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Determinants of Smallholder Farmers' Participation in Beekeeping in Godere District, Gambella Regional State, Ethiopia

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Abstract

Across the world, the livelihoods of communities living in forest areas are in general dependent on subsistence agriculture and specifically on beekeeping farming. This farming system has providing different alternative as sustainable livelihood option i'e generates income, creates job opportunity, and alleviates poverty through producing honey, beeswax and other bee products for small scale farmers However, in Ethiopia, there are various factors that hold back the rural households to increase and participate on beekeeping practices. The objective of this study was to analyze the factors that affect participation of smallholder farmers in beekeeping practices in the Godere district in 2023/24. To attain the objective of the study, cross sectional data were collected from rural households and analyzed using binary logistic regression model. According to the result of maximum likelihood estimation, the marital status, household size, sex, and the educational status of the household head, number of extension visits, membership in farmers' association, and access to credit were the statistically significant variables determining beekeeping adoption in the study area. The beekeeping constraints that had statistically significant influence on beekeeping adoption were grouped as marketing, natural, and financial. Therefore, to completely undo the income potential of beekeepers and consume the benefits from the enormous potential of honeybee colonies, the government of Ethiopia, Non government organizations, Development agencies and other associated actors and stakeholders should work together to overcome the constraints faced by beekeepers in adopting beekeeping practices that could result in improving their productivity, efficiency and livelihoods.

1 Introduction

1.1 Background of the Study

Globally, the beekeeping practice is one of the oldest known methods of food production and it is almost 5,000 years dates back in Africa (Gratzer et al., 2021). From African continent, the largest bee populations with over 10 million bee colonies are found in Ethiopia, out of which about 7.5 million are confined in hives and the remaining 2.5 million are feral colonies (Bayissa et al., 2024). In addition to various honeybee floras, the diversified agro-climatic conditions found in Ethiopia have created a favorable environment for 2 million people to involve on beekeeping practice (FAOSTAT, 2015; Yadeta, 2019).

From agriculture sector, beekeeping farming has gained importance depending on increasing demand of apicultural products. Beekeeping activity not only makes rural labour productive, but also makes destroyed natural resources valuable. Beekeeping is a production line that can be done continuously without consuming large resources and is an important tool of sustainable rural development. It is environmentally friendly practices and suitable for low income households. Particularly for rural households beekeeping can coexist effortless with regular farming activities (Abro et al., 2022). Those engaged in beekeeping could earn income from production and marketing of honey and its by-products (beeswax, royal jelly, pollen, propolis, bee colonies, and bee venom). The sector could also create a non-gender-biased employment opportuni-

ties.

Recently, the contributions of beekeeping in poverty reduction, sustainable development and conservation of natural resources have been recognized and well emphasized by the government of Ethiopia and NGOs. According to Tulu et al. (2020) it is non-farm business activity that has immense contribution to the economies of segments of the society and to a national economy as a whole. Ethiopia has the potential to produce 500,000 tons of honey, but current production is limited to 43,000 tons of honey.

Gambella Region is also one of the regions in the country that is endowed with high dense natural forest in which honeybee plants are grown. The mean annual temperature of the region (17.3°C to 28.3°C), annual rainfall (900-1,500mm), altitudes (1,900-2,100mm) and existences of big rivers (Baro and Alwero) making the region an ideal place for bees to survive and produce honey and other valuable bee products. In addition, beekeeping is heavily practiced in some zones of the region with extremely important income sources as means of maintaining family livelihood (CSA (Central Statistics Authority), 2013). Anywa, Majang, Gambella city and Itang special woreda are naturally endowed for bees and beekeeping is largely practiced by the community living in them. Even though the region as well as the Majang zone is the potential areas for beekeeping, to generate income, create jobs, and alleviate poverty, there are many constraints that hinder rural households from adopting and expanding beekeeping practices. Therefore, it is necessary to identify the constraints faced by rural households to adopt beekeeping practices

2 The Status of Beekeeping Production and Productivity in Ethiopia

The Ethiopian population is increasing at an alarming rate and reached around 129.5 million peoples (Worldometers, 2024). The fundamental problems challenging the government of Ethiopia today is ensuring for millions of households living in poverty to have access to enough food to maintain a healthy life through consuming more than two times in a day. However, Agriculture sector is taking the lion share to solve this community and Government pain and headache by providing enough food to those millions of people as their level in our country.

