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Factors Determining Adoption of Modern Beehive in Mengeshi District, Majang Zone, Gambella Region, Ethiopia

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Abstract

Ethiopia is one of Africa's Countries that has the largest honey bee population and potential of honey production due to its varied ecological and climatic conditions. However, the products obtained from honeybees were low due to several technical, socio-economic, and institutional constraints. This study is conducted in the Gambella region, Majang zone in Mengeshi District with the objective of assessing the factors that affect the adoption of a modern beehive and its intensity. The primary data was collected from beekeepers through a semi-structured interview schedule. The source of secondary data was from written documents such as journals, books, published documents. A two-stage sampling method was used. In the first stages, 4 kebeles were selected out of 30 kebeles from the study district by using random sampling methods. Then among the selected kebeles, the beekeepers were stratified into adopters and non-adopters of a modern beehive. A total of 172 (45 adopters and 127 non adopters) rural bees keepers were interviewed for this study with a proportional random sampling method. Descriptive analysis tools such as percentage, mean, standard deviations, t-test, and chi-square are used, and Tobit econometric model is applied by using STATA-14. The Tobit model result revealed that educational level, annual income of beekeepers; credit service, extension contact, number of livestock owned, participation in off-farm activities, and participation in training is the main significant factors in adoption decision and intensity use of modern beehive. Therefore, the policymakers and planners of governmental and NGOs must consider when setting their policies and strategies of honey production improvement interventions.

Keywords: Adoption, Beekeeping, Determinants, Modern beehive

1. INTRODUCTION

Beekeeping has been practiced since ancient times and honey has been considered by many cultures as a valuable and precious commodity that is used in traditional rituals, healing or as food (Lietaer, 2009). In nearly all countries of the world bees and their products are not only well known and have wide consumer preference, but provide sustainable livelihoods to many small-scale farmers and other rural and non-rural people (FAO, 2012). Beekeeping by its nature doesn't need huge investment (financial asset), large size of land and complicated technical knowledge. The outcomes of beekeeping are real; some of its outcomes include income, material goods, wellbeing and satisfaction (Nicola, 2009). Thus, contributes to incomes as well as food security through provision of honey, beeswax and pollen as food and propolis, bees' venom and royal jelly in medicine in addition to pollination services. Beekeeping supports millions of household livelihoods in Sub Sahara Africa (Gidey and Mekonen, 2010). Honey has for centuries been one of the most highly desired commodities among the hunter-gatherer communities, it is the only readily available sweetening agent and tradable commodity. Hive products have been used by mankind for centuries. For instance, bee brood is traditionally eaten as a high protein food while beeswax is used in candle making. Other hive products are now used in the pharmaceutical and cosmetic industries. For instance, propolis is now widely used in apitherapy for its anti-viral and anti- bacterial properties. Pollen on the other hand has found its way to some health food outlets as a protein rich commodity (Paterson, 2006). Beekeeping has immense benefits in terms of provision of pollinators, which enhance crop yield. It is estimated that one in every three bites of food we eat is a result of pollination of plants in which bees play a very important part. Adequate pollination leads to better quality seeds and fruits and is essential for sustaining biodiversity (Caroll, 2006).

