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Determinant factors affecting adoption of modern bee hive technology towards smallholder farmers: The case of Sodo Zuria Woreda, Wolaita Zone, Southern Ethiopia

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Abstract
This study was undertaken to investigate the determinant factors affection adoption of modern box bee hive technology. The study areas were selected based on high-potential beekeeping activates. A simple random sampling method was employed to select a sample of 115 household farmers using face to face interviews, focus group discussions, key informants and field observations. The binary logistic regression model and descriptive statistics were used to analyze the data. The results showed that 48.4% were adopters and 59.4% of the sampled farmers were non adopters. The results of the study indicated that sex, education, participation in cooperative organization, utilization to credit, contact with extension agent, Farm size, training, distance to market center and relative disadvantage were found to have positive and significant influence on adoption of improved box bee hive technology. Consequently, policy makers should take into attention the determinant factors affecting adoption of modern box bee hive technology.

Keywords: Adoption, improved box

Introduction
Ethiopia has a huge potential for beekeeping production because of its endowment with diversity in climate and vegetation resources for beekeeping (Kidane, 2014) [32].
In Ethiopia traditional, transitional and improved beehives were recognized for honey production with total of 5.15 million beehives (of 93% traditional) and the farm households keeping bees were 1.4 million. Endowing with diverse agro-climatic zones, the total honey and beeswax production estimates about 39,700 and 3,800 tons per year. Such an amount puts the country 10th in honey and 4th in beeswax production worldwide. Moreover, Ethiopia has the potential to produce up to 500, 000 tons of honey and 50, 000 tons of beeswax per year (GDS, 2009) [30].
Beekeeping, also called apiculture, is management of honey bee colonies for pollination of crops and honey and other products (Bradbear, 2009) [12]. It is an environmentally friendly and non-farm business activity undertaken by farmers and landless people. That means, it does not occupy cultivated land, requires less investment and provides quick economic benefits, besides, it being a nonpolluting intensive agricultural practice (Conrad, 2007) [18].
Honey and bees-wax are the two main products generated by the beekeeping subsector. World Trade of honey fluctuates between 997, 000 tons and 1, 000, 000 tons yearly. Totally one third amount of honey produced in the world is from the two biggest honey producer countries Russia and China. Developing countries taken as a group produce about 500,000 tons. Beekeeping offers environmentally beneficial activity that can help the developing countries in alleviation of poverty and maintaining natural biodiversity (MASHAV, 2016).
Ethiopia has a huge potential for beekeeping production because of its endowment with diversity in climate and vegetation resources for beekeeping (Kidane, 2014) [33].
Beekeeping activity has important contribution economically and ecologically (Ajebush, 2018) [2]. This sub sector has remarkable potential to contribute to employment generation, local and global market, livelihood improvement, and biodiversity conservation and helps ensuring economic advantages of women, youths and Ethiopia's geographical position poor households. Development of the Beekeeping practices could significantly enhance crop production, food security, maintenance of plant diversity and ecosystem stability 9-(Apimondia International Symposium, 2018) [4].

Moreover, the importance of beekeeping as an income-generating activity pivots on the fact that many people use honey as food, medicine and for sale. Beekeeping offers a great potential for development and is comparatively less demanding in terms of investment, labour and time. In addition, beekeeping is advocated to improve human welfare by alleviating poverty through increased household income: it is a source of food and nutritional security, raw materials for various industries, medicine, increased government revenue through levies and taxes, improved biodiversity conservation and enhancing environmental resilience (Kihwele *et al*., 1999; MNRT, 2004**)** [34].

Apiculture also plays a role in generating and diversifying the income of subsistence Ethiopian smallholder farmers mainly the small land holders and landless (EARO, 2000; Gezahegn, 2001) [24, 6].

Offa district has potential for beekeeping activities because relatively covered with rich natural resources and thus the apiculture is immense in it. In the district, where there is a high potential of natural resources, honey production is entirely a mean of income for small scale farmers. In this area, most of the beekeepers keep bees and use the income generated from that to purchase grains, agricultural input, clothes and to pay land tax. However, despite its potential role in the development of rural economy, the beekeeping sector faces several major problems such as lack of beekeeping skills, inappropriate production technologies, weak market access, weak price incentive systems, and limited financial capacity of beekeepers (Melaku *et al*., 2008) [31].

To solve these challenges, national efforts has made in linking small scale farmers with agricultural marketing chains. Access to market, credit service, new technologies and risk reduction are some of the benefits for farmers from producers association. But, small-scale farmers are often reluctant to adopt new production technologies.

