likely in adoption intensity of modern beehive than households those do not have access to training. This is probably because training creates awareness on improved technology and builds their skill on its utilization. The present study is consistent with the study results that conclude training as raises knowledge and beneficiary productivity of technology [12]. According to Sheleme study, training develops the beekeepers' self-confidence and increases the productivity of the technology [24].

Extension services encourage farmers to adopt improved agricultural technologies. As expected, the result of model indicated that number of extension contact significantly and positively affects the adoption decision of improved modern hive at 5% significance level. The model results indicated that as numbers of contact of farmers with agricultural extension agents on beekeeping increases in one, the probability to adopt modern hive technology is increases by 4.11% keeping others constant. The result is similar with [24].

4.3.2. Determinants of Intensity of Modern Beehive

Accessory is a very important tool for beekeepers in production of quality honey. Access to accessory was positively and significantly affects adoption intensity of modern beehive technology. In study area some farmers were borrowed ac-

cessory from bee experts. Households those have access to accessory were adopted more modern hive than those do not have access. Currently in study area some farmers transforming bees from modern hive to traditional hive as a reason of the lacking its accessories. The present study is coincided with the argument of absence of accessories was a major reason that makes households to dis-adopt modern beehive technology [25].

Table 6. *Heckman two-step model results for adoption of modern beehive.*

Adoption decision					**Adoption intensity**			
Variables	**Coef.**	**SE**	**t-value**	**dy/dx**	**Variables**	**Coef.**	**SE**	**t-value**
Sex of household head	.140	.089	1.57	.1397	Sex of household head	.088	.282	0.31
Age of household head	.009**	.004	2.22	.0093	Age of household head	-.015	.012	-1.25
Education level	.026***	.008	3.09	.0263	Education level	.055	.034	1.61
Distance from FTC	-.003	.003	-0.95	-.0026	Distance from FTC	-.022**	.009	-2.58
Beekeeping experience	-.006	.006	-0.96	-.0056	Household size	.051	.049	1.04
Livestock owned (tlu)	.046***	.017	2.65	.0461	Beekeeping experience	.022	.016	1.35
Land owned	.007	.010	0.70	.0070	Land allocated for bee forage	1.204	2.087	0.58
Number of extension contact	.041**	.020	2.07	.0411	Livestock owned (tlu)	.146**	.063	2.33
Access to training	.106	.102	1.03	.1057	Access to accessory	1.054***	.399	2.64
Access to credit	-.085	.236	-0.36	-.0855	Access to training	.537*	.312	1.72
Membership for beekeeping association	.071	.083	0.85	.0708	Access to credit	-.522	.727	-0.72
Participation on demonstration	-.025	.086	-0.29	-.0246	Supplementary feed	-.112	.239	-0.47
					Number of extension contact	.236***	.089	2.67
					Constant	-1.048*	.615	-1.70
Number of obs	180				Selected	52	Non-selected	128
Lambda	.2919 (.1008) P>|z|=0.004				Rho	1.000		
Wald χ^2 (12)	174.47***				Sigma			.2919

Note: ***, ** and * indicate significance at $P \leq 0.01$, $P \leq 0.05$ and $P \leq 0.1$
Source: Survey result, 2023

Distance from farmer training center (FTC) was negatively and significantly affects adoption intensity of modern bee hive technology. Supply of modern hive mostly delivered for farmers at respective kebele's FTC. Households residing in places far from FTC are less likely to obtaining information of modern beehive availability on time, at time they obtained information modern hive distribution is over and also transportation costs which hinders their adoption intensity. The result concurs with the findings of [18]. This finding is also agreement with the findings of Tadele, who concluded that households that are located far from place of inputs (like modern bee hive, honey extractor, protection materials, swarm bee and others) available were less likely to adopt modern beehive technology [25].

Livestock owned (tlu) is an important variable having significantly positive effect on adoption intensity of smallholder farmers' in the modern bee hive. Furthermore, the result assured that households who possessed large livestock owned positively adopted large numbers of modern hive. This study results consistent with Basuma and *Asfaw et al*. who indicated that owning of large livestock owned of households enable them to intensify improved box hive through being sources of income [6, 3].