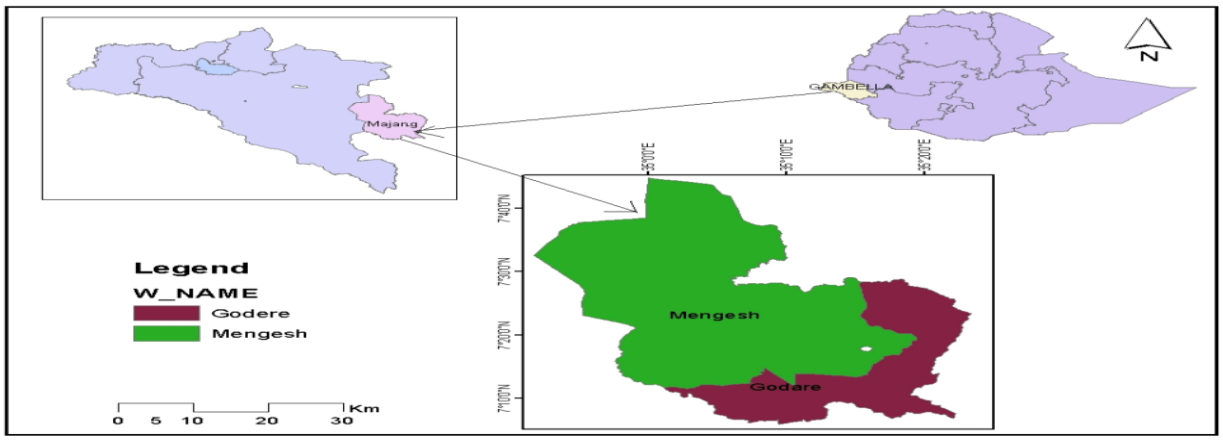
In Ethiopia, beekeeping is an integral part of the life style of the farming communities and except for a few extreme areas; it is a common practice in every place where human kind has settled. It is an important activity for many rural people; both men and women carried out in home gardens in all parts of the country. Adequate forage availability coupled with favorable and diversified agro-climatic conditions of Ethiopia creates environmental conditions conducive for the growth of over 7000 species of flowering plants which have supported the

existence of large number of bee colonies in the country that exist in the forest (Beyene and David, 2007). Additionally, Ethiopia is home to some of the most diverse flora and fauna in Africa that provide surplus nectar and pollen to foraging bees (Chala et al., 2012). It has the largest bee population in Africa with over 10 million colonies, out of which about 5 to 7.5 million are estimated to be hived while the remaining exist in the wild (CSA, 2009). Furthermore, Ethiopia is among the major producer of honey both in Africa and in the world. For instance in 2013 the country produced about 45 thousand tones which accounted about 27% and 3% of African and world honey production respectively and makes the country the largest producers in Africa and the tenth in the world (FAOSTAT, 2015).Endowing with diverse agro-climatic zones, Ethiopia has the potential to produce up to 500,000 tons of honey and 50,000 tons of beeswax per year (GDP, 2009 cited in Belets and Berhanu, 2014). Therefore, Ethiopia has recently give more attention to the sub-sector than ever before as an important intervention areas to support the poor and particularly women. As a result, large number of improved beehive technologies have been introduced and promoted by the regional bureau and other nongovernmental organizations over the past 10 years. However, the number of modern beehives used by farmers was very limited (Akinwumi, 2001).

2. RESEARCH METHODOLOGY

2.1. DESCRIPTION OF THE STUDY AREA

The Majang are agriculturalist Nilotic-speaking people of Surmic origin inhabiting south western Gambella of Ethiopia. Their habitation area now ranges from South of Gurafarda to the small forest around Metu. The area that they co-exist with the other tribes is the most densely forested in the Region and they too depend on forest resources for their livelihood. They are particularly noted as honey producers for which the forest ecosystem is critical. Moreover, for all population groups the ecosystem provides a variety of other essential resources, including wood for tools, grass for homesteads, wild food, medicinal and other useful plants, and access to water resources.



2.2 SOURCES AND TYPES OF DATA

To realize the objectives of this thesis both the qualitative and quantitative data was used from the primary and secondary data sources. The primary data source was from beekeepers through interview. The source of secondary data was from written document such as from journals, books and publish document.

