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Determinants of Honey Supply by Smallholder Farmers: The Case of Horro Guduru Wollega Zone, Oromia, Ethiopia

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Abstract: This study focused on analyzing the determinants of honey supply; and the major opportunity and challenges of honey production and supply in Horo Guduru Wollega Zone of Oromia Region, Ethiopia. A total of 121 honey producers were selected randomly from a list of honey producers found in 5 purposively selected 'kebeles'. The data were generated by individual interviews and group discussions using pre-tested semi structured questionnaires and checklists. Secondary data were collected from different published and unpublished sources. The data collected were analyzed with the help of descriptive statistics and econometric model (multiple linear regression model) with the aid of STATA version 14.2 software. The results obtained from the econometric analysis indicate that colony size, type of beehives used, beekeeping equipment, market information, current honey price, frequency of extension contact per year and training were positively and significantly affected honey supply. The major constraints of honey production and supply were: the shortage of bee forage, indiscriminate agrochemical application, pests and predators, rain at harvesting time, drought, absconding and migration, lack of knowledge and extension support, poor infrastructure, market problem, lack of beekeeping equipment and honey collection centers. However, some opportunities that encourage the activity like availability of bee colony, favorable environment and annual flora and farmers experiences have also been identified. To boost the volume of honey supply, which in turn increase producers' income from honey sale, all concerned bodies need to focus on building farmers capacity via training on improving honey production and supply, increasing access to improved beehives and its accessories, availing extension facilities, improving road facility, organizing honey producers to increase the volume, access to marketing and price setting and establishing honey market center is recommended for policy intervention.

Key words: Honey Supply · Determinants · Smallholders · Multiple Linear Regression Model · Opportunity and Constraints

INTRODUCTION

The Apicultural practice has been an essential part of agriculture in Ethiopia. Ethiopia has a longer tradition of beekeeping than other countries in the world during time of king Ezana, around the 3rd century; wax was needed for religious ceremonies and honey for nobility and the social elite for making traditional beverages. Despite its long history, beekeeping in Ethiopia is still an undeveloped sector of agriculture [1]. It is considered to be an income-generating activity that fits well with the concept of small-scale agricultural development in Ethiopia for those who are engaged in its production and marketing [2]. Beekeeping competitive advantage for on-farm integration is attributed to the low start-up costs, labor requirements, land, technology and reliance on traditional knowledge and skills. It provides complementary services to other on-farm enterprises like crop pollination. It has a significant role in generating and diversifying the income of subsistent smallholder farmers mainly the small

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landholders and landless, among marginalized and small income earners such as women, orphans and other vulnerable groups within the society [3].

Ethiopian economy dependent on agriculture which accounts 43% of the GDP: 90% of export commodity, 70% of industrial raw materials and 85% of employment covered by Agriculture. From these, the livestock sector contributions account 15% and beekeeping accounts 1.3% of GDP. Currently one out of ten rural households keep honeybees and the activity make a substantial contribution to rural income generation. The total honey production of Ethiopia is estimated to 53,970 tons and only a small amount of this is marketed. Around 95% of the honey produced goes to domestic market with about 50% of the honey is used for making honey wine (locally called *Tej*). About 30% of the honey produce annually is illegally smuggled across different corners of the country. The remaining is sold as table honey and also for different purposes. Local price of honey is high in towns (range from USD 6 to 10 per kg) and relatively low in remote rural areas (range from USD 1.4 to 5 per kg) [4].

Statement of the Problem: According to Kerealem Ejigu, Tilahun Gebey and Preston [5], providing smallholder farmers with access to well-functioning local and global markets are an effective strategy to reduce rural poverty. The major constraint to increase the welfare of small holder honey producer farmers in the country is their inability to access market for their product which result in low farm get price, reduced return to labor and capital. This is in turn results in subsistence level of production rather than market oriented production systems. Moreover, a number of studies identified factors influencing volume of honey supplied to the market in Ethiopia. For instance: [6] attempted to identify it at smallholder farmers' level in different part of Ethiopia. However, there are no prior studies which investigated the factors affecting volume of honey supplied in Guduru district where there is 26% of total rural farmers are doing beekeeping [7]. According to Mulugeta study result, 4,526 quintals (452 ton) of honey is produced in Gudru district annually. His study result shows that, more than 70% (316.5 ton) of produced honey is supplied to the market, without seeing the factors which affect the quantity supply. The determinants of honey supply has not yet been studied and analyzed for the target study area, where great potential of its production exists. The government offices and NGOs has been trying to give trainings and beekeeping equipment's in the area to increase the production and productivity without considering and notifying the income-generating activities undertaken by smallholder farmers to know the level of beekeeping contribution in household income, factors affecting volume of honey supply, opportunity and challenges in honey production and supply in the area. Hence, this study attempted to analyze determinants of honey supply, opportunity and challenges in honey production and supply in the area.

Review of Literature

Review of Empirical Studies on Determinants of Honey Supply by Smallholder Farmers: A number of studies are conducted on factors affecting the supply of honey to the market. For instance, [8] employed multiple linear regression models to analyze factors affecting market supply of honey. He investigated 10 factors that affect the market supply of honey in the study area namely, sex of the household, age of the household, education level of household, experience in beekeeping, extension access, the quantity of honey of produced, price of honey, access to credit, distance to the nearest market and market information. Hika wana and Nasir Ababulgu [9] employed multiple linear regression model to analyze the effect of export earnings on Ethiopian GDP. Hika wana and T. Anteneh [10] also used multiple linear regression model to analyze determinants of coffee supply to the market.

A Multiple linear regression model was employed by Samuel Sarka [11] to analyze factors that determine volume of hone marketed by the sample households. He found eight variables being significant determinants of the level of honey volume marketed. These variables were the age of household, previous year price, family size, beekeeping training, agro-ecology, literacy status of a household, size of livestock holding and total number of modern hives used in production by household heads.

According to Kassa Tarekegn, Jema Haji and Bosena Tegegne [12] investigation by using multiple linear regression models, six variables were found to be significantly affected the market supply of honey at household level. These are experienced in beekeeping, frequency of extension contact, number of beehives owned, type of beehives used, cooperative membership and distance to the nearest market. They argued that the honey producers in the study area faced marketing problems due to remoteness of some PAs, low farm-gate prices and long market chain which results to a low level of market participation. By using the same model [13], identified the four variables:- number of modern hives, credit use, training participation and a number of days of extension contact which are affecting market supply significantly and positively.

Quantity supply of honey computed to different explanatory variables by employing the econometric analysis i.e. multiple linear regression analysis and the regression result revealed out of 13 explanatory variables, 10 of the variables: - household age, household family size, education, price, distance from market, year of experience, credit access, land size, modern hives and annual income have a significant effect on quantity supply of honey [14]. Furthermore, Getachew, 2009 employed Heckman two-stage models and identified income from farm and nonfarm activities, beekeeping experience, beekeeping training, apiary visit and access to improved beekeeping equipment are as the major factors that significantly and positively affect the supply of honey by households.

Regarding to the production different studies reported beekeeping equipment such as the number and type of beehives, ownership of protective clothing, hand gloves, knives and baiting materials to influence honey yield. Other factors found to significantly influence honey production are access to market information, access to ready markets, source of beekeeping equipment, apiary management practices, availability of bee forage and beekeeping experience [15]. Though bee forage quality and availability are vital in honey production, these seem to continuously reduce over years due to changes in agricultural practices [16].

According to Chali Gutata [17], a study in Guduru district was that the amount of honey produced from traditional, transitional and modern hives for beekeepers accessing extension services is 6,246kg (62.8%), 1,079kg (92.5%) and 397kg (100%) respectively, while the honey harvest from traditional, transitional and modern hives for those beekeepers who do not have access to the beekeeping extension service is 3,695kg (37.2%), 87kg (7.5%) and 0kg (0%) respectively.