According to Etefa et al. (2022), agriculture remains to be the principal engine of growth of the economy and building block of the social life of the people in Ethiopia. This sector contributes about 36.3% of GDP, provides employment opportunities to more than 73% of total population that is directly or indirectly engaged in agriculture, generates about 70% of the foreign exchange earnings of the country and 70% of raw materials for the industries in the country (UNDP (United Nations Development Programme), 2018).

Ethiopia is believed to have the largest livestock population in Africa. This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. It is eminent that livestock products and by-products in the form of meat, milk, honey, eggs, cheese, and butter supply etc. provide the needed animal protein that contributes to the improvement of the nutritional status of the people. Livestock also plays an important role in providing export commodities, such as live animals, hides, and skins to earn foreign exchanges to the country.

From this large sector, the livestock sector donates around 20% to Ethiopia's GDP, at the same time it offers a livelihood to 60 – 70% of the population (Asresie, 2015; MOI/Ministry of Industry, 2016). By having varied and comfortable climatic and ecological conditions from African continent, Ethiopia have more than 10 million beehives which is feeding around 2 million peoples and it also contributes around 1.3% for GDP (Akessa, 2016; Tarekegn & Ayele, 2020). On average, beekeepers in Ethiopia produces 48,712 tonnes of honey and owns 5.89 million managed bee colonies (CSA/Central Statistical Agency, 2020).

From the world, Ethiopia ranks first in honeybee colonies, fourth in beeswax production in the world, and tenth in honey production (Girma & Gardebroek, 2015; Rivera et al., 2007). The beekeeping value chain generates jobs opportunity for nearly 2 million people in Ethiopia (Drost & Van Wijk, 2011). Beekeeping generates a non-gender-biased employment opportunities and also offers large opportunities for a lot of landless farmers – which includes many women and young people – to improve their livelihoods (Abro et al., 2022). Thus, this beekeeping sub-sector has getting attention from both government, different NGOs and development partners' (NPC (National Planning Commission), 2016).

According to The Mastercard Foundation (2020), more than70 thousand unemployed young people got job opportunity in beekeeping sector by the MasterCard Foundation which spends millions of dollars. Beekeeping is taking a lion share role in generating employment opportunities, increasing foreign exchange earnings and sustaining livelihoods of the large societies (Abro et al., 2022).

Despite the fact that, this very important sub-sector, beekeeping sector, is significantly challenged by different factors i'e diseases and pests, the indiscriminate application of agrochemicals for crop protection, low adoption of modern beekeeping practices and technologies and low quality of beekeeping products which brings honeybee colony losses and low production and productivity (Amulen et al., 2019; Chala et al., 2013; EIAR/Ethiopian Institute of Agricultural Research, 2017; Fikru, 2015; Girma & Gardebroek, 2015; Gratzer et al., 2021; Kalayu et al., 2018; Kenesa, 2018; MoA-ILRI, 2013; Pirk et al., 2016; Tassew et al., 2018; Tulu et al., 2020; Wagner et al., 2019; Wakagri & Yigezu, 2021).

To mitigate the sub-sector's challenges, the Ethiopian government has developed the national apicultural strategies and policies which assists the poor smallholder farmers to increase their production and productivity of honey by introduction and promotion of improved beehives technologies i'e Ethioribrab hive, Kenya top bar, Zender, and chefeka (Awraris et al., 2012; CSA/Central Statistical Agency, 2020; FDRE/Federal Democratic Republic of Ethiopia, 2009; MoA-ILRI, 2013).

Though the Policy designed by the government of Ethiopia admits the sub-sector's constraints, and it necessitates the sustainable and sustainable management of apiculture resources in the country (Abro et al., 2022).

The aim of the government was to create job opportunity for youth, to increase the income of the poor, to improve the living standard of the people, to reduce food insecurity and poverty as well as to

ensure the economic development and prosperity of the country through beekeeping technology adoption. Following the aims and goals of the government, different non government organizations and companies was come out along beekeeping value chain including traders, beekeeping equipment producers, and honey and beeswax processors for the successfulness and sustainability of the government aims and policies (Girma & Gardebroek, 2015).

Figure 1: Bee and beekeeping instruments

3 METHODOLOGY

3.1 Description of study area

The study was carried out at Godere districts of the Gambella People's Regional State (GPNRS). Godere is one of the districts in Majang Zone of Gambella Regional State. Majang zone is located at about 620 km away from Addis Ababa in South Western Ethiopia in between 7°10′ 0″-7°40′ 0″ N latitude and 35°0′ 2″-35°20′ 2″ E longitude. It also has an altitude ranging from 500 to 2400 m above sea level (Alemu et al., 2015). The climate of the district is a hot and humid type. It receives high rainfall between mid-March to October and low rainfall from November to February. The annual rainfall amount of the area ranges from 900mm to above 2200mm but the majority of the areas receive over 1500mm/annum. The lowest mean monthly temperature is 13.2°C and the highest mean monthly temperature is 33.1°C with an average temperature of 22.2°C (Alemu et al., 2015). The soil of the district is reddish brown, well drained and clay in texture (Yeshitela, 2008).

