Annals of Agricultural & Crop Sciences

Open Access

Austin Publishing Group

Research Article

Adoption of Modern Beehive Technology in East Hararghe Zone, Oromia Regional State, Ethiopia

Solomon Ayele*, Kibret Ketama and Belete Fekadu
Socio-Economics Research Team, Fedis Agricultural Research Center of Oromia Agricultural Research Institute, Harar, Ethiopia, P.O. Box 904, Ethiopia

***Corresponding author:** Solomon Ayele, Socio-Economics Research Team, Fedis Agricultural Research Center of Oromia Agricultural Research Institute, Harar, Ethiopia, P.O. Box 904, Ethiopia
Email: solomon4ayele@gmail.com

Received: October 23, 2025
Accepted: November 11, 2025
Published: November 13, 2025

Abstract

Even though East Hararghe Zone has a favorable climatic condition for honey production; the production and productivity is low as compared to its potential due to the low level of improved beekeeping technologies utilization. Therefore, this study was generally aimed to analyze the adoption of modern beehive technology in selected districts of East Hararghe Zone, Oromia Regional State, Ethiopia. Multi-stage sampling method was employed to select study districts and kebeles, and finally sampled beekeepers respondents. Both primary and secondary data were used for this study. From a total of 310 beekeepers interviewed, 94 (31.94%) and 211(68.06%) were adopters and non-adopters respectively. Both descriptive statistics and econometric models were used to analyze data. The results of the Tobit econometric model show that the adoption and intensity of adoption of modern beehive technology in the study areas had a significant relationship with the distances to farmers' training centers, annual farm income, numbers of traditional beehives owned, cooperative membership, access to modern beehive accessories, access to extension services, participation on technology demonstration, perception to high price of modern beehive and districts dummy. Based on the findings, this study recommends that the major factors in the adoption and intensity of adoption of modern beehives should be considered by policy makers, research, extension, and other actors along the honey value chain to improve further adoption of modern beehive among the strategy to increase honey production and productivity in the study areas.

Keywords: Intensity of adoption; East Hararghe Zone; Modern beehive; Tobit econometric model

Introduction

Ethiopia has a huge potential for beekeeping production due to its endowment with diversity climate and vegetation resources offering potentially favorable condition for beekeepers. These have enabled Ethiopia to make around 23.58% and 2.13% of the total share of in Africa and global level respectively [1]. This makes Ethiopia a leading in Africa and ninth in the world in honey production and first in Africa and third in the world in beeswax production [2]. The exact number of people engaged in the honey sectors in Ethiopia is not known. However, it's estimated that more than one million farm households are involved in the beekeeping business using traditional, transition and frame beehives [3]. In Ethiopia about 5.98 million bee hives exist, out of this 96.31%, 1.66% and 2.03% are traditional, transitional and modern bee hives respectively [4]. As it is known traditional beekeeping practice is the major and oldest type, exercised for more than thousands of years in Ethiopia, this way of beekeeping, especially by hanging over the long tree in the forest is not convenient for female beekeepers which is very difficult for management and harvesting, low productivity with production per hive averaging 5 - 6 kg compared to modern beehives which has average production of 15 - 20 kg/hive and even more [5]. Even though large number of improved beehive technologies have been introduced and promoted by the government and other nongovernmental organizations over the past 10-20 years still the amounts of modern beehive technologies used by farmers were very limited in Ethiopia [2]. To improve the production and productivity of beekeeping, it is important to adopt improved beekeeping technologies which is a decision of individual or groups to accept the use of recommended technologies over a reasonably long period [6,7]. In line with statement Fedis Agricultural Research Center (FARC) has been disseminated modern beehives in the East Hararghe Zone for the last decades. However, the amounts of modern beehive technologies used by farmers were very limited in the study area, East Hararghe Zone. So, identification of factors that influencing the adoption of technologies are important for policy makers, researchers and development practitioners to suitable modify the approach or/and the technology to improve its up taking by end users. However, there were no any studies conducted on the adoption of modern beehives technology in the study areas. Therefore, this research was initiated with general objective to analyze the adoption of modern beehive technology in East Hararghe Zone, Oromia Regional State, Ethiopia.