Empirical Reviews of Opportunity and Challenges of Honey Production and Supply in Ethiopia:

Major Opportunities for Honey Production and Honey Supply in Ethiopia: Beekeeping has received a renewed and special attention by the Federal Democratic Republic of Ethiopia as it is one of the key pathways to lift up millions of subsistent smallholder farmers out of poverty. It contributes to food security, economic and natural resource conservation, creating better employment opportunities and wealth. The Government of Ethiopia has established a favorable policy environment for the apiculture sub-sector within the agriculture sector of Growth and Transformation Plan. Adequate forage availability coupled with favorable and diversified agro-climatic conditions of Ethiopia creates environmental conditions conducive to the growth of over 6500 melliferrous species of flowering plants that have supported the existence of a large number of bee colonies in the country of which more 1500 identified as bee forage [18]. The ideal climatic conditions with diversified floral resources and huge water bodies allow the country to sustain around 10 million honeybee colonies, of which 70% of the colonies are domesticated and the rest as wild colonies [19]. It has been revealed that the opportunities for beekeeping were the existence and abundance of the honeybee, availability of potential natural forest with adequate apiculture flora, ample sources of water for bees, beekeepers' experience, availability of eager beekeepers to accept new technology and practices and socio-economic value of honey and demand for honeybee products.

In the last 15 years (2001-2015), Ethiopia's honey production increases from 28,000 tons to 54,000 tons and current production is 53,970 and 5000 tons of honey and beeswax production respectively Demisew [4]. Current honey production per annum represents only 11% of Ethiopia's honey production potential [20] According to Assefa [8], Tizazu, *et al*. [13], Zegeye [14], about 95%, 96.7% and 83% respectively of honey production were marketed through different marketing channels and the left for household consumption purposes in Ethiopia.

Oromia Regional State alone has about 6.7 million honeybee colonies in the region. These honeybee colonies comprise of five races that are adapted to the diversified agro-ecologies of the region from arid to highlands. Production of honey by the regions shows that Oromia accounts for over 55% of the bee colonies and 53% of the Honey production [21] Guduru district where this study will be undertaken is that, the total honey yield that can be harvested currently is (kg) 156.8 while an expected total yield per year is (kg) 588. The yield difference between actual and expected is 431kg, which is estimated in birr 21,560. Even though there is a possibility to harvest honey at least twice a year, the beekeepers are not fully utilizing the opportunity [22].

Honey production does not require expensive equipment, as simple hives and others can be made from local materials by local artesian. This stimulates business for local trades; no serious food is required by bees other than pollen and nectar in flowers; basic beekeeping techniques are easy to learn by both sexes and all age groups; Bees do not require daily attention; it do not take up valuable land as hives are placed on trees, wasteland or on flat rooftops [23].

Major Challenges for Honey Production and Honey Supply in Ethiopia: The main challenges of honey production are: Honeybee pests and predators, Misuse of pesticides and herbicides, Honeybee diseases, Colony absconding, Shortage of bee forages, Lack of hive products market infrastructure. Government and non-government institutions, collectors, wholesalers, retailers, processors and exporters and professionals were identified as the major constraints of the honey sub-sector [24]. He argued from his review that, some of the principal constraints and problems are highlighted as; low quality of honey products, lack of organized marketing channel, inadequate government support in promoting apiculture development, lack of skilled manpower and training institutions and lack of access to world market.

Honey bee disease, lack of the sufficient number of well-skilled manpower, lack of cultivated bee forage, insufficient market facility, weakness of the government policy on the apiculture sector, chemicals application, presence of pests and predators, lack of credit service for the beekeeping sector, high cost and limited availability of modern beekeeping equipment and accessories, absconding and migration of bee colonies, attempts of traditional beekeeping system and deforestation and recurrent drought are the major pain to beekeeping sector development in Ethiopia [25]. And also Demisew Presented to the 5th ApiExpo Africa of 2016 is that the main challenges/limitation in beekeeping sector are: inadequately trained personnel to solve problems related to skill and technology ; limited bee products (honey and beeswax) and little effort on production of products other hive products; very poor technology multiplication and uptake (extension system, structure) (only about 10% of beekeeping is using improved technologies), limited access to financial services for individual beekeepers, cooperatives, unions and others; illicit cross border trades (large volume of honey and beeswax is illegally smuggled through different corners of the country); limited promotional activities for hive products in both local and export markets; limited/little market information and assessment for both local and export market dynamics.

According to Assefa study, the honey producers are price takers and have low bargaining power and no ready market which attracts them. However, sparsely populated rural areas and poor infrastructural facilities; lack of negotiating skills, lack of collective organizations and lack of market information are impediments to market access. Similarly [26] revealed that, the market supply of honey is low as compared to its potentiality due to some socioeconomic, demographic, production, market and institution related factors. Honey producers faced marketing problems due to remoteness of some PAs, low farm-gate prices & long market chains which results to low level of market involvement.

Conceptual Framework of the Study: The conceptual framework of the factors, which consist of three key concepts of variables, is shown in Figure 1. The dependent element that includes the framework for this study is honey supply. Analysis of determinants of honey supply a household level/ honey market supply is found to be important to identify factors constraining or determinants of honey supply by smallholder farmers.

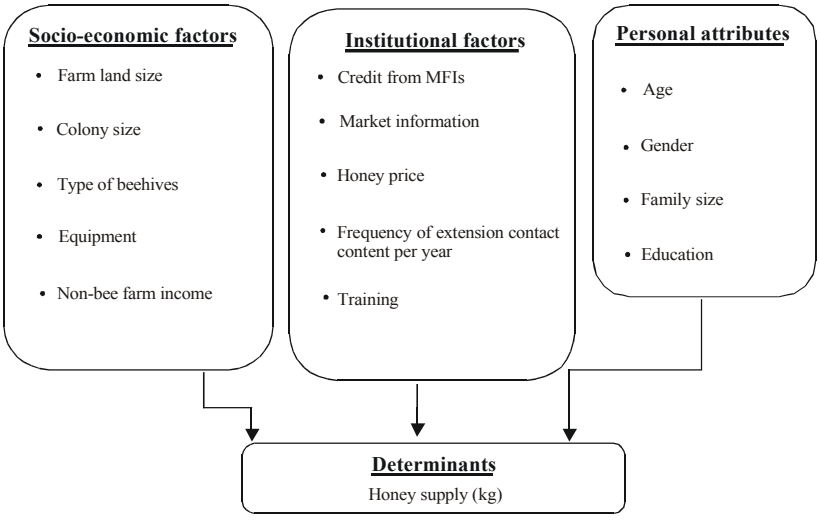

Fig. 1: Conceptual Framework of the Study

Based on the reviewed literature, determinants of honey supply by stallholder farmers is hypothesized as: personal attributes (Age, Gender, Family size, education etc.); socio-economic factors (Farmland size, colony size, Types of beehives, Beekeeping Equipment, non-bee farm income); the contribution of beekeeping (honey supply) and institutional (credit from MFIs, market information, honey Price, Frequency of extension contact per year, Trainings).

MATERIALS AND METHODS

This section presents the detail of the methodology that the research used. Description of the study area, Study population, Sampling Design, method of data analysis and definition of variables specification and working hypotheses are explained.

Description of the Study Area: The study was conducted in Guduru district which is one of the 12 districts of Horo Guduru Wolega Zone, Oromia Regional state and has 20 rural kebeles. Kombosha, the principal town of the district, is situated at about 262km, west of Addis Ababa and 67km from east of Shambu town, the capital town of the Zone.

The administrative boundaries of Guduru district is Ginda Barat district, from East, Choman Guduru district from South, Abay Choman district from West and Hababo Guduru district from North. The district is divided into two agro-ecologic zones these are midland which cover 79% and lowland which cover 21% of the total area. It has a mean annual rainfall of 1,350 mm - 1,400 mm, which is bimodal and erratic in distribution [27]. The mean annual temperature is 17°C-27°C minimum and 32°C maximum and its monthly mean temperature ranging from 15.4°C - 19.2°C which makes it to have a favorable climate for apiculture [28]. It has the potentially for both crop and livestock production, which is mainly undertaken by small holder farmers. The agro ecology in the district is best suited for diverse agricultural production. The main crops production of the districts maize 23.65%, Teff 23.50%, Niger seed 19%, Wheat 14.40%, sesame 5%, Beas 4.52% and others 9.93 (peas, barley, rape seed & millet seed). The livestock populations of the district are 111,155 cattle; 30,681 shoat, 14,099 Equines & 58,948 poultry [29].