3.2 Sources and Methods of Data Collection

Both primary and secondary data was collected from the study area. Primary data was collected from sample of households (beekeeping participants) using structured questionnaire. Besides the structured questionnaire, Checklist and FGD was used to collect the primary data. The data was collected from relevant sources such as bureau of agriculture of the districts, traders of honey, NGOs and other relevant institutions for general description and to verify the primary data. The secondary data was collected from different books and journals. In order to facilitate data collection process, experienced enumerators was recruited based on their proficiency in the local language and then trained on data collection techniques and on the content of the questionnaire.

By using the prepared semi-structured questionnaires which was pre-tested, and translated into local language, the selected beekeepers were interviewed. From primary data i'e numbers of bee colonies, socio-economic parameters, annual honey yield of single colony, and vernacular names of honeybee flora and their flowering calendar, types of beehives, etc. were collected from sampled respondent households. Moreover, the collection of other important data like potentials and constraints of honey production and marketing systems, honey harvesting frequency and seasons and way of harvesting was also supported by group discussions with experienced beekeepers and key informants.

3.3 Sampling Technique and Sample Size

To select appropriate sample households for this study, a two stage sampling technique was employed. In the first stage of sampling procedure, depending on the information taken from secondary data of the district Agricultural office, based on their production potential, two kebeles in the rural household of godere district (i.e., smallest administrative unit), kabo and Meti Zuria was selected through random sampling method based on the history of honey production and its representativeness to the district beekeeping potential areas. Consequently, around 120 beekeeping households