Solomon Ayele © All rights are reserved

Citation: Solomon Ayele, Kibret Ketama and Belete Fekadu. Adoption of Modern Beehive Technology in East Hararghe Zone, Oromia Regional State, Ethiopia. Ann Agric Crop Sci. 2025; 10(2): 1184.

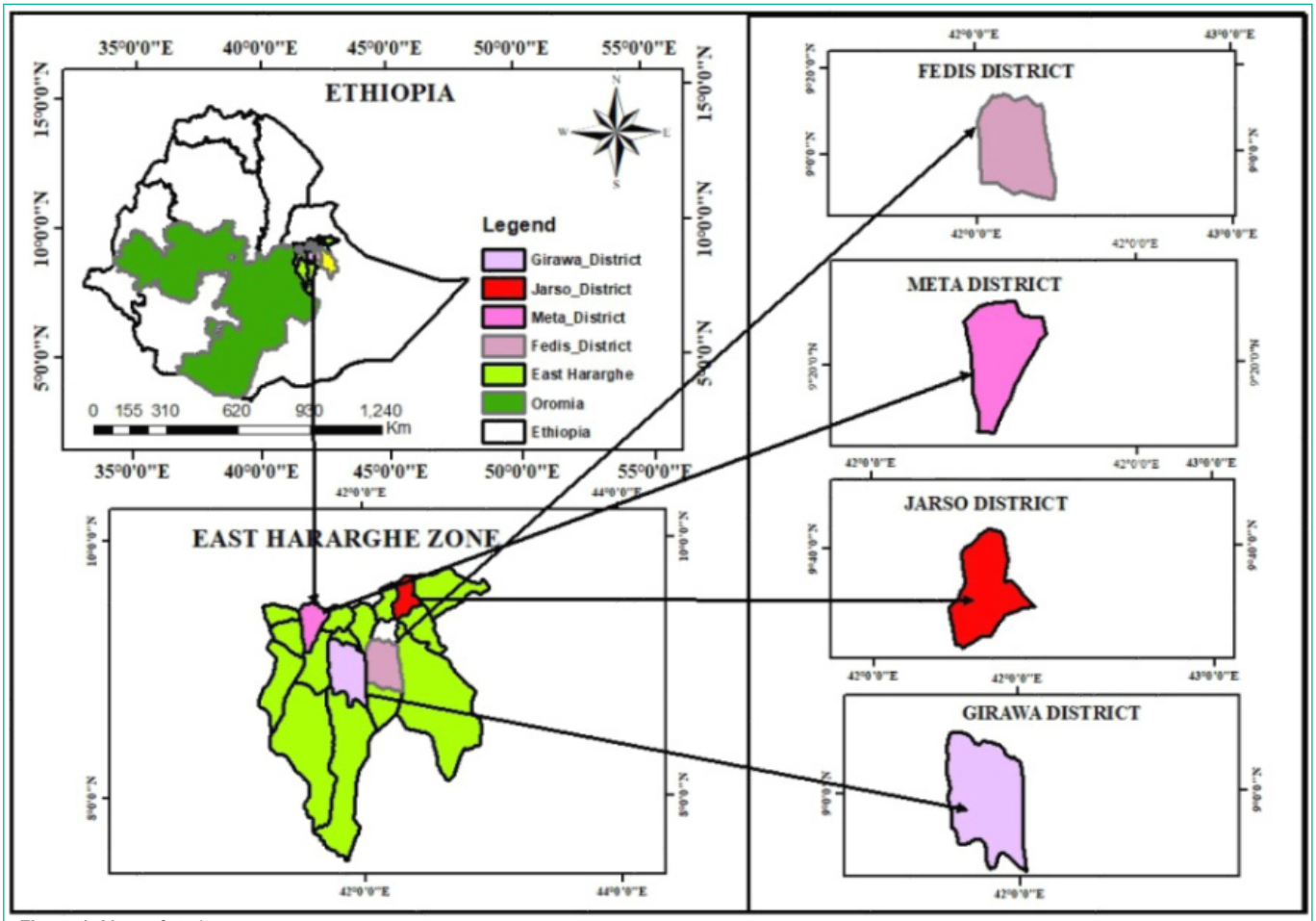

Figure 1: Maps of study areas.

