International Journal of Agricultural Extension and Rural Development Studies
Vol.8, No.1, pp.52-99, 2021
Print ISSN: ISSN 2058-9093,
Online ISSN: ISSN 2058-9107

ANALYSIS OF THE STATUS AND DETERMINANTS OF RURAL HOUSEHOLDS' ACCESS TO AGRICULTURAL EXTENSION SERVICES: THE CASE FF JIMMA GENETI WOREDA, OROMIA REGIONAL STATE, ETHIOPIA

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ABSTRACT: *Effective, comprehensive, need-based, and participatory agricultural extension service is a major factor in improving the income and welfare of rural households. However, it has been reported that ineffective, non-comprehensive, and not need-based in many developing countries. The study analyzed the status and determinants of rural households' access to agricultural extension services in the case of Jimma Gebeti Woreda (Ethiopia). A mixed-methods approach is used. Primary data are collected from 387 samples. Descriptive and inferential statistics and logit models are used to analyze the data. Results revealed that there are unaccessed sample heads to agricultural extension services in the current study area. Weak links between agricultural research and farmers extension problems, lack of coordination and communication between agricultural sectors and higher learning institutions, and lower salary level and fewer resources for field agricultural extension agents are found the major potential reasons/challenges that make sample households' unaccessed. Furthermore, Kebele/''ganda'' of the household head, access to agricultural extension training, access to credit service, irrigation use, and rural households' having a telephone were found the major determinant factors. Thus, based on the above results it is possible to conclude that rural households' access to agricultural extension services is not as it ought to be. Above it is found that the extension delivery is mostly non-participatory. Therefore, policy majors that could avert the above challenges and determinants are recommended like for example, empowering extension workers and delivering pluralistic and need-based agricultural extension services.*

KEYWORDS: Households, access to agricultural extension services, logit model (Ethiopia)

INTRODUCTION

Agriculture is the major sector in the economic growth, poverty reduction, and livelihood security enactment of agrarian rural societies. Thus, diffusion of effective, comprehensive, need-based, and participatory agricultural extension services to rural households has been found most critical to be considered. Conceptually, agricultural extension services are commonly about the supply of agricultural technologies/inputs to improve agricultural productivity, and agents are expected to

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provide useful technical information/advice to the farmers that can improve the income and welfare of rural people like linking smallholder farmers to high-value and export markets, promoting environmentally sustainable production techniques, adapting to climate change, and coping with the effects of HIV/AIDS and other health challenges that affect rural people (Global Forum for Rural Advisory Services/GFRAS, 2012). There are two relevant agricultural development theories. First, the diffusion of information (DoI) theory/theoretical framework/model of agricultural development has come to existence after repeated empirical observation of substantial differences in land and labor productivity among Households and regions. Diffusion is the process by which an innovation is communicated through certain channels over time among members of a social system (Rogers, 1995). Thus, the diffusion of agricultural technologies, expertise, and new ways of doing things from advanced Households and regions to traditional Households and regions was a better source of agricultural development (Rogers, 1995). Participatory & need-based agricultural extension and advisory services have a paramount role. Secondly, the high payoff input model states that the key to transforming a traditional agricultural sector into a productive source of economic growth is an investment designed to make modern high payoff inputs available to Households in poor countries and it is classified into three categories: (a) the capacity of public and private sector research institutions to produce new technical knowledge; (b) the capacity of the industrial sector to develop, produce, and market new technical inputs; and (c) the capacity of Households to acquire new knowledge and use new inputs effectively (Dercon & Douglas, 2014).