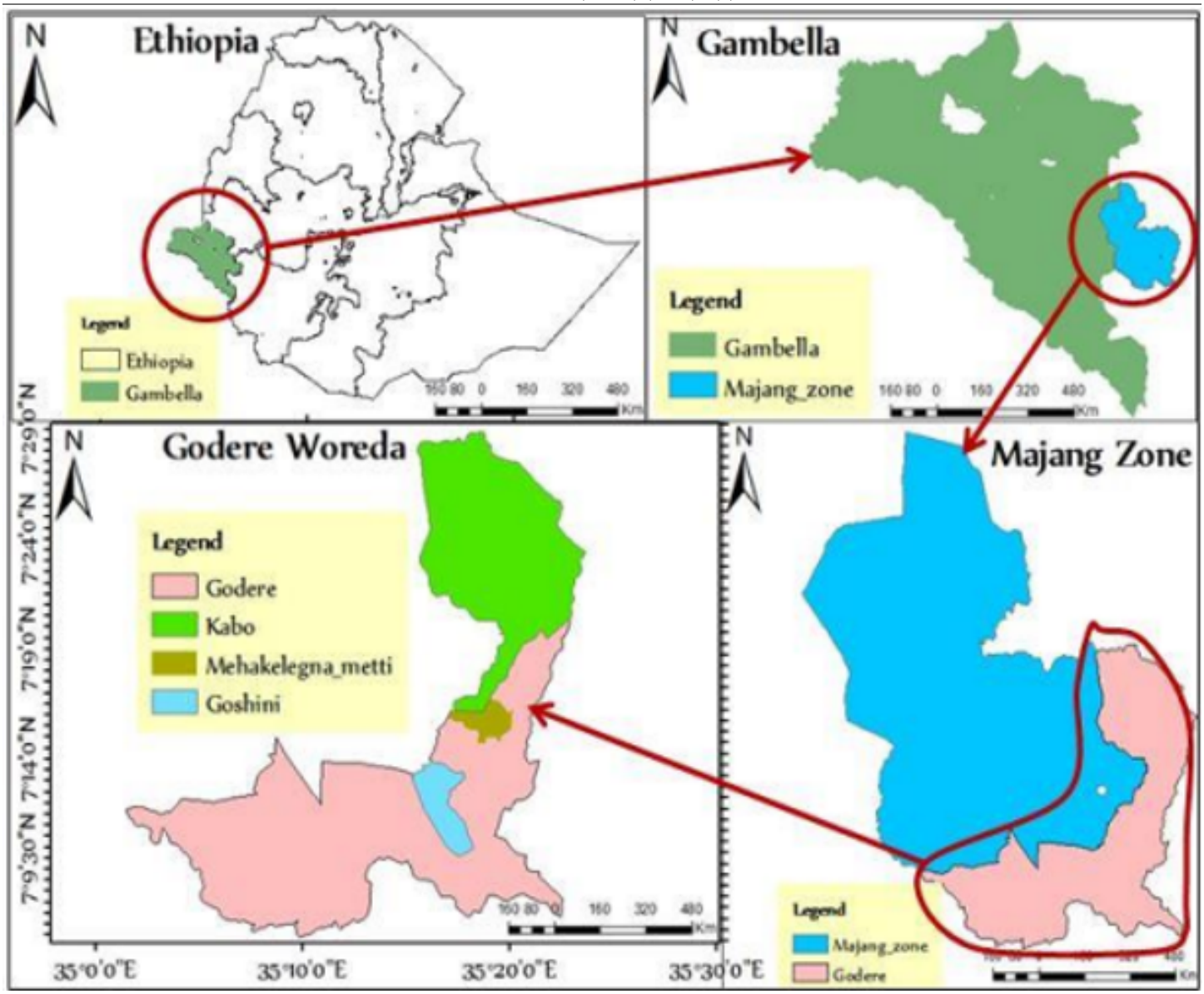

Figure 2: Map of study area: Godere district, Gambella Region

were selected, 60 from kabo and 60 from Meti Zuria kebeles by using Yemane formula (Yamane, 1967).

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

3.4 Method of Data Analysis

In order to analyze the data, both descriptive statistics and econometrics method was employed.

3.4.1 *Descriptive analysis*

The quantitative data was obtained through different data collection methods was analyzed using descriptive analysis and statistical tests. Descriptive statistics such as mean, frequency, standard deviation and percentage and correlation model were statistical tools. Moreover, statistical tests such as t-test, F-test, and chi-square test were used to test the significance of the variables under consideration.

3.4.2 *Econometric method (binary logistic regression model)*

The appropriate model applied when the dependent variable has dichotomous outcome is binary logistic regression model which is one from the non-linear econometric models. Therefore, for this study, we used binary logistic regression model to analyze the determinants of beekeeping participation in the study area. Logit model is tremendously flexible and significantly gives a very meaningful interpretation of the data (D. Gujarati, 1998). According to Wright (1995), binary logistic model is an influential instrument for estimating the individual influences of categorical and continuous

variables on a qualitative dichotomous dependent variable.

According to D. N. Gujarati (2004), in estimating the Logit model, the dependent variable (participation in this study) which takes a value of 1 if the household participated in a program and 0 otherwise. The advantage of this model is that the probabilities are bounded between 0 and 1. The dependent variable is dichotomous, taking two values, 1 if an individual participates in small-scale beekeeping and 0 otherwise. Based on D. Gujarati (1998), the logistic distribution function for the relationship between the probability of the dependent dichotomous variable and several independent variables can be specified as:

$$\frac{e^{Zi}}{1+_n e^{Zi}} \tag{2}$$

$$Zi = \alpha 0 + \beta i \sum_{i=1} Xi + \varepsilon i + Ui \tag{3}$$

$$1 - p(x) \stackrel{=}{} \frac{1}{1+_t e^{Zi}} \tag{4}$$

$$\frac{p(x)}{1-p(x)} = \frac{1+e^{Zi}}{1+e^{-Zi}_n} = e^{Zi} \tag{5}$$

$$\text{Li=Ln}\frac{\text{p(x)}}{\text{1-p(x)}}\text{=Ln}(e^{\alpha 0}+\beta \text{i} \sum_{i=1} Xi + ui) \tag{6}$$

Where,

- i= 1, 2, 3, - –, n
- $\alpha 0$ Refers to intercept
- βi=Refers to regression coefficients to be estimated
- ui= Refers to a disturbance term, and
- Xi= Refers to re-intervention characteristics.

4 RESULTS AND DISCUSSIONS

4.1 Availability of Equipment for Honey Production and Processing

In this section, the availability of equipment for honeybee production and processing presented by using descriptive statistics. As Subramanian et al. (2007), processing can be described as the steps followed from the raw honey harvest to bottling of honey

From the results obtained in this study, only 30% of the households in the study area processed the honey produced and around 70% of rural households did not process honey produce. In the study area, honey processing also includes converting/processing honey to traditional honey beer called Tej (made from mixing honey, Rhamnus prinoides (gesho), and malt). The Table 1 illustrates descriptive statistics of the percentage of the adopters who have access to equipment for honeybee production and processing. As illustrated in Table below, the greater part of the sampled respondents (72%) have no access the strainer equipment for honey production and only the remaining 28% had the access of it (Table 1).