Research Methodology

Description of Study Areas

This study was conducted in Fedis, Girawa, Jarso and Meta districts of Eastern Hararghe Zone of Oromia Regional State, Ethiopia (Figure 1).

Method of Sampling and Sample Size Determination

A multi-stage random sampling technique was used to draw sample respondents in the study districts. In the first stage, four potential districts were identified with East Hararghe Zone agriculture office based on their potentiality of honey production and improved beehive promotion in the zone. In second stage, two *kebeles* from each selected district were selected randomly based their potentiality of honey production and modern beehive promotion. A total of eight *kebeles* were selected for this study. In the third stage, the sample respondents were stratified into modern beehive technology adopter and non-adopter and listed in selected *kebeles*. Here the adopters were the beekeepers who currently used modern beehive while the non-adopters were those who used traditional beehive in the study districts. Finally, a simple random sampling technique was used to select the sample respondents in the study districts using proportion to population size (PPS).

Types, Sources and Methods of Data Collection

Both primary and secondary data were used for this study. The primary data were collected by using semi-structured questionnaire with sampled beekeepers. Secondary data were collected from secondary sources such as zonal and districts offices of agriculture, and published and unpublished documents. Secondary data were collected through reviewing of secondary sources and checklists.

Methods of Data Analysis

The collected data were analyzed by using descriptive statistics and econometric models. The descriptive statistics were frequency, percentages, mean value, standard deviations, graphs and figures whereas for inferential statistics t-test and x^2-square were used for continuous and categorical data respectively. Numerous econometric models have been applied to analyze the determinants of technology adoption. However, the econometric specification largely depends on the purpose of the study and the type of data available. One of the most used methods for modeling technology adoption behavior is the censored regression model also called the Tobit model. The key underlying assumption for the model specification is that farmers demanding improved technology it's have unconstrained by access [8].

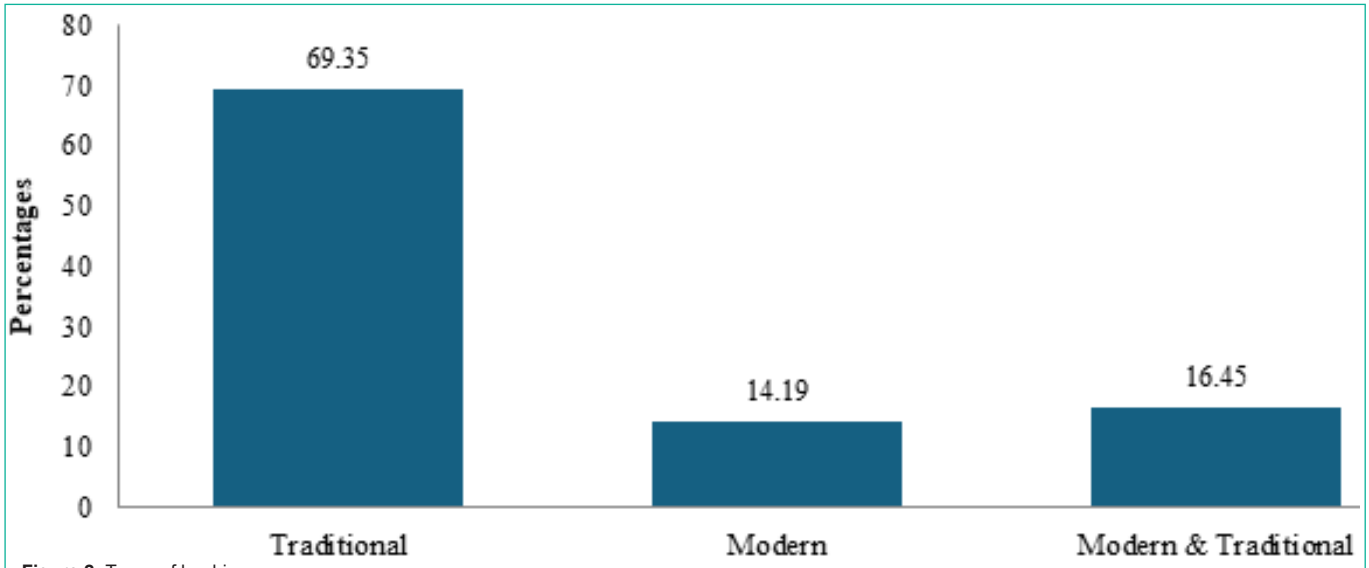

Figure 2: Types of beehives.