Furthermore, the world's present population grows from 6.7 to 9.1 billion by 2050, food production will need to double over this same period, and thus, more effective extension services are needed to address agricultural challenges including meeting the information needs of poor smallholder farmers in developing countries, in response, agricultural extension experts and institutions around the world are promoting the use of information and communication technology (ICT) by agricultural extension and education agents (FAO, 2009). Based on FAO (2009), other reasons for the need for ICTs are identified by different studies. For example, according to World Bank (2011), ICTs can expedite the process of agricultural technology transfer from research and development institutions to farmers, and ICTs improve the adoption of agricultural technology by supporting farmer learning, problem-solving, and accessibility to profitable markets for their crops. Besides, research findings reveal that ICTs do improve the productivity and livelihoods of poor smallholder farmers (Munyua, Adera, & Jensen, 2009). On contrary, Lasley, Padgitt, & Hanson, (2001) have expressed the view that ICTs could eventually replace traditional information and training systems used by extension services and even alter the role of extension agents. However, interestingly, Anastasioa, Koutsouris, & Konstadinos (2010) in their study of ICTs as agricultural extension tools in Greece, found that ICTs supplement rather than replace traditional extension methods. A study exploring the use of ICTs by extension agents in the Caribbean found that they use ICTs for personal benefits and increased professional productivity, but also continue to use traditional interaction methods with farmers (Strong, Ganpat, Harder, Irby, & Lindner, 2014). Furthermore, Jamil *et al*. (2016) reported that the type and composition of extension services received by farmers in Haiti as aquaculture (0%), conditioning and transformation (3%),

crop election (14%), arboriculture techniques (17%), field techniques (20%), livestock (22%), aviculture (20%), and apiculture (1 %).

In Sub-Saharan Africa, Abdallah & Abdul-Rahman (2016) have identified the descriptions of agricultural extension services in Ghana. Results of the descriptive statistics show that about 37% of the farmers belong to farmers associations with 15% having access to agricultural credit, about 92% lack knowledge of improved seeds and 86% apply fertilizer on their farms, and the average number of visits made by extension agent is 0.21 and the average distance from the farm to input store is 2.67 Km. Whereas, in Nigeria, Umeh & Ekwengene (2017) used descriptive statistics for data analysis on agricultural extension services. Results show that extension services in Nigeria have not done much in terms of regular visits and supervision which is the main thrust of the Training and Visit (T&V) system (Umeh & Ekwengene, 2017). The major constraint militating against effective utilization of the agricultural extension packages transferred to the farmers in Nigeria are irregular visit and supervision of farmers by extension agent 94(14.35%), scarcity of input 93(14.19%), land scarcity 92(14.0%), lack of fund 86(13.12%), untimely availability of inputs 83(12.67%), untimely dissemination of technologies 81(12.36%), no change in yield 62(9.46%), irregular technology 55(8.39%), poor understanding of technology 7(1.06%), technologies don't agree with the culture of the people 2(0.3%) (Umeh & Ekwengene, 2017). To reverse, the major factors found to enhance the utilization of agricultural development packages (ADP) agricultural extension packages are a value addition to farm output 96(14.24%), easy understanding and application of technologies 95(14.09%), affordable inputs 91(13.50%), increased farm output 90(13.35%), reduced cost of production 88(13.05), improvement of skills in farming 78(11.57%), increased standard of living 69(10.23%), as well as easy accessibility of technologies 66(9.79%) (Umeh & Ekwengene, 2017). Also, in Nigeria, Jibowu (2002) states that extension agents are poorly motivated in terms of remuneration and provision of transport facilitates to visit the farmers, where many extension agents live away from the farmers thereby minimizing interaction between them and the farmers.

Tata & McNamara (2016) have researched the "social factors that influence the use of ICT in agricultural extension" in South Africa. The theoretical framework of the agricultural development theory is known as the Diffusion of Innovation (DoI) theory (Rogers, 1995), has guided their study. According to Tata & McNamara (2016), Farm-book is a novel information communication technology (ICT) tool for agricultural extension. Farm-book enables extension agents to assess the productivity and profitability of farming enterprises in a faster and more reliable manner, to increase farmer incomes and achieve food security (Tata & McNamara, 2016). Multivariate techniques were used to analyze data on the relationship between Farm-book challenges with explanatory variables. Overall results show that personal and wider socio-economic conditions do have an impact on the proficiency of extension agents using Farm-book in South Africa and the study goes on to recommend measures to improve the training and ICT proficiency of extension agents adopting Farmbook (Tata & McNamara, 2016). Another study in South Africa was done by Ijatuy *et al*. (2017).To describe the socio-economic characteristics of the respondents, Ijatuyi *et al*. (2017) employed descriptive statistics such as percentages, frequency tables, and mean scores. The descriptive results showed that the average age of 55 years was recorded in the study; respondents were predominantly male and married, with an average household size of five people,