Table 1 also Concern the availability of packaging and transporting in the study area. Accordingly, only around 30% and 32% of the beekeepers did have packaging and transporting equipment, respectively; whereas 70% and 68% of the adopters did not have the said equipment in the study area. Additionally, from the results of the descriptive statistics, only around 22% of adopters had harvesting gear and the remaining 78% responded that they did not have harvesting gear in the study area.

Table 1: Availability of equipment for honeybee production and processing in the study area

Equipment needed for activities	Category	Percent
Sieve (Strainer)	Yes	28%
	No	72%
Packaging	Yes	30
	No	70
Transporting	Yes	32
	No	68
Harvesting gear	Yes	22
	No	78

Source: Survey result (2024)

4.2 The Test Statistics Of Reliability Of The Principal Components (Pcs)

Table 2 illustrates the test statistics of the composite and the reliability of individual PCs that confirm the values of the Cronbach's alpha (α) are greater than the required value. As recommended in **Cronbach1951<empty citation>**, the composite reliability of PCs and the standards of the reliability coefficient for the individual PCs is $\alpha \geq 0.7$ and $\alpha \geq 0.6$ respectively. As illustrated on Table 2, the Cronbach's α values were 0.991, 0.987, 0.994, 0.929, and 0.921 for the first, second, third, fourth, and fifth PC, respectively. The overall Cronbach's α value was 0.927. Therefore, the PCs are reliable indicators of the data set and hence explain a meaningful amount of the variance.

Table 2: Reliability test statistics of principal components

Name of principal component	Number of items (constraints)	Individual reliability (Cronbach's alpha)	Overall reliability
Marketing constraints	15	0.991	
Natural constraints	11	0.987	
Honeybee production constraints	11	0.994	0.927
Management constraints	5	0.929	
Financial constraints	4	0.921	

4.3 Determinants of Beekeeping Participation By Rural Households in Godere District

By using appropriate techniques, different econometric assumptions were tested before performing the econometric estimation. Consequently for binary logit model, initially, the presence of strong multicollinearity among continuous explanatory variables

was tested via variance inflation factors (VIF) and the data obtained can be concluded that the data set had no serious problem of multicollinearity. Second, contingence coefficient (CC) was used to check the existence of multicollinearity between discrete variables. There was no any continuous or discrete explanatory variable dropped from the estimated model since no serious problem of multicollinearity were detected from both the VIF and contingency coefficient results. As a result, all the explanatory variables were retained and moved to the analysis.

Table 3 below shows the results of the maximum likelihood estimation of the binary logistic regression model which we used to determine the significance of the determinants and of the constraints for beekeeping adoption. As shown on the table, among the 14 explanatory variables, 11 of them significantly influence beekeeping adoption in the study area. The result of the table concluded that, the model is well fitted since the value of the likelihood ratio $\chi 2$ was highly significant.

The sex of the household head was positively and significantly affects the beekeeping adoption in the study area which indicates that male headed rural households are more likely to adopt beekeeping practices than female headed rural households (Table 3). More specifically, the odd ratio in favor of beekeeping participation, being a male headed household increases the probability of beekeeping adoption by 32%. The similar result was found by Mushonga et al. (2019) and Amulen et al. (2019). They reported that gender bias is one of the challenges of beekeeping adoption and male headed farmers were more likely to be beekeepers than female headed households.

Regarding the household size of the household, the study found that, it's negatively and significantly affects the adoption of households in beekeeping, which indicates that having a large household size reduces the probability of beekeeping adoption in the study area (Table 3). More generally, the odd ratios in favor of beekeeping adoption, an increase in household size by one person decrease the probability of beekeeping adoption by 20.2%. This may be due to large household sizes require a larger proportion of their income to be exhausted on basic needs, which in turn limits larger size rural households head from adopting beekeeping practices. The result was consistent with the result of Abro et al. (2022), who got similar result in North West Ethiopia.

The study also found that, the marital status of the household head positively and significantly affects the household adoption in beekeeping, which shows that married rural household were more likely to adopt beekeeping practices than their counterparts' i'e single, divorced, and widowed (Table 3). The odd ratios in favor of beekeeping participation, being married household head increases the probability of beekeeping practice by 87%. This result was consistent with Abro et al. (2022) and Jeil et al. (2020).