Extension services improve altitude of farmers to wards improved agricultural technologies. Number of extension contact is one factor determining adoption intensity of modern beehive. Those farmers that had good contact with extension agents majorly with bee experts were get chances of honey

extraction and filtration done by experts. The present study is consistent with the argument of number of household contacted with agricultural extension offsets the intensity to adoption in modern hive [6].

4.4. Constraints of Modern Beehive Utilizations

Table 7. Problems challenging for utilization and adoption of modern beehive in study area.

No	Problems	Frequency	Percent	Rank
1	Chemical sprayed	7	8.75	3
2	Lack of beehive accessories	32	40	1
3	Unavailability of modern beehive on time	3	3.75	7
4	Negative perception towards modern beehive	6	7.5	5
5	Bee enemies	6	7.5	5
6	Lack skill and experience on modern beehive	7	8.75	3
7	Expensiveness of hive and bee wax	16	20	2
8	Labor intensive for management	3	3.75	7

Source: Own computation, 2023

According to results indicated above, lack of beehive accessories, expensiveness of beehive and bee wax, chemical sprayed and lack skill and experience on modern beehive are among the major challenging beekeepers in utilization of modern beehive (table 7).

5. Conclusions

Ethiopia has a very favorable climatic condition for beekeeping practices. As a result a country become potential in honeybee colony and honey production. To boost this honey production utilization of improved beekeeping practices like modern beehive is very important. For this different governmental and non-governmental body distributed and promoted modern beehive in a zone. But a technology was not properly observable on work near farmers. That is a reason this study was conducted to access adoption rate.

The study was undertaken with the objective of identify the determinants of adoption decision and intensity; as well as identify major constraints of modern beehive adoption of beekeepers in study area. It used qualitative and quantitative data collected from 180 beekeepers and analyzed in STATA software. In analysis descriptive statistics and econometric model (Heckman two stages) were used to analyze the collected data.

According to the descriptive analysis result of the study among sampled beekeepers only around 29% were adopters of modern beehive while the rest were non-adopters. Majority of beekeepers were non-membership for beekeeping association, lack of accessory and credit access, non-participation on demonstration and lacks training access. Besides, beekeepers in study area exist at productive age, serious land shortage with family size they owned, low extension contact on technology and they followed primary education level. Heckman two stage model results also revealed that age of household head, education level, number of extension contact and livestock owned (tlu) were the influencing factors of households' decision to adopt modern beehive. On the other hand, the intensity of modern beehive adoption of households' were influenced by distance from FTC, access to accessory, livestock owned (tlu), access to training and number of extension contact.

Finally, probability of beekeepers to adopt a technology will be increased when availability of accessories becomes certain in study area. Thus, it is clear that adoption and utilization of modern beehive is the best for quality and beekeeping productions even if there have been different constraints related to a technology in study area.

6. Recommendations

Based on the findings of this research the following recommendations are made.

1. GOs and NGOs that are willing to distribute and work on modern beehives, it is better to distribute with its full package (its accessory).
2. Training should focus on how to farmers prepare beeswax.
3. Increasing the extension constant will better to create awareness for farmers on the appropriate time of chem-

ical spray & neglect the negative perception farmers have towards modern beehives.

Abbreviations

ATI	Agricultural Transformation Institute
FTC	Farmers Training Center
GDP	Gross Domestic Product
GOs	Governmental Organizations
HABP	Household Asset Building Programme
m.a.s.l.	Meter Above Sea Level
MSEs	Micro and Small Enterprises
NGOs	Non-Governmental Organizations
tlu	tropical Livestock Unit
VIF	Variance Inflation Factor

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Author Contributions

Birhanu Angasu: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft

Gosa Alemu: Conceptualization, Data curation, Funding acquisition, Investigation, Project administration

Nimona Sime: Conceptualization, Data curation, Funding acquisition, Investigation, Project administration

Conflicts of Interest

The authors declare no conflicts of interest.

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Research Fields

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