having 16 years of farming experience, and with an average farm size of 400.5 hectares. In turn, Mwamakimbula (2014) has assessed the factors impacting agricultural extension training programs in Kilolo district (Tanzania). Descriptive statistics were used to analyze the data. Results showed that most farmers are motivated to attend extension education training to learn new ways of doing things to improve production, and farmers prefer to learn by doing through demonstration (Mwamakimbula, 2014). Despite the eagerness that farmers have for learning new ways of farming, most farmers are discouraged by the poor organization and coordination of extension training programs in their areas (Mwamakimbula, 2014). Most farmers know the importance of extension services in improving their production, but they are not satisfied with the way these services are being implemented (Mwamakimbula, 2014). The other factor that the study identified is the lack of a participatory approach among extension agents, which leads to the inability to meet farmers' needs and additionally, the study found that poor support by the government for the extension sector also lowers the effectiveness of the extension agent. In most cases, extension agents live far from their assigned villages due to a lack of housing. There is also a lack of transport for extension agents, which seems to be another reason for not helping farmers in their work station (Mwamakimbula, 2014).

In Ethiopia, gender differences in access to extension services and agricultural productivity were studied by Catherine *et al*.(2012). Results suggest that female heads of households and plot managers are less likely to get extension services and less likely to access quality services than their male counterparts after controlling for plot, household, and village level characteristics(Catherine et al.,2012). At the regional level (Oromia regional state), Gurmessa, Felekech, & Taha (2011) studied the survey on women's access to agricultural extension services in the administrative Zone of Oromia Region in Central Rift Valley namely; Dugda, Boset, Ada'a, and Fentale districts. The data were analyzed by using descriptive statistics namely; frequencies, mean, and standard deviation by using SPSS.13 version. Chi-square and t-test were also employed for data analysis. Results show that the participation of female-headed households in the agricultural extension package program was still very low (44.4%) when compared with male-headed households (75%) (Gurmessa, Felekech, & Taha, 2011). The major constraints to accessing and utilization of extension packages identified by this study include; low supply related problems, cost of the technology (expensive), delay of inputs (input is not available on time), low awareness about technology recommendations, and biasedness of extension agents towards progressive farmers can be mentioned. Participation of women farmers in extension events like training, field days, and demonstration is also very low (<21%) (Gurmessa, Felekech, & Taha, 2011). The study recommends that female-headed farmers need to be encouraged to participate in agricultural extension package program on their participation in extension events like training, field days and visits need to be re-considered, Strengthening of linkages between development agent and women farmers is one of the other critical factors that requires giving due attention, and there is a need to diversify women's livelihood options (Gurmessa, Felekech, & Taha, 2011).

Concerning the determinants of households' access to agricultural extension services, several studies have been done. For example, Yurttaș & Atsan (2006) revealed that households' need for extension services differ based on their age. That is, Abdallah & Abdul-Rahaman (2016) found

that because older farmers have a comparative advantage in terms of capital accumulated, extension visits, and creditworthiness, they are more likely to access different types of extension services in rural Ghana, but only at a certain age. In other words, access to agricultural extension services differs with their ages. Consistently, Umeh & Ekwengene (2017) found that the age of sample households' had a negative and significant relationship with the utilization of agricultural extension packages in rural Nigeria. Boahene (1995) found that the education level of households has been observed to have positive effects on extension access of rural households. Similarly, Yurttaș & Atsan (2006) revealed that households' need for extension services differ based on their educational level. That means Catherine *et al*. (2012) state education creates a favorable mental attitude for the acceptance of new practices, especially information-intensive and management-intensive practices, and hence has been observed to have positive effects on extension access. Furthermore, Arias *et al*. (2016) found that education level has a positive, yet small effect on receiving extension services in Haiti. Besides, Umeh & Ekwengene (2017) found that the education level of sample households' had a positive and significant relationship with the utilization of agricultural extension packages, implying that an increase or improvement on the education level of sample households' enhance or boost utilization of agricultural extension packages, ceteris paribus, in the study area (rural Nigeria). On contrary, using the logit model Abdallah & Abdul-Rahaman (2016) found that though not significant, the negative sign of the education variable indicates farmers who are educated may have a comparative advantage over other farmers in accessing extension services in rural Ghana. In terms of information search, education provides the rural households of the study area with an opportunity to read and understand manuscripts as well as posters about extension teachings and practices. It also presents the sample households' information about any extension program.