2.3 SAMPLING TECHNIQUES AND SAMPLING SIZE

The study was used a two stage sampling method. At the first stage 4 Kebele's was selected out of 30 Kebele's by using lottery random sampling methods. Then among the selected Kebele's, the beekeepers was stratified into adopters and non-adopters of modern beehives. The total sample size for the study was 172 beekeepers. Based on their probability proportional to size principle, 45 adopters and 127 non-adopters were taken for interview through systematic sampling method. By using Yamane formula the sample size was determine as follow (Yamane Taro, 1967)

$$n = \frac{N}{1+N*(e)^2} \quad (1)$$

Where;

n= the sample size

N= the population size

e = The acceptable sampling error

Then population size=5608

The confidence interval is 92.5% there for e = 0.075

n=?

$$n=\frac{N}{1+N*(e)^2}$$

(2)

$$n=\frac{5608}{1+5608*(0.075)^2}$$

(3)

n=172

(4)

2.4 METHOD OF DATA COLLECTION

Primary and secondary data was used for this study. The primary data was collected primarily from beekeepers through interview. Semi-structured interview schedule was designed and it was pre-tested with enumerators to evaluate for consistency, clarity and to avoid duplication and to estimate the time requirement during data collection.

For these purpose 8 development agent enumerators was employed and trained. The secondary data was collected from written document such as from journals, books and publish document.

2.5 METHOD OF DATA ANALYSIS

The tools for data analysis were used descriptive statistics such as percentages, mean and standard deviations; t-test and $\chi 2$ were also used to test the continuous and discrete variables, respectively. STATA version 14 was used to analyze quantitative data. In this study Tobit model was employed to analyze the determinant factors of adoption and intensity of adoption of modern bee hive.

2. RESULTS AND DISCUSSION

2.1. DESCRIPTIVE STATISTICS

Under descriptive statistics important determinant characteristics of households and outcome variables were displayed with appropriate statistical tools such as percentages, mean and standard deviations; t-test and $\chi 2$ was also applied to test the continuous and discrete variables, respectively. Adoption of modern beehives by farm households to the context of this study was therefore, measured in terms of modern beehives users and non-users. Based on descriptive results household characters, socio-economic factors and institutional factors are presented as follow.

2.1.1. Household demographic character

Sex of household head: The survey result indicated in (Table 4) that, out of the total respondents 95.35% were male headed and the remaining was female headed households. But with regard to adopters and non-adopters about 100% of the adopters and 93.7% of the non-adopters group were male headed. The percentage difference between adopters and non-adopters in terms of sex was significant at 10% significance level.

Age of household head: The survey result shows that, the mean age of the total respondents was 48.12 year. As indicated in (Table 5) that, the mean and standard deviation of age of household head for adopters and non-adopters was 43.48, 49.76 years, and 6.72, 8.41 respectively. The t-test indicates that, the mean difference of age of household head between adopters and non-adopters was significant at 1% significance level.

Family size: The survey result shows that, the mean family size of the total respondents was 5.59. As indicated in (Table 5) that, the mean and standard deviation family size of adopters and non-adopters was 5.66, 5.56 and 1.52, 1.33 respectively. The t-test indicates that, the mean difference of number of family size of household head between adopters and non-adopters was not significant.

Education of the household head: The survey result indicated in (Table 4) that, out of the total respondents 43.02% was literate and the remaining was illiterate. But with regard to adopters and non-adopters about 91.11% of the adopters and 25.98% of the non-adopters

group were literate. This implies that literate farmers have more exposure to the external environment and information which helps them easily associate to technology. The percentage difference between adopters and non-adopters in terms of literacy was significant at 1% significance level.

Household economic factors

Total land holding; Farm size was thought to be a good proxy indicator of wealth status the farmers in the country. The survey result shows that, the average land holding of the total respondents was found to be 1.07 hectare. This figure is lower than the national figure, which is 1.5 hectare implying in the study area land holding is low. As indicated in (Table 5) that, the mean and standard deviation of land holding of adopter and non-adopter was 1.43, 0.95 hectare and 0.36, 0.37 respectively. The t-test indicates that, the mean difference of total land holding between adopters and non-adopters was significant at 1% significance level.