According the result of the study, the coefficient of the number of visits by extension agents was positive and significant for beekeeping participation (Table 3). Specifically, odds ratio in favor of beekeeping adoption increases by 0.2% as the household head had more extension visit than those who doesn't. Consistent result was obtained by Tarekegn et al. (2017), Tarekegn and Ayele (2020) and Tulu et al. (2020).

Table 3: Marginal effects of the determinants of beekeeping adoption after Logit analysis

Explanatory variable	Marginal Effect	P-value
Sex of the household head (dummy)	0.32	0.014**
Age of the household head in number of years	-0.019	0.923
Marital status of the household head (dummy)	0.87	0.003***
Household size measured by the number of persons in the family	-0.202	0.011**
Educational status of the household head (dummy)	0.561	0.012**
The number of years a household lived in the district	-0.015	0.401
Number of visits by extension agents in the previous year	0.002	0.062*
Membership in a farmers' association (dummy)	0.647	<0.001***
Access to credit to the household (dummy)	0.490	0.046**
Whether a household processes honey produce (dummy)	0.004	0.743
Marketing constraints (PC1)	-0.110	0.064*
Natural constraints (PC2)	-0.029	0.075*
Constraints for honeybee production (PC3)	-0.162	0.057*
Management constraints (PC4)	0.018	0.661
Financial constraints (PC5)	-0.288	0.034**

Note: ***, **, and * represent significance at the 1%, 5%, and 10% level of significance, respectively.

Being membership in association of farmers' was positively and significantly influenced the beekeeping adoption by rural households in the study area (Table 3). This means, the odds ratio in favor of beekeeping participation, being a membership of a farmers' association increases the chance of adopting beekeeping practices by 64.7%. Similar result was found by Tarekegn et al. (2017) and Tarekegn and Ayele (2020). In the study area, the credit access was positive and had a significant influence on beekeeping adoption, which shows that household heads who had access to credit have greater probability to be adopter and to have necessary technologies and equipment for beekeeping practice easily (Table 3). More specifically, the odd ratios in favor of beekeeping practice; having more credit increases the probability of beekeeping adoption by 49%. This result is consistent with that of Amulen et al. (2019) and Tulu et al. (2020).

Table 3 shows that, the marketing constraints were affects the beekeeping practices in the study area negatively and significantly. Specifically, the odd ratios in favor of beekeeping adoption, facing more marketing problems and challenges decreases the probabil-

ity of beekeeping adoption by 11% in the study area. Similar result was found by Mushonga et al. (2019) and Tulu et al. (2020).

5 Conclusions And Recommendations

To attain the objective conducted research, binary logistic regression model was used with its maximum likelihood estimation results. According to the output of the model, seven variables from the stated variables i'e educational level, marital status, household size, sex, number of extension visits, membership in a farmers' association, and access to credit influence beekeeping adoption significantly in the study area.

There are also other constraints which are statistically affecting beekeeping participation in the study area accordingly marketing constraints, natural constraints, constraints for honeybee production, and financial constraints. The findings of the study forwarded some policy implications for the beekeeping sector specifically as well as for the whole economy in general.

Ethiopia has a huge potential in the beekeeping sector from livestock sector from east Africa. Although the country in general and the households specifically consuming the benefits obtained from the beekeeping sector even though it's very low. To harvest more benefits from beekeeping sector in the country, the concerned bodies i'e government, non government organizations and different companies related to this sector should be able to focus on training programs, credit schemes, women-focused interventions related to beekeeping practices.

Above all, specifically for regional government and Godere district, it's better to design policies focusing on improving the education level of the household, the financial access of rural, the aware and motivate female headed households in beekeeping, increasing the frequency of visits of agricultural extension agents, and enabling farmers to share their experience and knowledge and giving training by organizing them in a group or association.

Additionally, we recommend that, to obtain more output from the sector, concerned stakeholders, including community beekeeping groups, local processors, NGOs, and packagers, and researchers should focus on the constraints to solve properly and should introduces modern beekeeping by constructing from locally available materials to reduce the cost of production in the study area.

Most of all, given the time and budget constraints, the study focused only on the factors that affect the participation of small holder farmers in beekeeping practices in Godere district. In these regard future research in the area is needed to investigate the impact of adoptions of modern technologies and roles of women in beekeeping.

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Data availability Statement

Data can be made available on the behave of the request

Declaration of interests' statement

The author declare that no competing interests

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