Arias *et al.* (2016) found that prior agricultural training is a major determinant of the receipts of agricultural extension services in Haiti. Catherine *et al*. (2012) asserted that those with a shorter distance to market are more likely to have access to agriculture-related information through different channels in rural Ethiopia. A similar study by Arias *et al*. (2016) also revealed that location (distance from town) is an important determinant of the likelihood of receiving agricultural extension services by rural households in Haiti. Besides, Abdallah & Abdul-Rahaman (2016) found the inverse relationship between distance to town and the probability of demand for extension services by households as nearness to major markets decreasing transaction cost and guarantees market participation thereby encouraging the demand for extension services. Umeh & Ekwengene (2017) found that the income of sample households' had a positive and significant relationship with the utilization of agricultural extension packages in rural Nigeria. Arias *et al.* (2016) found that location (distance to input supply) is an important determinant of the likelihood of receiving agricultural extension services by rural households in Haiti. Abdallah & Abdul-Rahaman (2016) found that distance to input store found to be significant at 10% significance level in rural Ghana. Michailidis *et al.'s* (2011) study shows that internet access in rural Greece positively and significantly rural households access to agricultural extension services. Consistently, it was hypothesized that internet access in the field for development agents/DAs has a positive and significant association with sample households' access to agricultural extension services Qamar (2005) states that unhealthy perception and lack of trust in extension prevails in

many developing countries has been contributed to its ineffectiveness. Qamar (2005) also states that the imperfect initial organizational set-up of FTCs in developing countries negatively contributed to the rural households' access to agricultural extension services. Besides, Jamil *et al.* (2016) found that poor management of agricultural extension has negatively determined rural households' access to such services in Indonesia.

Effective participatory and need-based agricultural extension services have a motivational factor for to households adopt agricultural extension services (Churi *et al*., 2012) it not, demotivate them to adopt agricultural extension services. Besides, Arias *et a*l. (2016) found that promoting a hybrid system of extension may be more efficient than supporting only public or NGO-provided extension services. Moris (1991) pointed out that a lower salary level and fewer resources for field extension agents have been negatively affected the effectiveness of rural households' access to agricultural extension services in most developing countries. Belay & Abebaw (2004) reported that the efficiency of agricultural extension work depends on the availability of personnel who are qualified, motivated, committed, and responsive to the ever-changing social, economic, and political environment. On contrary, Jamil *et al.* (2016) found that the development of human resources has positively affected the action program of agricultural extension services and improved farmers' behavior (competency and participation) in agricultural extension services in Indonesia. Abdallah & Abdul-Rahaman (2016) found that knowledge of fertilizer use was also found to be significant because extension agents possessed knowledge on how to use modern fertilizer; as part of the efforts to spread this knowledge, extension agents move to rural areas where farmers can easily access them. This thus increases access to extension services. Abdallah & Abdul-Rahaman (2016) found an insignificant relationship between households' access to agricultural extension services and the frequency of extension visits in rural Ghana.

At the study area level, according to Jimma Geneti Woreda land administration office (2017), the secondary data on land use type show that, out of the total 410.068 Km2, cultivated land converted 193.12 Km2, forest land covered 11.205 Km2, grazing land covered 39. 655 Km^2 and others covered 166. 0268 Km2.In the study Woreda, according to Woreda Agriculture and Natural Resource Office (2017; 2018), agriculture continues to play a dominant role in the livelihoods of rural households' source of income, nevertheless, agricultural production in the woreda has primarily relied on erratic seasonal rainfall, unpredictable & insufficient and as a result, there are repeated failures of agricultural production in the Woreda. Furthermore, concerning the average farm holding size per household in a hectare, secondary data show that the total number of farm landholding sizes was 19,311 hectares both in 2017 and in 2018. The document revealed that there are 11,877 households in the Woreda and as a result, the average farm landholding size (ratio of total farm landholding size to the number of households) in both 2017 and 2018 show that 1.625 hectares each year. Concerning the percentage of the farers with farm landholding size per household, it was found that no data available for ½ hectare holders both in 2017 and 2018.