Geography: The geographical location of the study area is 9°15'0''N to 9°37'0''N and 37°10'0'' E to 37°40'0''E it is entirely situated in the catchment of Blue Nile at the bigger scale and partially in Guder and partially in Fincha'a sub catchment at the smaller scale. In terms of altitude, the area varies between 1,190masl at closer to Guder River in 'Kenate Dhinsa' PA and 2,240masl at 'Alamin Hachalu' and 'Eni Ama Tolera' PAs.

Beekeeping in the Study Area: Farmers in the district have ample knowledge of traditional beekeeping and the annual honey production of the district is estimated to be 270 tones. Beekeeping sub-sector in this district is quite evolving with an estimated number of 1,043 farmers [30]. Besides beekeeping, farmers in the district are also involved in other agricultural activities with crop production as their major activity.

Yet, there are potentials to increase the volume of honey production to more than 1,600 tons per annum with only the existing beekeepers in the study area according to DAMMA. The total existing beehive with colony in the district is 53,934 (51,114 traditional, 2,375 transitional and 445 modern). However, Kibebew & Alemayehu study revealed that based on 100% potential resource use in the district is that, the total honey reserve is 35,609,760 kg and the number of colonies that can be sustained per hive for the district is 259,925 in traditional, 240,606 in transitional and 222,561 in modern beehives.

Honey Marketing in the Study Area: The beekeepers of the area supplied honey to the market without extraction directly as harvested by using available containers like grain bags and plastic containers. Beekeepers of the area sell 4% of their production to district level household buyers, 2% for Tej houses and 94% for collectors & wholesalers, who are grain traders and engaged in honey trading as a sideline business. These collectors & wholesalers supply 95% of the honey they bought to Addis wholesale market (Gojam Berenda) but the rest 5% is sold to retailers and other adjacent districts household buyers with 3% and 2% share respectively.

Study Population: Based on the census carried out recently the total population of the district is estimated to 113,123 (55,433 male and 57,690 Female). The total number of the rural population is 78,664 (38,548 male and 40,116 female). The total number of urban population is 34,459 (16,885 male and 17,574 Female). The total number of rural household heads is 10,033 (9,473 male and 560 female).

Sampling Design: A cross-sectional survey was adopted for conducting the study. The information was collected at one shot and then organized and analyzed. To increase the reliability of the study, identification and selection of

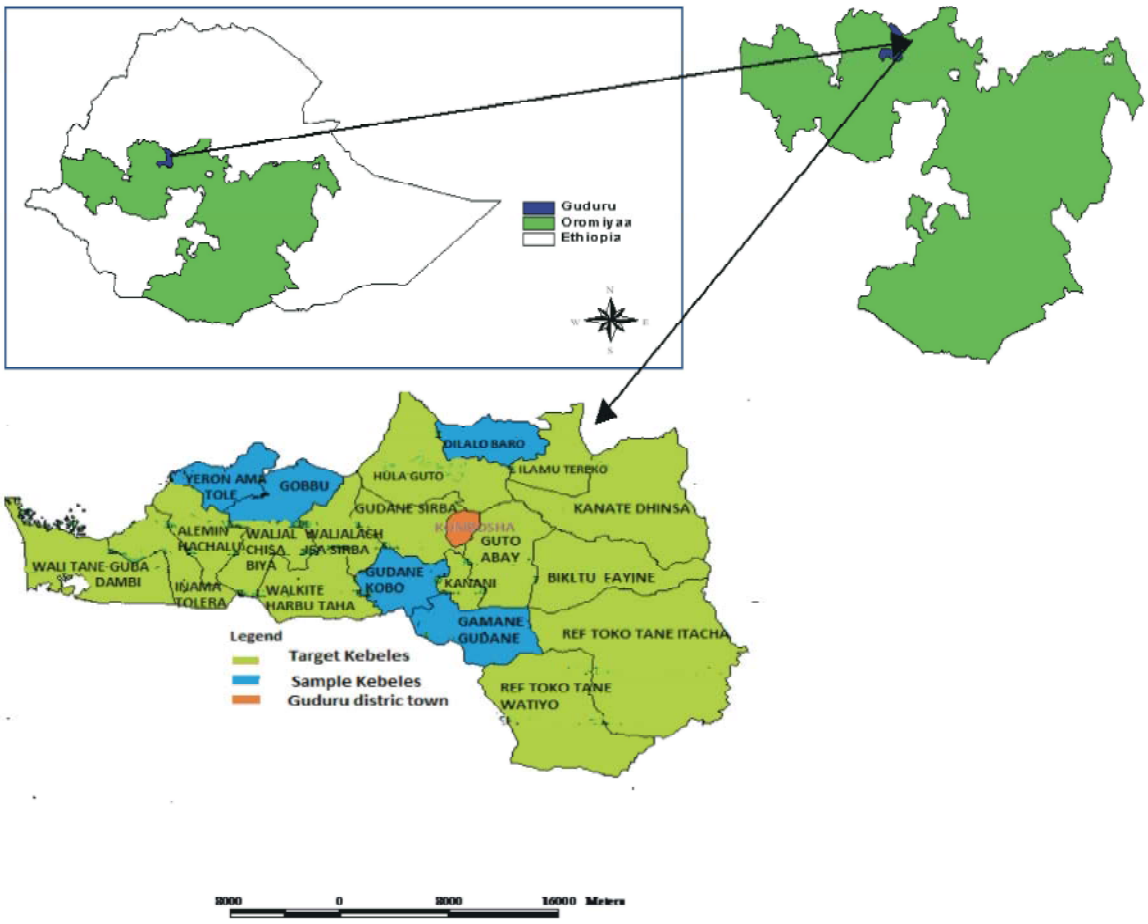

Fig. 2: Administrative locations of target area and sample area
Source: (GRLALUO, 2019)

sampling kebeles, where beekeeping activities are practicing, were carried out by employing a purposive sampling method. In the district, currently, there are 25 kebeles (20 rural and 5 urban). For the study a two-stage sampling procedure was employed to select a specific honey producer household. First, purposive sampling was employed to identify kebeles in which more beekeeping activity is undertaken. Based upon their beekeeping potential and number of involved farmers, socio-economic homogeneity of the community, researcher's operational area and some factors like financial resources and time, the researcher fixed the number of sample kebeles to be 5. These are: Dilalo Baro, Gamane Gudane, Gudane Kobo, Gobbu and Yeron Ama Tole. Among the selected 5 kebeles, the smallholder farmers of honey producers were selected purposively. According to Storck as cited by Chali [15], the size of the sample depends on the available fund, time and other reasons and not necessarily on the total the population. In the second stage, using the population list of honey producer farmers from sample kebeles, the intended sample size was determined proportionally to population size of honey producer farmers. So, by using a simple random sampling a total of 121 sample household heads of honey producers were selected.

Sample Size Determination: The study was used the following formula to calculate sample size. This study applied a simplified formula provided by Yamane [31], to determine the required sample size at 95% confidence level degree of variability = 0.5 and level of precision = 8% (0.08).

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

where; n = designates the sample size the research uses;
N = designates total number of households
e = designates maximum variability or margin of error 8 %
1 = designates the probability of the event occurring.

Table 1: Sample distribution of farmers (honey producers)

No.	Name of Kebeles	Total Farmers Household Head	Honey Producer Households	Sample Households	%
1	Yeron Ama Tole	345	112	25	21%
2	Gobbu	402	107	24	20%
3	Dilalo Baro	356	94	21	18%
4	Gudane Kobo	329	105	24	20%
5	Gamane Gudane	547	118	27	22%
	Total	1,577	536	121	100%

Source: - Own Survey result, 2019

The following steps were used to determine sample size derived from the above formula to collect quantitative data using questionnaire.

Therefore; $n = \frac{536}{1+536x0.08^2}121$

Therefore, the total sample size was 121 out of this: 27 from Gamane Gudane, 25 from Yeron Ama Tole, 21 from Dilalo Baro, 24 from Gobbu and 32 from Gudane Kobo kebeles proportionally to population size as shown on the following Table 1.