Thus, this study is designed to investigate the information gap on factors affect smallholder farmers' adoption hinder to use improved box hive technology.

Objectives of this study

The specify objective of this study is:

- To discover factors affecting adoption of improved box hive technology in the study area.
- To ascertain the perception of smallholder farmers towards improved box hive technology.

Research Methodology

Description of study area

The study was accompanied in Sodo zuria district, found in southern Ethiopia. Livelihood of Most of people is Agriculture and the agricultural activities of rural poors is depends on rain fall. This exposes them to lead their life continuously in severe circumstance.

Study design

This study was engaged both quantitative and qualitative design for descriptive research. The method of research which concerns itself with the present phenomena in terms of conditions, practices beliefs, processes, relationships or trends invariably is termed as descriptive survey study. According to Aggarwal (1998) [35], descriptive research is devoted to the gathering of information about prevailing conditions or situations for the purpose of description and interpretation. Similarly, this study were intended to gather relevant information, which utilizes a semi-structured questionnaire on perception of smallholder farmers towards modern box hive technology and its contribution in household food security and current status of honey production potentials in the study area.

Questionnaires of quantitative data were analyzed through descriptive statistics using SPSS version 20 software whereas Factors affect Adoptors and non-adopters of the hive was analyzed through descriptive statistics and binary logit model was used.

Sample size and Sampling techniques

Multisrage-stage sampling procedure was used to select sample respondents. First, three kebele in Sodo Zuria woreda were designated by simple randomly Gilo Bisare, Gulgula and Buge wanche. Second, beekeepers were stratified into sub-groups based on agro-ecology zones, and users and non-users of box hive technology. Third, purposive sampling was used to select household for survey. The sampling frame of the study was the total households of selected kebeles. The sample size was determined by using simplified formula of Yamane n= N/1+N (e) 2

Type and Source of Data

Both quantitative and qualitative data obtained from primary and secondary sources. Household data collection methods such as survey questionnaire, FGDs and key informant interviews were used to obtain primary data. The primary data that were collected for quantitative research regarding to explanatory variables.

Secondary data such as description about the study area location, topography, climate, population, agricultural production was collected from relevant sources like books, internet, related journals and annual report of zone and woreda agricultural office.

Methods of Data Collection

The central data gathering tool for this study was semi-structured interview. In addition to that, for qualitative study, Key informant Interview and group discussion were used.

The quantitative primary data required for the study was collected from sampled households by conducting formal survey using Semi-structured interview.

Data Analysis

The data were analyzed using software SPSS version 16 version. Appropriate techniques and procedures were used in the analysis to identify the influence of demographic factors, socioeconomic, institutional variables and psychological factors on the adoption decision process of modern box bee hive technology. Descriptive statistics were used such as mean, standard deviation frequency and percentile. Inferential statistics such as Chi-square test; f test were used to test significant levels of the dependent variables on independent variables and also the econometric analysis was employed.

Binary logistic regression is used to calculate the probability of two possible outcomes. In this finding, the two possible outcomes were either adopters or non-adopters. To examine the factors that influence adoption of improved box bee hive technology a binary logistic regression was employed.

Binary logistic regression is used to calculate the probability of two possible outcomes (Bagley SC. *et al*. 2001). In this research, the two possible outcomes were either adopters or non-adopters.

The logistic model considers the relationship between a binary dependent variable and a set of independent variables. The logistic model for 'k' independent variables

(Xi, X2, X3, Xk) is given by:

$$\text{Logit}(x) = \alpha + \sum_{i=1}^{k} \beta i\, xi$$

Results and discussions

Results of Descriptive statistics of variables

Regarding its relationship with adoption of improved box bee hive, therefore the Pearson chi-square test indicated that sex of the household head had significant relationship (χ^2 = 6.553, p=0.028). Results of Pearson chi-square test indicated that education level of the household head had significant relationship (χ^2 = 29.8, 0.000) with adoption of improved box bee hive at 1% significance level. The mean age of non-adopters and adopters were found to be 45.74 And 43.54 years respectively. Result of mean test using one-way ANOVA indicated that there was no significant mean difference (F=0.772, P=0.7690) among adoption categories, implying the absence of significant relationship of age with adoption of improved box bee hive technology. The result of participates in cooperatives while (44.5%) did not participate in cooperative association (X2 = 18.274, P = 0.000). The result revealed that there is significant relationship between membership and the adoption of improved box bee hive at 1% level. During the study it was found that 60.9% (26.4% adopters and 34.5% non-adopters) and Chi-square analysis revealed between non-farm employment and adoption of modern box hives insignificant. The results of one way ANOVA with value of F= 2.602 and P= 0.014 indicates that there was statistically significant mean difference among adoption categories of farm size. The one way ANOVA (F=.644, P=.816) suggests that there is no statistically significant difference between the holding of household livestock and the adoption of modern box hive technology. The one way ANOVA result shows the significant mean difference (F=.013, P=0.000) between adoption categories in relation to perceived comparative disadvantages of the technology characteristics and existence of significant mean difference between adoption categories at 1 percent probability level. The reason replied by most of respondent on why they are not adopting modern beehive was cash shortage and expensiveness of the technology were 22.8% and 24.6% respectively.