Livestock size (TLU): The survey result shows that, the average livestock size (TLU) of the total respondents was 4.63. As indicated in (Table 5) that, the mean and standard deviation of livestock owned by adopter and non-adopter was 7.19, 3.72 and 1.94, 1.72 respectively. The t-test indicates that, the mean difference of livestock holding between adopters and non-adopters was significant at 1% significance level.

Number of local beehive: The survey result shows that, the average of number of traditional beehive owned by the total respondents was 2.8. As indicated in (Table 5) that, the mean and standard deviation of traditional beehive owned by adopter and non-adopter was 2.6, 3.3 and 2.12, 1.7 respectively. The t-test indicates that, the mean difference of number of traditional beehive between adopters and non-adopters was significant at 5% significance level. The survey result shows that, the mean and standard deviation of number of modern beehive owned by the total modern beehive adopter was 1.64 and 0.80 respectively. As indicated in (Appendix Table 4 and Appendix Table 5), the minimum and maximum number of traditional beehive owned by the total respondents was 0 and 10 respectively whereas the minimum and maximum number of modern beehive owned by adopter was 1 and 4 respectively.

Total annual income: The survey result shows that, the average total annual income of the total respondents was 30046.92 Ethiopia birr. As indicated in (Table 5) that, the average yearly

total income of adopter and non-adopter was 40559.33 and 26322.05 Ethiopia birr respectively. The t-test indicates that, the mean difference of total annual income between adopters and non-adopters was significant at 1% significance level.

Institutional factor

Credit use: As indicated in (Table 4), it was revealed that 7.56% out of the total respondents and 28.89% among the adopters were the only beneficiaries of the existing credit opportunity. However, from the total non-adopters no one benefit from the existing credit opportunity. The percentage difference between adopters and non-adopters in terms of credit use was significant at 1% significance level.

Extension contact: As indicated in (Table 4), out of the total respondents 44.19% of the respondents had one and more than one times a month contact with extension agent. But with regard to adopters and non-adopters about 91.11% of the adopters and 27.56% of the non-adopter's group were one and more than one times a month contact with extension agent. The percentage difference between adopters and non-adopters in terms of frequently contact with extension agent was significant at 1% significance level.

Participate on training: As indicated in (Table 4), it was revealed that 24.42% out of the total respondents and 71.11% among the adopters were trained about beekeeping. However, from the total non-adopters only 7.87% were trained. This percentage difference between the two categories was statistically significant at 1% level. This implies that training has a positive contribution to adopt the modern beehive since the proportion of the adopters who were trained was much higher than non- trained adopters.

Involvement in off-farm activity: As indicated in (Table 4), out of the total respondents 5.23% of the respondent was involved in off-farm activity. But with regard to adopters and non-adopters about 15.55% and 1.57% of adopter and non-adopter respectively, was involved in off-farm activity. This implies that the adopters more participate on off-farm activity. This helps them to solve financial problem. The χ2-test shows that, the difference between adopters and non-adopters with respect to involvement in off-farm activity was significant at 1% significant level.

Price of modern beehive: The price of modern beehive in the study area was 1050 Ethiopian birr. As indicated in (Table 4), out of the total respondents 69.77% were responded that the

price of modern beehives was expensive. But with regard to adopters and non-adopters about 64.44 % of the adopters and 71.65% of the non-adopters group were responded that the price of modern beehives was expensive. The percentage difference between adopters and non-adopters in terms of price of modern beehive was not significant.