Method of Data Collection: Both primary and secondary data were used for this study which is qualitative and quantitative in nature. Primary data were collected from sample households using a semi-structured questionnaire and checklist. The data were collected by enumerators (DAs) and the researchers. The enumerators (DAs) were trained on how to conduct the interview schedule and how to approach farmers during the interviews. So as to revise and modify the questionnaire for the final survey, a pre-test of the interview schedule was conducted on selected respondents who are assumed to be representative of the households living in the sample Kebeles. Based on the feedback obtained from the pre-test, the interview schedule was customized. In addition to this, Focus Group Discussion and key informant interview were employed to supplement the research finding with qualitative information. Secondary data were gathered from various sources such as records, documents, reports etc. of both governmental and non-governmental organizations such as Guduru district office of livestock and fish, Gurmuu Development Association, Agricultural and Natural Resource Offices, rural land administration & land use office and others office.

Methods of Data Analysis

Data Processing: Quantitative data entry was started after all actual data compilation and summary were carefully organized and manual editing was completed. Filled questionnaires were coded and keyed into STATA software of version 14.2. Once the process of data entry was accomplished, polishing and cleaning of the data were started. Data cleaning and editing focus on checking whether the assigned value for each case is legitimate, on the logical consistency and structure of cases.

Descriptive Statistics: Descriptive statistics such as mean, minimum, & maximum values or scores, percentage, standard deviations and frequency were used along with econometric model to analyze the determinants of honey supply by smallholder farmers. Primary data that were collected through focus group discussions and key informant interviews was analyzed using qualitative technique of data analysis. Identification and then ranking was used for income-generating activities practiced by smallholder farmers, opportunity and challenges intended for honey production and honey supply in the study area. On the other hand, data collected through interviews were analyzed through narration and interpretation.

Econometric Analysis: Different models can be employed to analyze the determinants of market supply. The commonly used ones are Multiple Linear Regression, Tobit and Heckman's sample selection models. If participation of all beekeepers in marketing of the honey is not expected, using OLS model by excluding non-participants from the analysis introduces selectivity bias to the model. Tobit, Double Hurdle and Heckman two stage procedures have been suggested to overcome such problems. If only probability of selling is to be analyzed, probit and logit models can adequately address the issue. If some households may not prefer to participate in a particular market in favor of another, while others may be excluded by market conditions Tobit or Heckman models are used to analyze market supply. By using Tobit model, the market supply can be analyzed by clustering the respondents' into supplier and non-suppliers. If censored regression is applied, the model estimates are biased because of there is no clustering honey producers as all of households supply their product to market [32].

Like Tobit model, sample selection model (Heckman) is used in some cases when sample selection biased occurred in addition to clustering of respondents. The first stage of the Heckman model a 'participation equation', used to construct a selectivity term known as the 'inverse Mills ratio' which is added to the second stage 'outcome' equation that explains factors affecting volume of product marketed and estimated by using ordinary least square according to Wooldridge.

However, in the study area all honey producers participate in the market by supplying their produce and therefore there is no clustering of honey producers in honey market participant and non-participant. Thus, for this study, multiple linear regression model and its estimation using ordinary least squares (OLS) was used to identify determinants of honey supply.

Econometrics Model Specification: The econometric model specification of the variables is as follows.

Y = f (Age, Gender, Family size, education, Farm Land size, Colony size, types of beehives, beekeeping equipment, non-bee farm income, credit, Market information, honey price, Frequency of extension contact per year, training, etc.)

$$Y_i = \beta_0 + \beta_1 X_1 i + \beta_2 X_2 i + \bullet\bullet\bullet + \beta_{14} X_{14} i + Ui \quad (1)$$

where:

Y = Honey supplied (yield) in kg;
X_1 = Age
X_2 = Gender
X_3 = Family size
X_4 = Education level
X_5 = Farm land size
X_6 = Colony size
X_7 = Types of beehives
X_8 = Beekeeping equipment
X_9 = Non-bee farming income
X_{10} = Access to credit from MIFs
X_{11} = Market information
X_{12} = Honey price,
X_{13} = Frequency of extension contact per year
X_{14} = Training on beekeeping
$\beta 0$ = Constant term;
βi, = Coefficients of the regression model;
Ui = Random error/ residual variable

Econometric model specification of supply function in matrix notation is the following.

$$Y = \beta X + U \quad (2)$$

where,

Yi = Honey supplied to the market
β = A vector of estimated coefficient of the explanatory variables
X = A vector of explanatory variables
Ui = Disturbance term

Testing for Assumption Validation: The parameter estimates of the OLS model may not be Best Linear Unbiased Estimator (BLUE). Hence, it is important to check the presence of multicollinearity between the hypothesized explanatory variables, heteroscedasticity, omitted variable and normality problems among the variables that affect the supply of honey in the study area. As Gujarati pointed out multicollinearity refers to a situation where it becomes difficult to identify the separate effect of independent variables on the dependent variable because there exists strong relationship among them. In other words, multicollinearity is a situation where explanatory variables are highly correlated. There are two measures, which suggested testing the existence of multicollinearity. These are: Variance Inflation Factor (VIF) for association among the continuous explanatory variables and Contingency Coefficients (CC) for dummy variables.

$$VIF = \frac{1}{\left(1 - R^2\right)}$$

where, R^2 is the multiple correlation coefficients between the independent variables.

As a rule of thumb, according to Gujarati, states that if the VIF value of a variable exceeds 10, which will happen if R^2 (explained variation) exceeds 0.90, then, that variable is said to be highly collinear. In this study, the problem of multicollinearity was tested and the result of VIF showed that the absence of severe multicollinearity problem among independent variables because the value of VIF was less than 10. Similarly, contingency coefficients (CC) were computed to check the existence of multicollinearity problem among the dummy variables. The contingency coefficient is computed as:

$$CC = \sqrt{\frac{\chi^2}{N + \chi^2}}$$

where,
CC = Contingency Coefficient,
χ^2 = Chi-square random variable and
N = Total sample size.

If CC is greater than 0.75, the variables are said to be collinear. The decision rule for CC is that when its value approaches to 1, there is aproblem of association between the dummy variables.Likewise, the result of CC showed that the absence of severe multicollinearity problem among independent variables because the value of CC was not greater than 0.75.

Heteroscedasticity occurs when the variance of the dependent variable varies across data. This means that the conditional variance of Y increases as X increase. This was tested by using the visual test and Breush pagan test. Visual test helps to detect with plotting the residual against the fitted value of the dependent variable and see the scatteredness of the residual from Gujarati [31]. If heteroscedasticity has existed, scatteredness of the residual increases with the dependent variable. Breusch-Pagan-Godfrey Test (sometimes shorted to the Breusch Pagan test) tests whether the variance of the errors from a regression is dependent on the values of the independent variables. If the test statistic has a smaller p-value or below an appropriate threshold (e.g. $p < 0.05$), then the null hypothesis of homoskedasticity is rejected and heteroskedasticity assumed according to Wooldridge. Similarly, linearity and normality of the standard errors assumptions were also tested by generating a scatter and quantile-quantile plot (QQ plot) respectively. Linearity was tested simply by sketching the graph and observed the s catterings of the approach of predicted residuals to normal probability line. If the residuals follow the straight line on the graph, they are normally distributed. A graphical tool for assessing normality is the normal probability plot, a quantile-quantile plot of the standardized data against the standard normal distribution. Here the correlation between the sample data and normal quantiles (a measure of the goodness of fit) measures how well the data were modeled by a normal distribution. For normal data the points plotted in the QQ plot should fall approximately on a straight line, indicating high positive correlation.

The omitted variable bias was tested with Ramsey Reset test. Omitted variables are variables that significantly influence Y and so should be in the model, but are excluded. If an important variable is omitted, the OLS residuals showed a distinct pattern. If the F statistic is greater than the critical value at a given significance level then we reject the null hypothesis of correct specification. This indicates that there is a functional form misspecification, including unobserved omitted variables and heteroscedasticity according to Wooldridge, 2013. The overall goodness of fit of the regression model was measured by the coefficient of determination (R^2). R^2, thus defined, of necessity lies between 0 and 1. The closer it is to 1, the better is the fit and a value of R^2 that is nearly equal to zero indicates a poor fit of the OLS line Gujarati [31]. Adjusted R^2 shows the same as R^2 but adjusted by the number of cases and number of variables. When the number of variables is small and the number of cases is very large then adjusted R^2 is closer to R^2. This provides a more honest association between X and Y [34].