Results and Discussion

This section was discusses the descriptive statistics and econometric model analysis results in the study areas.

Results of Descriptive Statistics

Demographic and Socio-Economics Characteristics of the Respondents:

As indicated in Tables 1 and 2 among the total number of respondents 87.74% were male-headed and 12.26% were female-headed households. Among the total sample of households, 34.21% of the female-headed and 65.79% of the male-headed households were adopters but the chi-square value was insignificant. The chi-square test shows that membership in beekeeping cooperatives, access to extension services, access to modern beehive accessories, participation in technology demonstrations and beekeepers' perceptions of the high cost of modern beehives had a positive and significant association with the probability of adoption of the modern beehive at less than 1% and 5% significance level of respectively in the study areas.

The mean age of respondent was 38.03 and 37.32 for non-adopters and adopters which show statistically insignificant between non-adopters and adopters in the study areas. The mean household size was 6.53 and 6.10 for non-adopters and adopters which show statistically significant differences between non-adopters and adopters respectively in the study areas (Table 3). The average numbers of local beehive holding were 1.972 and 1.144 for non-adopters and adopters respectively which show a statistically significance difference at less than 1% significance level between non-adopters and adopters in the study areas. The distance from the district's town was 3.485 kilometers for non-adopters and 2.037 kilometers for adopters which is a statistically significant difference (Table 3). The survey results depicted in Table 3 show that the honey yield of modern beehives

Table 1: Socio-Economics characteristics of the respondents (Dummy variables)

Variables		Non- Adopters (N = 211)		Adopters (N = 99)		Total (N= 310)		χ2- value
		N	%	N	%	N	%	
Sex of respondents	Female	25	65.79	13	34.21	38	12.26	0.172
	Male	188	69.12	84	30.88	272	87.74	
Education level of respondents	Illiterate	80	68.97	36	31.93	116	37.42	0.006
	Literate	133	68.56	61	31.44	194	62.58	
Membership to beekeeping cooperatives	No	207	72.38	79	27.62	286	92.26	23.112***
	Yes	6	25	18	75	24	7.74	
Off/Non-farm activities	No	175	69.72	76	30.28	251	80.97	0.628
	Yes	38	64.41	21	35.59	59	19.03	

Source: Own survey data results, 2023, Note: *** is significant at less than 1% significance level

Table 2: Respondents' access to institutional services (Dummy variables)

Variables		Non- Adopters (N = 211)		Adopters (N = 99)		Total (N= 310)		χ2- value
		N	%	N	%	N	%	
Access to Extension services	No	172	85.15	30	14.85	202	65.16	72.88***
	Yes	41	37.96	67	62.04	108	34.84	
Participation on modern beehive technology training	No	191	79.25	50	20.75	241	77.74	55.98***
	Yes	22	31.88	47	68.12	69	22.26	
Participation on modern beehives technology demonstration	No	201	74.44	69	25.56	270	74.2	32.01***
	Yes	12	30	28	70	40	25.8	
Access to modern beehive accessories	No	206	78.63	56	21.37	262	84.52	77.39***
	Yes	7	14.58	41	85.42	48	15.48	
Access to improved bee forages	No	210	71.2	85	28.8	295	95.16	17.42***
	Yes	3	20	12	80	15	4.84	
Access to credit services	No	211	69.18	94	30.82	305	98.4	1.948
	Yes	2	0.94	3	3.09	5	1.6	
Access to protective materials	No	212	81.54	48	2	260	83.87	123.4***
	Yes	1	18.46	49	98	50	16.13	
Supplementary feed for bee colony	No	75	75.75	31	29.25	106	34.19	0.3133
	Yes	138	67.65	66	32.35	204	65.81	
Perception to high price of modern beehives	No	60	68.97	151	67.71	211	68.06	0.832**
	Yes	27	31.03	72	32.29	99	31.94	