Econometric analysis

Table 1: Binary logit model output

Variables	B	S.E.	Wald	Sig.	Exp (B)
EDUC	.855	.249	14.124	.001	3.375
ACCTC	1.434	.451	12.434	.002	4.354
AGEHH	-.045	.037	3.637	.104	0.957
SEXHH	1.424	.545	4.735	.023	5.156
TRAI	1.568	.412	12.825	.003	4.600
CWEXA	3.130	.640	21.752	.004	24.200
NONFAC	.027	.344	.001	.725	1.0567
EXPER	-.348	.256	2.537	.058	0.792
REDADVIB	-.179	.066	6.498	.006	0.619
DISTMRT	-.520	.270	5.554	.024	0.805
LABAV	.556	.368	2.341	.134	1.662
FARSIZ	1.070	.352	8.681	.003	2.375
TLU	.588	.188	12.336	.073	1.902
PICOOP	1.751	.432	15.630	.001	7.541

Pearson χ2 value= 125.646, Log likelihood = -40.849, Cox & Snell R Square=0.732
Sample size 115, Probability=0.000 , significant at *, ** 1% and 5% level
Source, own survey, 2021

Recommendations

- The study revealed that education status of household head positively and significantly affects farmers' decision to adopt modern box hive technology. More educated household heads are in the better position to adopt the new technology. Therefore, the regional and zonal Government sector involved in education should boost the educational status of the farmers through adult education.
- Extension services was found to be significantly influencing adoption MBH hive, it should be strengthened down to the village level to inform farmers in order to increase the rate of adoption.
- Zone and woreda cooperative office should strengthen the existing cooperative beekeepers and Encarouge those to form as savings and credit cooperatives as finance to increase their apiary size.
- The respondents were found to face marketing limitations which significantly bound their benefit from improved box bee hive adoption. Hence, greatly emphasis of zonal and woreda government has to be given to the improvement of market and marketing system particularly through cooperative unions.
- Farmers were found to face marketing constraints which significantly limit their benefit from beekeeping. Thus, considerably emphasis of zonal and woreda government has to be given to the improvement of market and marketing system particularly through cooperative unions.
- Participation in training was among the important variable that positively influenced the adoption of improved box bee hive. This indicates that extension service should be extended by establishing additional development centers and empowering them. Therefore, to sustain the positive contribution of the extension service to the adoption of improved box bee hive, strengthening extension services is necessary. Therefore, attention should be given to the research and extension linkages, and frequent training must be organized for beekeepers to adopt improved technologies.
- Female-headed households are less adopter of improved

box hive than male headed households. This might be due to lack of access to information sources. Hereafter, increase the participation of women and awareness creation should be done both by governmental and non-governmental organizations about the versatile of improved box bee hive technology more effectively.

- According on the discovery of this study further researches can be executed in the forthcoming in order to improve box hive and beekeeping technology in the study area

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Appendix 1

Appendix Table 1: Conversion factors used to compute man day equivalent

Age group (Years) Man Days Equivalent (MDE	Man Days Equivalent (MDE)	
	Male	Female
<10	0	0
10-13	0.2	0.2
14-16	0.5	0.4
17-50	1.0	0.8
>50	0.7	0.5

Source: Storck *et al.,* (1991)

Appendix 2

Appendix Table 2: Conversion factors used to estimate Tropical Livestock Unit

Animal Category	TLU
Cow and Ox	1.00
Heifer	0.75
Young bull	0.80
Calf	0.25
Weaned Calf	0.34
Sheep and Goat (Adult)	0.13
Sheep and Goat young	0.06
Donkey (Adult)	0.70
Donkey (Young)	0.35
Chicken	0.013

Source: Storck *et al.,* (1991)