The problem of endogeneity occurs when an explanatory variable is correlated with the error term, which causes, the ordinary least squares estimators of the relevant model parameters to be biased and inconsistent. The source of endogeneity could be omitted variables, measurement error and simultaneity according to Wooldridge, 2013. In order to test problem of endogeneity, Hausman test was employed. It is by comparing the Hausman statistic to a critical value obtained from its sampling distribution and rejecting the null hypothesis of correct specification if the Hausman statistic exceeds its critical value [35].

Variables Specification and Working Hypotheses
Hypotheses:

H0 = There is no statistically significance on honey supply by smallholder farmers due to personal attributes, socio-economic factors and institutional factors.
HA = There is statistically significance on honey supply by smallholder farmers due to personal attributes, socio-economic factors and institutional factors.

Dependent Variable: The main objective of this research is to analyze the determinants of honey supply by smallholder farmers. Honey is produced mainly for the market and is one of the most beekeeping products and cash commodities for Guduru district farmers. For this, the honey marketed or supplied is a dependent variable and it is a continuous variable measured in Kg.

Independent Variables

Table 2: Summary of Independent Variables hypothesized to determine honey supply

Variables in	Units	Description	Effect
Independent Variables			
X_1	Continuous variable (Years)	Age of beekeeper	+
X_2	Dummy: (1=male, 0=female)	Gender of beekeepers	+
X_3	Continuous variable (number)	Family of beekeeper in number.	-
X_4	Continuous variable (years in schooling)	Education level	+
X_5	Continuous (hectare)	Land size owned by smallholder farmers	+
X_6	Continuous variable (number of bee colony)	Colony size or total number of beehives with bee colony	+
X_7	Dummy (improved (Transitional & Framed) = 1, Traditional = 0)	Types of beehive smallholder farmers do have	+
X_8	Dummy variable (yes = 1, no = 0)	Access to beekeeping equipment	+
X_9	Continuous variable (birr/year)	Smallholders' non-beekeeping income	+/-
X_{10}	Dummy variable (yes = 1, no = 0)	Access to credit from MFIs	+
X_{11}	Dummy variable (yes = 1, no = 0)	Market information	+
X_{12}	Continuous variable. birr/kg (2019 value)	Price of honey	+
X_{13}	Continuous variable (Frequency of extension contact days/year)	Number of days by which the beekeepers contacted by Extension workers	+
X_{14}	Dummy variable (yes = 1, no = 0)	Smallholder farmers training on beekeeping	+

Source: Own Hypothesis, 2019

RESULTS AND DISCUSION

Respondents' Access to Services: Access to different services could be essential to improve production and productivity of smallholder's farmers. More specifically, access to credit, training, extension contact and market information, are the most important factors that promote production and marketing of honey and thereby increase income of the producer are displayed below in Table 3.

Access to and Availability of Credit: Credit is important to facilitate the introduction of innovative technologies and for input and output marketing arrangements. From the total of 121 sample households, only 44.6 percent (f=54) of them had received a minimum of 1,200 and maximum of 12,000 Birr and its mean was 4993.3019 with 3378.94569 standard deviation. However, the result showed that the mentioned credit was not for beekeeping purpose rather it was for farm inputs purchase 79.25% (f=43), livestock purchase 3.70% (f=2) and household consumption 16.67% (f=9) as per displayed on Table 3 above.

It is similar with Chali [17] study result that, all interviewed respondents reported that there are no any credit facilities. Similarly, Mulugeta, 2014 study shows that, regarding to financial service in Gudruu district, OCSCO and WASASA have given agricultural loan and there is no loan distributed to beekeeping activity. And also Aseffa, 2009 study result showed that, even though farmers need credit to purchase different inputs to enhance the quantity and quality of the honey production, the short repayment period as well as the high interest rate of the service was not suitable to the individual respondents.

Access to Extension Contact: Beekeeping extension service is provided by the district livestock and fishery Office and NGOs. Each sampled kebeles has DAs of animal production and two other professionals. As a result, about 89.3 percent (f=108) of the sample respondents had access to extension service to promote the apiculture sector and thereby increase the quantity and quality of the commodity at farm level. About 10.7 percent (f=13) did not get extension service at all. Thus, according to the information gathered from the study, minimum number of days that the respondent contacted by extension agent is 0, maximum is 139 days its mean is 45.59 days with the standard deviation of 43.845 as per shown on Table 3.

Access to Beekeeping Training: Among 121 respondents 65.3 percent (f=79) of the respondents took training on Improved Beekeeping Approach which have been provided by DAs, NGOs and district livestock and fishery offices while 34.7 (f=42) were not took these trainings as shown on Table 3.

Access to Beekeeping Accessories: The beekeeping equipment's like smokers, gloves, bee veils, overall, boots, water sprayer, bee brush, queen excluder, fork, knife, honey container, honey presser, honey sieve, honey extractors and other accessories was accessed for

Table 3: Beekeepers' access to credit, extension service, training & market information

Services	Response	Frequency	Percent
Credit access	Yes	54	44.6
	No	67	55.4
Market information	Yes	55	45.5
	No	66	54.5
Training	Yes	79	65.3
	No	42	34.7
Beekeeping equipment	Yes	68	56.2
	No	53	43.8
Extension contact	Yes	108	89.3
	No	13	10.7

Extension contacting frequency (days/year)	N	Minimum	Maximum	Mean	Std. Deviation
Number of days contacted per year	121	0	139	45.59	43.845

Source: Own survey data, 2019.

Table 4: Share of credit for different activities' of the respondents

Variable	Frequency	Percent
Farm input purchase	43	79.63
Livestock purchase	2	3.70
Invest on honey production	0	0.00
Household consumption	9	16.67

Source: Own survey data, 2019.

Table 5: Share of equipment sources

Equipment Accessed from	Frequency	Percent
Donation	15	12.4
Own	53	43.8
Not accessed	53	43.8

Source: Own survey data, 2019

Table 6: Opportunity of the honey production in the study area

No	Opportunities to honey production	(1) Yes (2) No	Rank
1	Bee colony availability	1	2
2	Environmental conducive	1	1
3	Bee fodder availability	1	3
4	Water availability	1	4
5	Market demand	2	
6	High price	1	10
7	Knowledge & skill	1	7
8	NGO attention	1	5
9	Government attention	1	8
10	Privet sectors attention	2	
11	Union attention	1	9
12	beekeepers' experience	1	6
13	Equipment accessibility	2	
14	Other (specify)		

Source: Own survey data, 2019.

68 respondents (56.2%) and 53 respondents (43.8%) replied not accessed to as shown on Table 3. According to Table 14, the share of the resources for those who were replied yes on access of beekeeping equipment, was 12.4% donation from NGOs and AGP, 43.8% own purchase in collaboration with Gurmuu Development Association and district livestock and fishery offices facilitation.

Access to Market Information: With regard to access to the market information, 45.5 % (f=55) of the sampled respondents had access to the nearby market price information as table able 3. The survey result presented in Table 3 also shows that, 54.5% (f=66) honey producers were limited to some source of market information. Accordingly, 45.5% of the total sampled households respond that, they obtain price information from NGOs (Gurmuu Development Association), extension agent and personal observation on market.

Opportunities and Challenges of Honey Production and Supply in the Study Area

Opportunities of Honey Production in the Study Area: There are important honey production opportunities and immense potentials in Guduru district. Accordingly, some of the opportunities associated with the study area and described by the respondent beekeepers are presented on Table 6 below:

Ethiopia has huge potential for honey production which is clearly observed in the last few years with significant increment, even though the subsector is still practicing with traditional low productive systems. Bee farming provides supplementary and sometimes major source of income to the farmers, especially to the small farmers in the country. In conclusion opportunities for beekeeping were the existence and abundance of honeybee, availability of potential natural forest with adequate apiculture flora, ample sources of water for bees, beekeepers' experience, availability of eager beekeepers to accept new technology and practices and socio-economic value of honey and demand for honeybee products [36].