Source: Own survey data results, 2023, Note: *** and ** significant at the 1 and 5 significance levels respectively.

was by far better than that of the traditional beehives in the study areas. The average honey yield per hive from frame hive in 2014/15 production years was 11 and 4.5 kg/hive/year respectively. Thus, the use of improved beehives had a yield advantage of 6.5 kg or 59.1% compared with the yield from traditional beehives in the study areas.

Adoption Status and Level of Adoption of Modern Beehive Technology:

According to this survey results out of 310 respondents, only 99 (31.94%) were the adopters of modern beehives while the remaining 211(68.06%) were non-adopters. The highest (60.67%) and lowest (15.85%) adoption status of modern beehive technology was recorded in the Fedis and Jarso districts respectively (Table 4). According to the respondents, this low adoption rate of improved beekeeping technology was due to the high cost needed for the technology, the need for accessories, and the lack of knowledge about the technology. Moreover, the lack of training and extension support were also mentioned as factors for a low adoption rate. There was a statistically significant difference in the adoption of modern beehive technology among districts at less than a 1% significance level. This may be due to the difference in access to extension services, close to research center, for instance, Fedis Agricultural Research Center, and access to modern beehive and its accessories which influence the adoption of modern beehive technology among the districts.

The level of adoption of modern beehives showed that about 16.77%, 9.68% and 2.9% of the adopters of modern beehive had owned one, two and three modern beehive per households respectively in the study areas (Table 5).

The beekeepers used traditional, modern and both modern and traditional beehives in the study areas. However, there was no transitional beehive available in the study areas (Figure 2). About 75.74%, 19.22% and 5.04% of the adopters had accessed modern beehives through purchasing, supplied by NGOs and offices of

Table 3: Socioeconomics characteristics of respondents (Continuous variables)

Variables	Mean			t-test
	Non-Adopters (N = 211)	Adopters (N = 99)	Combined (N = 310)	
Age of respondents in years	38.03	37.32	37.81	0.489
Total amount of farm land owned in hectares	0.329	0.334	0.3304	-0.207
Number of livestock owned of the household in TLU	2.43	2.32	2.39	0.553
Total number of household size	6.53	6.10	6.39	1.343*
Total annual farm income (1000 Birr)	28.84	66.83	40.72	-3.452
Beekeeping experience in years	6.103	6.186	6.129	-0.094
Number of local beehive owned	1.972	1.144	1.713	4.91***
Distances to district town in kilometer	10.461	6.994	9.376	4.338***
Amount of honey yield harvested per colony from traditional hive (Kg)	5.13	3.1	4.5	4.595***

Source: Own survey data results, 2023, Note: *** and * significant at the 1 and 10% significance levels respectively.

agriculture respectively in the study areas. The high purchasing cost was 5500 Birr/hive.

Results of the Econometric Models

Factors Affecting Adoption and intensity of Adoption of Modern Beehive Technology:

The results of the Tobit regression model indicated that distances from farmers' training centers, total annual income, number of traditional beehives owned, cooperative membership, access to modern beehive accessories, access to extension services, perception of the respondents to high price, participation in demonstration of modern beekeeping technology and districts dummy were statistically significant variables that affected simultaneously adoption and intensity of adoption of modern beehive technology in the study areas (Table 6). Here, the Fedis district was used as a reference due to the difference in access to extension services, farmers' awareness about advantages and sources of modern beehives, close to the research center, for instance, Fedis Agricultural Research Center, and access to modern beehive and its accessories. Distances from FTC were positively and significantly associated with modern beehive adoption and level of adoption as a contrast to hypothesize. Holding other variables constant, the beekeepers reside closer to the FTC by one kilometer, and the probability of adopting a modern beehive likelihood increased by 3.2%. FTC is a bridge to transmit extension information through the demonstration of the technology by development agents to the farmers which was agree with Hassen, [9]. Annually farm income of households was associated positively with adoption and intensity of adoption of modern beehive technology at less than 10% significance level. The result revealed that as the annual farm income of households' increases by one thousand birr, the likelihood of adoption of modern beehives increases by 0.05 percent keeping other factors constant. This could be explained by the fact that an increased use of modern beehive technology required additional income to purchase it. This may improve their financial constraint since the price of modern beehives is high cost. Therefore, farmers with higher incomes were more likely to increase the utilization of modern beehives. This finding was consistent with Kassa *et al.,* [10] which indicated that as the annual farm income of the beekeepers increased by one thousand birr, the likelihood of adoption and intensity of modern beehives was increased by 10 percent.