However, it was found that the number of 1-hectare holders was 697, 1.5-hectare holders were 2,454, 2-hectare holders were 787, 2.5-hectare holders 4,226, 3-hectare holders were 2,394, and 4 and above hectare holders were 1,319 households both in 2017 and in 2018. Agricultural input

supply in the study Woreda shows that fertilizers like NPS+B 5309 quintals in 2017 and 5,563.5 quintals in 2018 and UREA 8,314 quintals in 2017 and 5,471 quintals in 2018; pesticides 263 lt in 2017 and 150lt in 2018; Herbicide like 2-4D 3,420lt in 2017 and 2,462lt in 2018; and Wheat improved seed 335 Quintals in 2017 and 285 Quintals in 2018 and Maize improved seed 506.125 Quintals in 2017 and 555.125 Quintals in 2018 were distributed (Woreda Finance and Economic Development Office, 2017). The agricultural calendars of the study Woreda are land clearing in March and April, sowing/planting in May, June, July & August, Weeding in June, July, and August, Harvesting in December and January, and Storing in January and February (Woreda Agriculture and Natural Resource Office, 2017; 2018).

In the study area, Teff, Wheat, Barley, Sorghum, and Maize are among the dominant cereals produced in the Woreda. The total cultivated land of the Woreda in 2017 was: Teff on area 4,721 (Hekt) 103,983 (Quintal), Barley on 3,571 (Hekt) area 9,360 (Quintal), Wheat on 5,459 (Hekt) area 139,740 (Quintal), Maize on 4,713 (Hekt) area 274,425 (Quintal), Sorghum on 33 Area (Hkt) 1,221 (Quintal), millet no areas and no production, Oats on 34 areas (hectare) 392 (Quintal), and Pulses are horse beans on (1,803hkt) 31,365 (Quintal), Field peas on723(Hekt) 10,962 (Quintal), Nug on 608 (Hkt) Area 5,445 (Quintal), and linseeds are on 19 (hectare) area 148 (Quintal),, Linseed on19 (hectare) area 148 (Quintal), Rapeseed on 113 (hectare) area 1,667 (Quintal), and Sesame, Fenugreek(Ocholoni) no production was produced in 2017. Whereas, in 2018, out of the total cultivated land, Teff on area 4,350 (Hekt) 52,200 (Quintal),Barley on 3,252 (Hekt) area 52,032(Quintal), Wheat on 4,608 (Hekt) Area 103,680 (Quintal), Maize on 3,650 (Hekt) Area 91,250 (Quintal),Sorghum on 33 Area (Hkt) 23 (Quintal), Oats on 55 Areas (Hekt) 990 (Quintal),and Pulses are horse beans on (1,845hkt) Area 14,783 (Quintal), Field peas on 743 (Hekt) 8916(Quintal),Nug on 605 (Hkt) Area 1,855 (Quintal) were cultivated. In summary, the secondary document review shows that, on 15,900 hectares of land 569, 006 Quntilas in 2017 and on 15,843 hectares of land 443,907 Quntilas in 2018 portions of cereal were produced; on 2,655 hectares of land 39,969 Quntilas in 2009 and on 2,713 hectares of land 29,615 Quntilas in 2018 pulses were produced, and on 756 hectares of land 7,891Quntilas in 2009 and on 755 hectares of land 5,357 Quntilas in 2018 oilseeds were produced. The area under cultivation of cereal crops decreased because of crop rotation and cereal crop production are decreased due to fluctuation rain fails, crop disease affection (Woreda Agriculture and Natural Resource Office, 2017; 2018).