According to Chali [17] study result, availability of rich culture and tradition of honey production and management experience, indigenous knowledge and skills, farmers' hard-working culture and keen interest to easily

adopt bee-friendly improved technologies and to undertake in bee protection and husbandry. Another important opportunity for the beekeepers in the study area is that NGOs, such as, (Gurmu Development Association, HEKS-EPER and ASPIRE (Apiculture Scale-up Program for Income and Rural Empowerment) are also closely working with them to create synergy in the sub sector, particularly through providing extension services, equipment, training and capacity building.

According to the presentation of Demisew [4] on 5th Api Expo Africa 2016 held in Kigali, Rwanda that, registration and control of pesticides, special Decree No. 20/1990 to lay a scheme of registration and control of hazardous chemicals to life and products of honeybees; Apiculture Resources Development and Protection Proclamation, No. 660/2009 for development and protection of apiculture resources; Establishment of the competent authority MoLF to ensure apiculture development by Strengthening extension delivery system; Establishment of Ethiopian Apiculture Board (EAB) as an Apex body to coordinate professional Associations and other stockholders towards the implementation of policies and development activities; Encouraging and supporting of Associations like Ethiopian Society of Apiculture Science (ESAS) and Ethiopian Honey and Beeswax Producers and Exporters Association (EHBPEA) and Facilitating conditions for existence of synergic public and private stakeholders (SNV, ACDI/VOCA, FC, MCF) are the major opportunity for honey production.

Opportunities of Honey Supply in the Study Area: According to the study result, newly starting of honey purification, NGO initiation, pure honey price increment trend, favorable road & transportation, even though there is no honey trader in local area, there is grain or other agricultural product traders' market place is not far from respondents as shown on the following Table 7.

According to Demisew, 2016, Ethiopia has developed honey and beeswax Standards (ES 1202 and ES 1203), which comply with ISO and CODEX Standards. Ethiopia is listed as a third country permitted to export honey and beeswax by the European Commission since 2008 on the approval of residue monitoring plans submitted by third countries in accordance with Council Directive 96/23/EC, notified under document C (2010) 3548 (2010/327/EU) also the opportunity to supply honey.

Challenges of Honey Production in the Study Area: The prevailing honey production challenges in the beekeeping development are important issues to bring solution. A questionnaire was designed as part of the study with the objective of identifying the existing problems limiting development of the apiculture sector. The interviewed beekeepers were mentioned the major honey production challenges in the district are: low quality of honey product, high cost of modern beekeeping equipment's and accessories, shortage of bee forage, indiscriminate agrochemical application, problem of pests and predators (especially, Ants), raining during harvesting time, drought (lack of rainfall), absconding and migration, lack of knowledge, lack of extension support, poor infrastructure development, market problem and lack of equipment. The interviewed respondents were able to lists the major beekeeping challenges in the district. According to Table 8, the major challenges in the study were identified and prioritized by the respondents.

This result agrees with report of Kerealem, *et al.*, 2009 'shortage of bee forage', 'threat of pesticide, 'honeybee pest and predators', poor infrastructure development, 'shortage of bee equipment's which were reported as the major beekeeping constraints in Amhara regional state.

Table 7: Opportunity of the honey supply in the study area

No	Opportunities to honey supply	(1) Yes (2) No	Rank
1	Market Access	2	
2	Full market information	2	
3	Near market place	1	1
4	Favorable road and transportation	1	3
5	High price	1	2
6	Stability Price	2	
7	Processors	2	
8	Accessibility of containers	2	
9	Other (specify)		

Source: Own survey data, 2019.

Table 8: Summarized challenges in honey production in the study area

o	Challenges on honey production	(1) Yes (2) No	Rank
1	Shortage of bee forage	1	6
2	Raining during harvesting time	1	9
3	Shortage of water	1	10
4	Drought (lack of rainfall)	1	3
5	Absconding and migration	1	2
6	Pest and predator	1	1
7	Disease	1	11
8	Indiscriminate agrochemical application	1	7
9	Death of colony	1	8
10	Decrease in price of honey	2	
11	Increased cost of production	2	
12	Lack of knowledge	1	13
13	Lack of extension support	1	12
14	Market problem	1	4
15	Lack of equipment	1	5
16	Lack of swarm	2	
17	Others (specify)		

Source: Own survey data, 2019

Similarly, Mulisa & Fekadu, 2016 study shows also, the major constraints of Ethiopia in the beekeeping sub sector are the unpleasant behaviors of bees (aggressiveness, swarming tendency and absconding behaviors), lack of skilled manpower and training, institutions, low level of technology used, high price of improved beekeeping technologies; drought and deforestation of natural vegetation; poor post-harvest management of beehive products and marketing constraints; indiscriminate application of agrochemicals, honeybee disease, pest and predators, poor extension services, absence of coordination between research extension and farmers, weakness of policy in apiculture, shortage of records and up-to- date information and inadequate research institutions to address the problems.

Challenges of Honey Supply in the Study Area: The major challenges to increasing the welfare of smallholders are their inability to access markets. Enhancing the ability of poor smallholder farmers to reach markets and actively engage in them is one of the most pressing development challenges. This, in turn, reduces incentives to participate in economic transactions and results in subsistence rather than market-oriented production systems. Sparsely populated rural areas and difficulties to transport honey product are physical barriers for accessing markets; lack of organized markets and market channel, No buyer or lack of market (in bulky), lack of containers, lack of negotiating skills, Price instability, low quality of honey products, lack of improved technologies for processing honey, honey collection center and lack of market information are other impediments to market access. Accordingly, respondent beekeepers have identified the following major challenges which they want to have immediate interventions in honey supply. Of course, some opportunities have also been indicated.

Results of Econometric Analysis: The econometric analysis was planned to analyze factors affecting the volume of honey supply to market in the area.

Table 9: Honey supply problems encountered by sample respondents

No	Challenges to supply honey	(1) Yes (2) No	Rank
1	Poor road	1	6
2	Market place is far	2	
3	Poor weather	2	
4	No buyer or lack of market (in bulky)	1	1
5	Price instability	1	4
6	Hygiene problem	1	3
7	Less/no market information	1	5
8	Lack of containers	1	2
9	Other (specify)		

Source: Own survey data, 2019.

Determinants of Honey Market Supply: According the information gathered from the study result, 95 % of honey is produced mainly for the market and it is one of the most important cash commodities for Guduru district farmers. Respondents also pointed out that the remaining percentage (5%) of total production was accounted for home consumption. All honey producers of the study area supply honey to the market. Analysis of determinants of household level honey supply was found to be important to identify factors constraining honey market supply. Hence, for this study, multiple linear regression models and its estimation using ordinary least squares (OLS) was used to identify determinants of honey marketed supply. From the survey result, the variation in volume of honey supplied at households' level and other independent variables was found to be high and the logarithmic transformation was implemented to reduce the variation.

Interpretation of OLS estimates is possible if and only if the basic assumptions of multiple linear regression models are satisfied. Thus, after regression of OLS model existence of multicollinearity between the hypothesized explanatory variables, heteroscedasticity, omitted variable and normality problems were checked. Therefore, for this study, the Variance inflation factor (VIF) was used to detect multicollinearity problem for continuous variables. On the other hand, for dummy variables contingency coefficient was used. The test for multicollinearity in appendix Table 2 suggests that there is no serious problems of multicollinearity among explanatory variables since the mean VIF value was less than 10 which is 1.68. Likewise, the result of CC showed that the absence of severe multicollinearity problem among independent variables because the value of CC was not greater than 0.75 as shown in appendix Table 3.

The omitted variable bias test with Ramsey RESET test ($F(3, 103) = 2.09$; prob> F= 0.1060) shows the absence of omitted variable in the model indicating that the model has no problem of omitted variable bias as per appendix Table 4. Heteroscedasticity test was performed using Breusch-pagan/Cook-Weisberg which is $chi^2(1) = 0.07$; prob> $chi^2 = 0.1923$); suggests that the errors are of the same variance shown on appendix Table 4. Thus, the null hypothesis that the errors have constant variance is accepted. In addition, normal probability plot for residuals shows error terms are normally distributed as the normal probability plot for residuals approaches to normality line as shown on appendix Figure 5.