The results from the econometric model show that the number of traditional beehives possessed by beekeepers negatively affect both the probability of adoption decision and the intensity of adoption of modern beehive at less than 1% significance level. This indicated that as the number of traditional hives possessed by the households increased by unit the likelihood of adoption and intensity of adoption of modern beehives decreased by 20.25 percent. It may be argued that beekeepers who owned large numbers of traditional beehives were reluctant to use large numbers of modern beehives they would rather experiment with small numbers of modern beehives to compare the honey yield between modern and traditional beehives. This result was similar to Asmiro *et al.,* [11] on the study conducted on adoption and intensity of use of modern beehives in Wag Himra and North Wollo Zones, Amhara Region, Ethiopia. Cooperative membership

Table 4: Adoption status of modern beehive technology in the study areas

Districts	Total samples	Non-Adopters	Adopters	χ2- value
Fedis	89	35 (39.33)	54 (60.67)	54.7665***
Jarso	82	69 (84.15)	13 (15.85)	
Meta	70	56 (80)	14 (20)	
Girawa	69	51 (73.91)	18 (26.1)	
Overall	310	211 (68.06)	99 (31.94)	

Source: Own survey data results, 2023, Numbers in parentheses were percentages

Table 6: Factors affecting adoption and intensity of adoption of modern beehive technology

Variables	Coefficient	Robust Std. Err.	P-value
Sex of the respondents	0.0771	0.1261	0.542
Age of the respondents	-0.0026	0.0040	0.525
Education level of the respondents	0.0688	0.1001	0.492
Household size of the respondents	-0.0143	0.0146	0.329
Beekeeping experience	0.00470	0.0050	0.349
Distances to district town	0.00111	0.0091	0.904
Distances to FTC	0.03196*	0.0165	0.055
Total land size owned	-0.20026	0.1929	0.300
Non-farm Income	-0.1208	0.095	0.205
Annual Farm Income	0.0005*	0.00021	0.011
Livestock ownership (TLU)	0.0219	0.0251	0.384
Number of traditional hives owned	-0.2025***	0.0437	0.000
Cooperative membership	0.6942***	0.1423	0.000
Access to modern beehive accessories	0.4204***	0.0869	0.000
Access to extension services	0.3729***	0.0926	0.000
Participation on technology Demonstrations	0.1708*	0.0976	0.082
Access to credit services	0.1394	0.1911	0.467
Perceptions of high price to modern beehive	-0.1878**	0.09171	0.041
Meta District	-0.4421***	0.1099	0.000
Jarso District	-0.9813***	0.1539	0.000
Girawa District	-0.657***	0.1619	0.000
_Constant	0.4092	0.2644	0.123
/Sigma	0.4588	0.03306	

Note: ***, ** and * significant at the 1, 5 and 10% probability levels respectively, Log of Likelihood = -124.51, Censored observations = 211, Uncensored observations = 99, Prob > F =18.26 (0.000)***

influences positively the adoption and intensity of adoption of improved beehive technology at less than a 1% level of significance. As compared to those households who were not member of cooperatives, the adoption of improved beehives increased by 69.42 percent for those households who were members of cooperatives. This might be due to differences in the benefits of being membership of cooperatives in terms of training and technical support which can increase adoption of improved technology. A study by Kassa *et al.,* [10] and Asmiro *et al.,* [11] confirmed that being a member of a cooperative motivates farmers to use improved beehives more by giving technical advice, access to inputs and up-to-date information provision to their members.