Table 1 Demographic and socio-economic characteristics of respondents (Dummy variables)

Variable		Adopters= 45(26.16)	Non adopters=127(73.84)	Total=172	Chi-square value
Sex of respondents	Female	0(0)	8(6.3)	8(4.65)	2.97*
	Male	45(100)	119(93.7)	164(95.3.5)	
Level of education	Illiterate	4(8.89)	94(74.02)	98(56.98)	57.49***
	Literate	41(91.11)	33(25.98)	74(43.02)	
Extension contact	Yes	41(91.11)	35(27.56)	76(44.19)	54.41***
	No	4(8.89)	92(72.44)	96(55.81)	
Credit access	Yes	13(28.89)	0(0)	13(7.56)	39.69***
	No	32(71.11)	127(100)	159(92.44)	
Involvement in off farm activities	Yes	7(15.56)	2(1.57)	9(5.23)	13.1***
	No	38(84.44)	125(98.43)	163(94.77)	
Participate on training	Yes	32(71.11)	10(7.87)	42(24.42)	72 ***
	No	13(28.89)	117(92.13)	130(75.58)	
Participate on demonstration site	Yes	9(20)	3(2.36)	12(6.98)	15.93***
	No	36(80)	124(97.64)	160(93.02)	
Expensive price of modern beehive	Yes	29(64.44)	91(71.65)	120(69.77)	0.818
	No	16(35.56)	36(28.35)	52(30.23)	

***, **, and * show the level of significance at 1%, 5% and 10% respectively and figures in parenthesis is percentages

Source: own survey result, 2018.

Table 2. Demographic and socio-economic characteristics of respondents (Continuous variables)

Variables	Adopters		Non- adopters		t-value
	Mean	Standard deviation	Mean	Standard deviation	
Age of the respondents.	43.48	6.72	49.76	8.41	4.51***
Number of family size	5.66	1.52	5.56	1.33	-0.41
Land size	1.43	0.36	0.94	0.37	-7.44***
Livestock size	7.19	1.94	3.72	1.72	-11.2***

Number of traditional beehive	3.33	2.12	2.61	1.7	-2.27**
Total annual income	40559.33	6953.57	26322.05	10529.89	-8.43***

***, **, and * show the level of significance at 1%, 5% and 10% respectively.

Source: own survey result, 2018.

3. ECONOMETRIC ANALYSIS

3.1. DETERMINANTS OF MODERN BEEHIVE ADOPTION

With descriptive statistics of sample households, we test of the existence of relationship between the dependents and independent variables to identify factors affecting intensity and adoption of modern beehive. Identifications of these factors alone are however not enough unless the relative influence of each factor is statistically determined. In this section, Tobit model was used to see the relative influence of demographic, socio-economic and institutional variables on intensity and adoption of modern hive. The overall significance of the model is measured by the Wald statistics which follows a chi-squared distribution with 10 degree of freedom.

The hypothesis that all the coefficients except the constant are zero is rejected as equation is significant at 1 percent significance. This implies that significant proportion of the dependent variable is explained by independent variables. The likelihood-ratio chi-squared had a value of 57.35 with Pseudo-$R^2$of about 64.39 percent which implies that about 64.39 percent of the variation in the intensity and adoption of modern hive in the district was explained by the variables considered (Table 6). Therefore, Heteroscedasticity problem was corrected by the use of command *robust* in STATA (version 14). The multicollinearity problem was checked by using VIF (Variable Inflation Factor) for continuous variables and CC (Contingency Coefficient) for dummy variables and there was no series problem (Appendix Table 6 and Appendix Table 7, respectively). By rule of thumb, there was no problem of multicollinearity as CC was found to be less than 0.8 and VIF found was less than 10. Out of the total hypothesized variables, 7 of them were found to be significant in determining modern beehive adoption and its intensity of adoption. Thus variables are education status of household head, access to loan, extension contact, total annual income, livestock size, participate on off farm activity and. participate on training.

Table 3.Measurements of goodness of fit from the Tobit model

Tobit regression		Number of obs	=	172
		LR $chi^2(10)$	=	207.44
		Prob > chi^2	=	0.0000
Log likelihood =	-57.356636	Pseudo R^2	=	0.6439
		Left-censored observations at intensity <= 0	=	127
		Uncensored observations	=	45
		Right-censored observations	=	0

Source: own survey result, 2018.