Table 10: OLS Logarithmic Estimation of Factors Affecting Honey Supply

Variables	Coefficient	Standard Error	t	P>/t/
Age of honey producers	-0.1178084	0.2339897	-0.50	0.616
Family size	-0.1338359	0.1065191	-1.26	0.212
Educational level	0.0276318	0.0676864	0.41	0.684
Land size holding	0.075816	0.0864102	0.88	0.382
Colony size holding	0.5867068	0.100082	5.86	0.000***
Non beekeeping income	-0.1233739	0.1301633	-0.95	0.345
Honey price of 2019	0.9020927	0.3069513	2.94	0.004***
Frequency of extension contact/year	0.329542	0.0468153	7.04	0.000***
Gender	0.030105	0.1577284	0.19	0.849
Hive type (improved & traditional)	0.4467838	0.0800878	5.58	0.000***
Beekeeping equipment	0.2398899	0.1131643	2.12	0.036**
Credit access from MIFs	0.0503588	0.093183	0.54	0.590
Market information	0.2844809	0.1062403	2.68	0.009***
Beekeeping training	0.3202609	0.1238973	2.58	0.011**
_cons	-2.323031	1.738594	-1.34	0.184
Number of obs				121
F(14, 106)				55.37
Prob> F				0.0000
R-squared				0.8797
Adj R-squared				0.8638
Root MSE				0.452

Note: "***", "**" shows the significance level of variables at 1% and 5% respectively. Dependent variable is volume of honey marketed (in natural logarithm).
Source: Own computation from survey result, 2019

Hausman test was applied to check the presence of endogeneity. The result of Hausman test shows that the model result had no endogeneity as per shown on the appendix Table 6. The overall goodness of fit of the regression model is measured by the coefficient of determination (R^2). So, as to identify the factors affecting the quantity supply of honey, taking quantity supply of honey as the dependent variable along with personal attributes, socio-economic and institutional factors as explanatory variables, was presented in Table 21 below and estimation result with R-squared = 0.8797, Adj R-squared = 0.8638. It was observed that the adjusted coefficient of determination was 86 percent in the marketable supply function. This implies that, 86 percent of the variations in market supply of honey were explained by the explanatory variables. The F value, with degrees of freedom F (14, 106), = 55.37, Prob> F = 0.0000, shows that the explanatory variables can significantly predict the dependent variable. This indicates that, overall, the model applied can statistically significantly predict the dependent variable, quantity supply of honey.

Fourteen explanatory variables were hypothesized to determine the household level marketable supply of honey. Among the hypothesized seven variables were found to be significantly affected the market supply of honey at the household level. These are colony size (number of beehives owned), type of beehives used (improved and traditional), beekeeping equipment, market information, honey price of 2019, frequency of extension contact per year and training as per presented on table 20. The remaining seven variables (age, gender, family size, education, farm land size, non-bee farm income and credit) were found to have insignificant effect on honey market supply.

Total Number of Honeybee Colonies (COLONYSIZ): It is proxy variable for quantity of honey produced and positively influence the volume of honey supplied to market at 1 percent significance level. This indicates that producer with more number of beehives with bee colony can harvest more volume of honey and not only having of better market surplus but will able to sell more. The model result indicated that as the number of hives with bee colony used increased by one, the volume of honey marketed increased by 58.67 percent. It is confirmed that the use of large number of hives directly related with the amount supplied to the market and return earned by beekeeper, Kerealem, *et al.* [5]. This result is also in line with finding of Getachew [6], Kassaa, *et al*. [12] and Tizazu, *et al.* [13].

Types of Beehives (HIVETYP): As it was expected improved hive use is positively related with quantity supply of honey and the coefficient is statistically significant at 1 percent significance level. The model result shows that using both improved (Transitional and

Framed hive) and traditional beehives affected quantity of honey supplied significantly and positively. Keeping a unit increase in improved hive leads to increase in quantity supplied of honey by 44.68 percent. The possible reason for this result is the use of improved hive is directly related with the amount of honey produced, supplied to the market and return earned by beekeepers. Improved beehives allow honey bee colony management and use of a higher-level technology with larger colonies and can give higher yield and quality of honey thus in turn increase market supply. This result is also coinciding with the finding of Kassaa, *et al*. [12] ,Zegeye [14], The Case of Damot Gale district of Wolaita Zone and Chena district of Kaffa zone in Southern Ethiopia respectively.

Equipment Beekeeping (EQPMNT): It was expected that possessing beekeeping equipment (accessories) affect quantity of honey produced and positively influence the volume of honey supplied to market at 5 percent significance level. This indicates that producer with beekeeping accessories can harvest more volume of honey and abled to supply more honey to the market by 23.99 percent. This is in line with Chali [17], who found that, the positive relationships between access to beekeeping accessories and honey production, which in turn with the quantity of honey supply to the market. Gezehagn [37] found that coffee farming equipment has effect on coffee productivity.

Access to Market Information (MARKTIFO): Access to market information significantly and positively influences quantity honey market supply at 1 percent significance level. The model result confirms that as compared to households who have no access to market information, households who have access of market information increases quantity of honey supply to the market by 28.45 percent, all other factors held constant. Market information is vital instrument during marketing because it informs the farmers about marketing conditions. Farmers who have price information prior to marketing tend to sell more of their produce than those without. Also this result is in line with Nasir Ababulgu [38] who found that producers who have market information supply more coffee to wholesalers than collector. The finding is also consistent with the results of Nugusa Abajobir Bekele [39] who found the existence of positive relationship between the market information and market participation decision of maize at Guduru district.

Price of Honey in kg (PRICE): In this study it was hypothesized that price of honey in 2019 G.C. was one of the major determinants of quantity supply. The finding shows price of honey is positively related to quantity supply and statistically significant at 1 percent significance level. Producers checked the price of honey for their best benefit. Other variables remain constant at their mean value, as price of honey increase, quantity supply of honey increase by 90.21 percent. Similarly, previous studies conducted by Asseffa [8] and Zegeye [14] found that, current honey prices affected marketable supply of honey significantly and positively. This is in line with Nugusa [39], who find out that there is positive relationship between maize sold and current price.

Frequency of Extension Contact per Year (EXCOFRQ): It was positively and significantly related to the volume of honey supplied to the market at 1 percent significance level. The positive and significant effect was mostly due to the reality that beekeepers who frequently contact extension worker concerning beekeeping particularly about modern honey production, harvesting and handling methods contributed to increase the amount of honey supplied to market. The model result predicts that increase in number of extension contacts per year by one in relation to honey production, increases the amount of honey marketed by 32.95 percent. This suggests that frequent extension contact avails information regarding improved technology which improves production that in turn affects the marketed supply. The result is consistent with earlier results of Getachawu [6], Samuel [11] and Kassaa, *et al*. [12]. Also with the study of Hika wana and Asfew Lemesa [40].

Beekeeping Training (TRAIN): The model result in table 21 also showed that participation in beekeeping training was significantly affecting the volume of honey supplied at households' level in Guduru distrct. It was a dummy variable and significant at 5 percent significance level. It is known that giving trainings for producers on beekeeping can fill the knowledge gap that constrained production and productivity. The model result predicted that as compared to those households who did not participate in beekeeping trainings, the marketed supply of honey for those households who participated in beekeeping trainings increases by 32.03 percent. The result is consistent with previous results of Samuel Sarka [41].

CONCLUSION

There are important honey production opportunities and immense potentials in Guduru district. Accordingly,

some of the opportunities associated with the study area and described by the respondent beekeepers were: bee colony availability, environmental conducive, bee fodder availability at raining time since the area is known with crop production potentiality, water availability, high price, indigenous knowledge & skill and experiences on beekeeping, NGO and government attention. And regarding to the market supply, newly starting of honey purification, NGO initiation, pure honey price increment trend, favorable road & transportation (even though there is no honey trader in local area, there is grain or other agricultural product traders' market place is not far from respondents).