Access to extension services had a positive influence on the adoption decision and intensity of adoption of improved beehive technology at less than 1% significance level. The result of the model indicates that as the beekeepers had access to extension services the probability of adoption and intensity of adoption increased by 37.29 percent. Thus, the farmers who are frequently visited by extension agents tend to be more progressive in the adoption of improved beehive technology. The result is consistent with Asmiro et al., [11], Kassa et al., [10] and Amanuel [2]. As expected, access to modern beehive accessories positively influenced the adoption and intensity of adoption of modern beehives at less than a 1% probability level. As the beekeepers' had access to modern beehive accessories, the adoption and intensity adoption of modern beehives increased by 42.04 percent. The results of this study show that the access and availability of modern beehive accessories or inputs were necessary conditions for the adoption and intensity of the adoption of modern beehives. Modern beehive accessories (honey harvesting and processing equipment like wax-stumper, queen excluders, honey extractors, bee smokers and others) were among the other major constraints to modern beehive adoption [12,13].

Table 5: Level of adoption of modern beehive in study areas

Number of modern beehives owned	Frequency	Percentage	Number of modern	Frequency	Percentage
1	52	16.77	6	1	0.32
2	30	9.68	8	1	0.32
3	9	2.92	9	1	0.32
4	4	1.29	10	1	0.32

As compared to non-participants, the maximum likelihood of adoption and intensity of adoption of modern beehive technology increased by 17.08 percent for those who participated in the demonstrations of modern beehive technology. This may be due that those beekeepers who participate in demonstrations of improved beehive technology get the chance to exchange knowledge and experience with experts, researchers and beekeepers themselves which motivates the beekeepers towards adopting the technology. Hence, conducting demonstrations of modern beehive technology at the model farmers' apiary sites and FTCs are an important mechanism to introduce beekeeping technologies that create easiness of adoption. This finding was similar with Tulu et al., [14]; Kassa et al., [10] and Tamrat (2015). The beekeepers' perception of the high price of modern beehives was negatively associated with the adoption and intensity of adoption of modern beehive technology at less than a 5% significance level. This indicates that as the purchasing price of modern beehives increases the maximum likelihood of adoption and intensity of adoption of a modern beehive decreases by 18.78 percent. This is a fact because the unavailability and high price of modern beehive was the main problems in the adoption and intensity of adoption of modern beehive in the study areas. This finding was similar to Kassa et al., [10] who said that as compared to farmers who perceive the price of improved box hive price high, the adoption decision of improved box hive increased for those farmers who had low and medium perception on the expensiveness of improved hive respectively

Conclusion and Recommendations

Conclusion

Even though the government of Ethiopia gives great attention to the beekeeping sub-sector to promote improved beekeeping technologies, the probability of adoption and use intensity of

modern beehives is still low due to different factors such as socio-economics, access to and availability of institutional services, access to and availability of inputs and improved technological accessories, psychological and knowledge of the technology which is also similar with study areas.

This study aimed to analyze the adoption of modern beehive technology in Fedis, Girawa, Jarso and Meta districts of East Hararghe Zone, Oromia Regional State, Ethiopia. The current adoption status of modern beehives indicates that there was low adoption status in the study areas. Only 31.94% of beekeepers adopted modern beehives.

The results of the Tobit econometric model show that the adoption and intensity of adoption of modern beehive technology in the study areas had a significant relationship with the distances to farmers' training centers, annual farm income, numbers of traditional beehives owned, cooperative membership, access to modern beehive accessories, access to extension services, participation on technology demonstration, perception to the high price of modern beehive and difference among districts to the reference.

Based on the findings, the authors recommend that the major factors in the adoption and intensive adoption of modern beehives should be considered by policymakers, research, extension, and input suppliers, and other actors along the honey value chain interventions are needed to improve further adoption of modern beehive then increasing the production and productivity of honey in the study areas.

Recommendations

The government should have to consider policies and strategies in order to improve the adoption of modern beehive technology in study areas. Therefore, based on the above conclusions on the constraints and empirical results the following recommendations were suggested for policy, research, extension, and development interventions in the study areas.