Table 4 . Results of Tobit model regression for factors determining adoption and intensity

Variable	Coef.	Std. Err.	T	Marginal effect for adoption	Marginal effect for intensity
Age of household head	-.015	.014	-1.06	-.000	-.001
Participation on off-farm activity	.547	.311	1.76*	.038	.06
Education level of household head	1.423	.300	4.74***	.099	.147
Extension contact	1.622	.323	5.02***	.125	.17
Land size	-.049	.295	-0.17	-.001	-.004
Total livestock unit	.1	.053	1.86*	.002	.009
Access credit	1.402	.258	5.43***	.273	.212
Participation on Training	.441	.254	1.74*	.02	.044
Natural logarithm of total income	1.71	.456	3.74***	.049	.156
Number of traditional beehives	.057	.053	1.08	.001	.005
_cons	-20.383	4.863	-4.19		
/sigma	.701	.075			

***, ** and * show the level of significance at 1%, 5% and 10% respectively.

Source: own survey result, 2018.

Household head education; Educational level of the household head is important to note as determinant of adoption to farm technologies. The possible reasons for more adoption of modern hives by beekeepers with higher educational backgrounds could be that education may increases access to information and their knowledge to understand the technology. Beekeepers, who can read and write, can have simple and diversified communication ways to extension

services. As the Tobit model result indicates in (Table 7), education status of household head is positive and statistical significantly correlated with adoption of modern beehive and its intensity of adoption at 1% level of statistical significance. The marginal effect result also shows that, beekeepers those who can read and write, keeping other things constant, have 9.9% and 14.7% respectively, higher probability of adopting, modern beehive and its intensity of adoption unlike illiterate beekeepers. The result is also supported by earlier study (Sisay et al., 2013 and Sheleme, 2017).

Access to credit; As a liquidity factor, the more farmers have access to source of finance, the more likely to adopt agricultural technologies that could possibly increase honey yield. As the Tobit model result indicates in (Table 7), access to loan was positive and significant influence on adoption of modern beehive and its intensity of adoption at 1% statistical significance level. The marginal effect result also shows that, beekeepers those who had access to loan, keeping other things constant, had 27.3% and 21.2% respectively, higher probability of adopting modern beehive and its intensity of adoption compared to non-adopter farmers. This finding is consistent with (Sisay et al., 2013 and Tadele, 2016).

Extension contact; As the Tobit model result indicates in (Table 7), extension contact has positive influence on the probability of modern beehive adoption and its intensity of adoption at 1% statistical significance level. From this result it is possible to state that farmers who are frequently visited by extension agents tend to be more progressive and more likely to experiment with modern beehive. The marginal effect result also shows that keeping other things constant the estimated increase in the probability of adoption of modern beehive and its intensity of adoption due to frequent contact with extension agent was 12.5% and 17% respectively. The result is consistent with (Sheleme, 2017).

Total annual income: As the Tobit model result indicates in (Table 7), total annual income is positive and statistical significantly correlated with adoption of modern beehive and its intensity of adoption at 1% level of significance. The marginal effect result also shows that keeping other things constant, when the income of the beekeeper increase by one percent the probability of adopting, modern beehive and its intensity of adoption increase by 4.9% and 15.9% respectively.

The result is also supported by earlier studies , farmers who have higher total annual income will be able to buy modern beekeeping equipment's better than others that who have lower total annual income (Asmiro et al., 2013 and Tamrat, 2015).

Livestock size (TLU): In rural context, livestock holding is an important indicator of household wealth. In addition, livestock is considered to be a source of income, food and drafting power for crop cultivations. The number of livestock owned by farmers was positively associated with adoption decision in most adoption literature. As the Tobit model result indicates in (Table 7), livestock size is positive and significantly correlated with adoption of modern beehive and its intensity of adoption at 10% level of significance. The marginal effect result also shows that keeping other things constant, when livestock size (TLU) of beekeeper increase by one unit the probability of adopting, modern beehive and its intensity of adoption increase by 0.2% and 0.9% respectively. The result is also supported by earlier studies having more units of livestock was positively related to the adoption of agricultural technologies because it serve as proxy for wealth status (Asmiro et al., 2013).