The interviewed beekeepers were mentioned and prioritized the major honey production challenges in the district. According to the sample respondents, low quality of honey product, high cost of modern beekeeping equipment's and accessories, shortage of bee forage, indiscriminate agrochemical application, problem of pests and predators (especially, Ants), raining during harvesting time, drought (lack of rainfall), absconding and migration, lack of knowledge, lack of extension support, poor infrastructure development, market problem and lack of equipment were identified in sequences.

Similarly for supply also the major challenges are identified by respondents like sparsely populated rural areas and difficulties to transport honey product are physical barriers for accessing markets; lack of organized markets and market channel, No buyer or lack of market (in bulky), lack of containers, lack of negotiating skills, Price instability, low quality of honey products, lack of improved technologies for processing honey, honey collection center and lack of market information are other impediments to market supply of honey in order of importance.

Estimation of determinants of marketable supply of honey with the help of multiple regression models (OLS estimator) analysis was employed with fourteen hypothesized variables. The result of the model analysis pointed out that, among the hypothesized seven variables were found to be significantly and positively affected the market supply of honey at household level as expected. These are colony size (number of beehives owned), type of beehives used (improved and traditional), beekeeping equipment, market information, honey price of 2019, frequency of extension contact per year and training. The remaining seven variables (age, gender, family size, education, farm land size, non-bee farm income and credit) were found to have insignificant effect on honey market supply.

Recommendation: Possible recommendations that could be given on the basis of the study so as to be considered in the future intervention strategies which are amid at the promotion of honey production and marketing of the study area were as follows:

The colony size (number of beehives owned), type of beehives used (improved and traditional), beekeeping equipment, market information, honey price of 2019 G.C, frequency of extension contact per year and training was found to influence the quantity supply significant positively during the survey time. The positive significant effects of the variable propose that by the all mentioned above for smallholder farmers, sale volume of the honey can be expanded. Therefore, increasing the number of hives with colony, distribution of improved (both transitional and framed) hives accompanied by safety protective materials and other accessories for farmers of the district would bring additional marketable supply of the produce. Availing the strategies to support farmers with beekeeping business through facilitating access serves like credit availability, extension contact, trainings on improved beekeeping approach, cooperative formation, input supply and market facilitation/linkage also bring additional marketable supply of honey product, Additionally, addressing the identified problems like designing effective honeybee pests and predators controlling methods; planting different flora especially, considering for dry period; improving pre- and post-harvest handling of bee products and make ready for market.

Accordingly, the district Livestock and Fishery offices, NGO and other development partners should give weight on adequate practical skill training, facilitate on credit access for beekeeping purpose, implementing new technology, continuous follow up and technical support on honey production and marketing, design ways to collect and disseminate business information timely for beekeepers. District and Zonal cooperative office and farmers union should give attention for honey producers and increase ability of smallholder producers to organize themselves into effective commercial entities (honey producers group) and encourage their participation in local and global trade. Farmers' cooperative Union should have to construct standardized honey collection center and create enabling environment for processors and exports make smallholder farmers beneficial. All development agents of apicultural activities in the area should develop branding strategy and ensure traceability.

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APPENDIXES

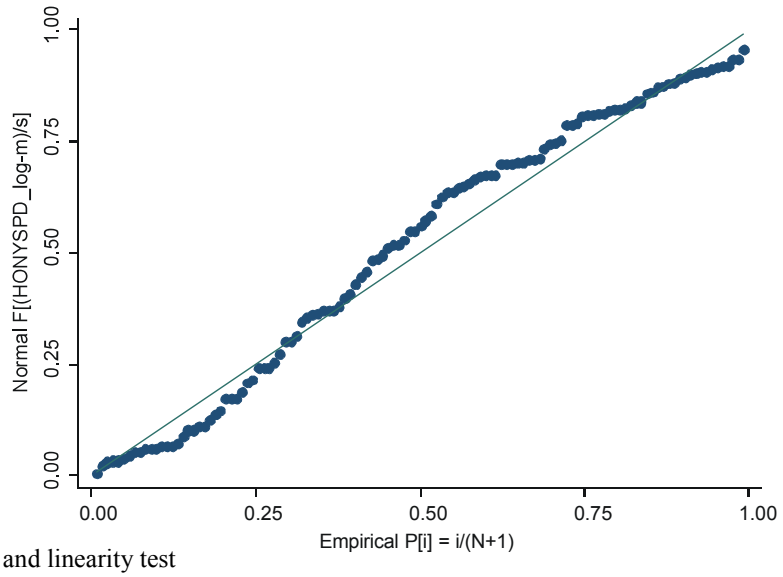

Fig. 1: Normality and linearity test

Table 2: Multicollinerity test with VIF for continuous variables

Variable	VIF	1/VIF
EXCOFRQ_log	2.57	0.389104
PRICE_log	2.25	0.445181
COLONYSIZ_~g	2.09	0.478948
EDUCATI_log	1.50	0.666513
LANDSIZ_log	1.29	0.772716
INCOME_log	1.29	0.775610
AGE_log	1.24	0.805637
FAMLSIZ_log	1.18	0.850873
Mean VIF	1.68	

Source: Own from survey data, 2019

Table 3:" Contingency Coefficient for dummy variables

. corr GNDR HIVETYP EQPMNT CREDIT MARKTIFO TRAIN (obs=121)

	GNDR	HIVETYP	EQPMNT	CREDIT	MARKTIFO	TRAIN
GNDR	1.0000					
HIVETYP	-0.0941	1.0000				
EQPMNT	-0.0265	-0.5836	1.0000			
CREDIT	-0.0474	0.1614	-0.2740	1.0000		
MARKTIFO	0.0000	-0.5253	0.2451	-0.0639	1.0000	
TRAIN	0.2525	-0.5391	0.1888	-0.1538	0.3518	1.00

Source: Own from survey data, 2019

Table 4: Specification /Omitted Variable test result (ovtest).

. ovtest

Ramsey RESET test using powers of the fitted Values of HONYSPD_log

Ho: model has no omitted variables
F(3, 103) = 2.09
Prob> F = 0.1060

Source: Own from survey data, 2019

Table 5: Heteroscedasticity test result (hettest).

. hottest
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of HONYSPD_log
$chi^2(1) = 0.07$
Prob> $chi^2 = 0.1923$

Source: Own from survey data, 2019

Table 6: Endoginiouty test result

. estat endogenous
Tests of endogeneity
Ho: variables are exogenous
Durbin (score) $chi^2(0)$ = -2.0e 14 (p=.)
Wu-Hausman F(0,106) = . (p = .)

Source: Own from survey data, 2019

Table 7: Multiple Linear Regression Model Result

Source	SS	df	MS		
				Number of obs	= 121
				F(14, 106)	= 55.37
Model	158.375225	14	11.312516	Prob > F	= 0.0000
Residual	21.656646	106	.204307981	R-squared	= 0.8797
				Adj R-squared	= 0.8638
Total	180.031871	120	1.50026559	Root MSE	= .452

HONYSPD_log	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
AGE_log	-.1178084	.2339897	-0.50	0.616	-.5817157	.346099
FAMLSIZ_log	-.1338359	.1065191	-1.26	0.212	-.3450205	.0773486
EDUCATI_log	.0276318	.0676864	0.41	0.684	-.1065629	.1618266
LANDSIZ_log	.075816	.0864102	0.88	0.382	-.0955006	.2471326
COLONYSIZ_log	.5867068	.100062	5.86	0.000	.3882845	.7851292
INCOME_log	-.1233739	.1301633	-0.95	0.345	-.3814352	.1346875
PRICE_log	.9020927	.3069513	2.94	0.004	.2935319	1.510653
EXCOFRQ_log	.329542	.0468153	7.04	0.000	.2367262	.4223579
GNDR	.030105	.1577284	0.19	0.849	-.2826068	.3428169
HIVETYP	.4467838	.0800878	5.58	0.000	.2880021	.6055656
EQPMNT	.2398899	.1131643	2.12	0.036	.0155306	.4642491
CREDIT	.0503588	.093183	0.54	0.590	-.1343856	.2351031
MARKTIFO	.2844809	.1062403	2.68	0.009	.0738492	.4951125
TRAIN	.3202609	.1238973	2.58	0.011	.0746224	.5658993
_cons	-2.323031	1.738594	-1.34	0.184	-5.769962	1.1239

Source: Own from survey data, 2019