- Modern beekeeping accessories (protective, honey extractor, wax stumper, smokers etc.) have to be supplied or made easily accessible to the beekeepers by districts offices of agriculture which can positively affect the adoption and intensity of adoption of modern beehive;
- Districts offices of agriculture should be improve the supply of modern beehives for the beekeepers with its partners like NGOs, Research Center, and Private sector in the study areas;
- Districts offices of agriculture should have to deliver adequate and relevant extension services (training on modern beekeeping technologies; both theoretical and practical), and demonstration, and beekeepers to beekeepers experience sharing, advises, frequent visit etc) are important in the study areas;
- Integrating beekeeping activities with crop and livestock production by beekeepers is important in order to diversify their income, and improve financial constraint to access modern beekeeping technologies;
- District cooperative offices should organize newly jobless youth and women in beekeeping cooperatives on closure areas, and strengthen the existing beekeeper cooperatives by facilitating access to financial services, providing training, facilitations of access to modern beehives and its accessories, and frequent flow up are important in the study areas;

Acknowledgements

The authors are thanks from the bottom heart to Oromia Agricultural Research Institute for the financial support. In addition the authors are gratefully thanks beekeeper farmers, woreda experts, DAs, enumerators and drivers who were participated for the success of this study.

References

1. Workneh, A.; Puskur, R. Beekeeping sub sector challenges and constraint in Atsbi Wenberta district of eastern Tigray Region, Ethiopia. 2011.
2. Amanuel Bekuma. Review on Adoption of Modern Beehive Technology and Determinant Factors in Ethiopia. Mettu University, College of Agriculture and Forestry, P. O. Box 318, Bedele, Ethiopia. 2018.
3. Gidey, Y.; Mekonen, T. Participatory technology and constraints assessment to improve the livelihood of beekeepers in Tigray Region, northern Ethiopia. *Momona Ethiopia Journal of Science*. 2010; 2.
4. Central Statistical Authority (CSA). 2021/22, Agricultural sample survey 2021/22 on livestock and livestock characteristics. Central Statistics Authority, Addis Ababa, Ethiopia.
5. Holeta Bee Research Center. Beekeeping Training Manual. Holeta, Ethiopia. 2004.
6. Feder, L., R. E. Just; O, Zilberman. Adoption of agricultural innovation in developing countries: A survey. Economic development and cultural change. 1985; 32: 255-298.
7. Dasgupta, S. Diffusion of agricultural innovations in village India. Department of Sociology and Anthropology, University of Prince Edward Island, Canada. 1989.
8. Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data*, 2nd ed.; Cambridge, MA: MIT Press. 2010.
9. Hassen, B. Factors Affecting the Adoption and Intensity of Use of Improved Forages in N. East Highlands of Ethiopia. *American Journal of Experimental Agriculture*. 2004; 4: 12-27.
10. Kassa, T.; Jema, H, Bosena, T. Factors affecting market supply of honey in Chena district, Kaffa zone, Southern Ethiopia. *Journal of Development and Agricultural Economics*. 2018; 10: 99-109.
11. Asmiro, A.; Kindye, A.; Mulugeta, A.; Lijalem, A. Adoption and Intensity of Modern Bee Hive in Wag Himra and North Wollo zones, Amhara region, Ethiopia. *Agricultural and Resource Economics: International Scientific E-Journal*. 2017; 3: 5–26.
12. Gebiso, T. Adoption of Modern Bee Hive in Arsi Zone of Oromia Region: Determinants and Financial Benefits. *Agricultural Sciences*. 2015; 6: 382-396.
13. Wongelu Endale. Adoption of Transitional Chefeka Bee Hive Package: The Case of Wolmera Woreda, Oromia Special Zone, MSc. Thesis. Haramaya University, Haramaya Ethiopia, 2014.
14. Dereje, Tulu; Melkam, Aleme; Gezahegn, Mengistu; Ararsa, Bogale; Amsalu, Bezabeh; Esayas Mendesil. Improved beekeeping technology in Southwestern Ethiopia: Focus on beekeepers' perception, adoption rate, and adoption determinants, Cogent Food & Agriculture. 2020.