Participation on off farm income source: This variable affects adoption of modern beehives and intensity of adoption positively and significantly. As the Tobit model result indicates in (Table 7), participation on off farm income source was positive and significantly correlated with adoption of modern beehive and its intensity of adoption at 10% level of significance. The marginal effect result also shows that, beekeepers those who participate on off farm income source keeping other things constant, have 3.8% and 6% respectively, higher probability of adopting, modern beehive and its intensity of adoption.

The result is also supported by earlier study**;** farmer's involvement in off-farm/non-farm activities will relieve their financial constraints to purchase inputs such as modern beehives equipment's (Sisay et al., 2013 and Tamrat, 2015).

Participation on training: This variable affects adoption of modern beehives and intensity of adoption positively and significantly. As the Tobit model result indicates in (Table 7), participation on beekeeping training is positive and significantly correlated with adoption of modern beehive and its intensity of adoption at 10% level of significance. The marginal effect result also shows that, beekeepers those who participate on beekeeping training keeping other things constant, have 2% and 4.4% respectively, higher probability of adopting, modern beehive

and its intensity of adoption. The result is also supported by earlier studies (Sisay et al., 2013 and Tamrat, 2015).

CONCLUSION

Even though the government of Ethiopia gives great attention to the beekeeping sub sector to promote modern beekeeping technologies, but the probability of adoption and intensity use of modern beehive is found to be very minimal (Amanuel, 2018). The main determinants probability of adoption decision and the intensity use of modern beehive are education status of household head, access to loan, extension contact, total annual income, livestock size, participate on off-farm activity and participate on training. Even though almost all beekeepers know the presence of modern beehives, they did not adopt because of different reasons. For instance, the result of survey from descriptive statistics shows that beekeepers do not have enough awareness on advantages of the technologies that enable them to use modern beehives because of their was poor extension contact with extension agent, no enough training and demonstration site visiting; lack of capital and also most of the beekeeper responded that the price of modern beehive was expansive. Those were the major problems around the beekeepers. The result of econometric model also clearly indicates that education status of household head, access to loan; extension contact and total annual income were among the most significant determinants of adoption and intensity of adoption of modern beehive. That means probability of adoption of modern beehive and intensity of adoption beekeepers, those who can read and write, keeping other things constant, have 9.9% and 14.7% respectively, higher probability of adopting, modern beehive and its intensity of adoption unlike illiterate beekeepers; who had access to loan, keeping other things constant, had 27.3% and 21.2% respectively, higher probability of adopting modern beehive and its intensity of adoption unlike non-adopter beekeepers; keeping other things constant the estimated increase in the probability of adoption of modern beehive and its intensity of adoption due to frequent contact with extension agent was 12.5% and 17% respectively and keeping other things constant, when the income of the beekeeper increase by 1% the probability of adopting, modern beehive and its intensity of adoption also increase by 4.9% and 15.9% respectively.

RECOMMENDATION

Based on the results of the study, the following recommendations are suggested to increase modern beehive adoption and its intensity of adoption: Adult education programs must be promoted and expanded in rural areas as a precondition to facilitating modern beehive adoption and its intensity of adoption either by GO or NGOs. Extension contact between beekeepers and extension agents should be further strengthened; by reducing farmer to development agent ratio and by increasing frequency of contact to promote modern beehive that focuses on a practical approach. Therefore, Provision of credit service to beekeeper which helps the poor beekeepers to solve their financial constraints, the beekeeper can use the loans to buy modern beehives. GO and NGOs must work on to increase farmer's income source like increase animal health center and species to increase the income from livestock, increase crop yield by using different technology and support farmers to participate on off-farm activity by giving training. Training should be given by giving attention to increase the skill and knowledge's of the beekeepers about modern beehive either by GO or NGOs.

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