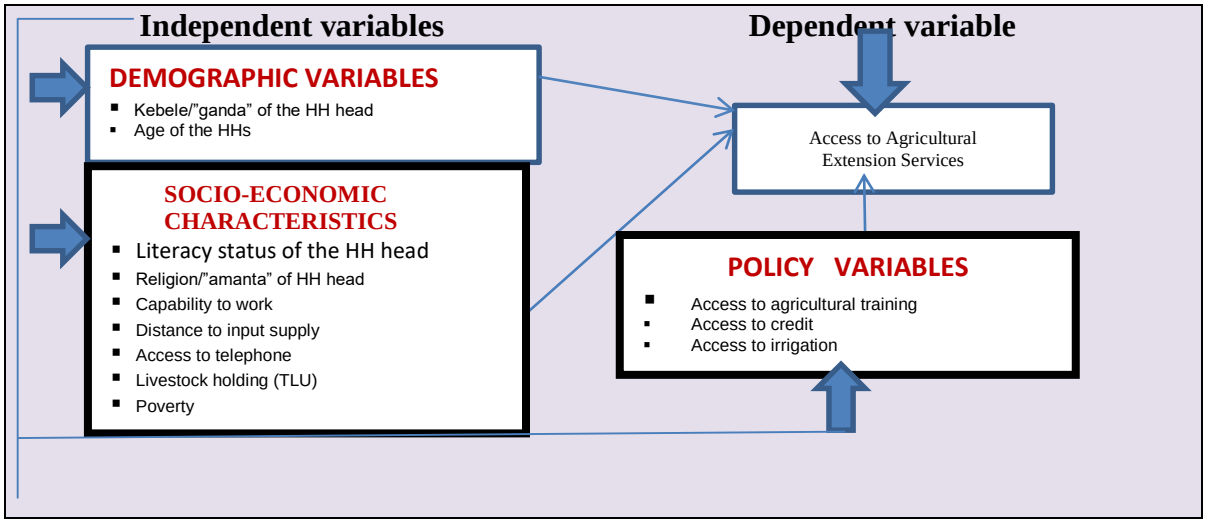
Furthermore, livestock plays a great role [provide meat, milk, transport, manure, skin, hid and furnish regular and easily realizable cash income]in the day-to-day life of rural households. In the study area, the status of livestock population shows that the number of Cattles are 126,194 in 2017 and 132,508 in 2018, Goats are 39,523 in 2017 and 41,501 in 2018, Sheep are 76,291 in 2017 and 78,674 in 2018, Horses are 20,208 in 2017 and 21,218 in 2018, Mules are 2,486 in 2017 and 2,622 in 2018, Donkeys are 12,201 in 2017 and 19,625 in 2018 (Woreda Animal Health Office, 2017; 2018). Furthermore, concerning the status of irrigation in the study Woreda, Jimma Geneti Woreda Irrigation Office (2018) document entails us that, the main source of water for irrigation practice is surface water (River, spring, reservoir) that enabled traditional schemes developed by individual farmers 7,224 hectares, flood recession 460 hectares, modern schemes developed 41hectars and

pump schemes for commercial purpose are 299 hectares and size of land irrigated in the district are 8,024 hectares of surface water.

Neither of the documents has grouped households of the study area either based on asset endowment or income-based indicators or both. Despite agriculture play a significant role in the rural households of the study area, some of the major constraints of agriculture in this district includes fluctuation of rainfall, increased costs of agricultural input, a large number of unproductive labor, the backwardness of work culture, undeveloped working culture, land degradation and loss of fertility, absence of local research and encouragement on farmers plot/farm, absence of modern irrigation scheme, absence of crop diversification, large family size and the growth of population causing the shortage and scarcity of cultivable land, loss of soil fertility, over-cultivation and overgrazing of agricultural lands, and lack of farmland management practices and as a result, low production, more pressure on scarce land and it in return aggravate youth immigration from the area to nearby Hareto town (rural-to-rural migration or rural -to- town migration), the gradual loss of land productivity particularly depletion of soil fertility and hence the low yield and low productivity of agricultural production increase the problem of household poverty(Woreda Finance and Economic Development Office, 2017:18).

Based on the above review, the gap analysis revealed that Ethiopia, despite considerable growth of households' participation in extension services, remained low (Abrham, 2013). That is, in enhancing household livelihood security and reduce poverty, in particular, rural poverty, different studies have shown that there are several determinant bottleneck problems of the effectiveness of Ethiopian's agricultural extension services. The current study has investigated both the status and determinants of rural households' access to agricultural extension services, thereby, established the association among dependent variables in the study area. Thus, the major objective of this study is to investigate the status and determinants of rural households' access to agricultural extension services. It devoted to answering the following basic questions: first, what is the current status of rural households' access to agricultural extension services in the study area? And secondly, what are the determinants of rural households' access to agricultural extension services in the study area? Which are the major determinant ones? Below is the conceptual framework of the current study (Fig. 1).

Fig 1: Conceptual framework



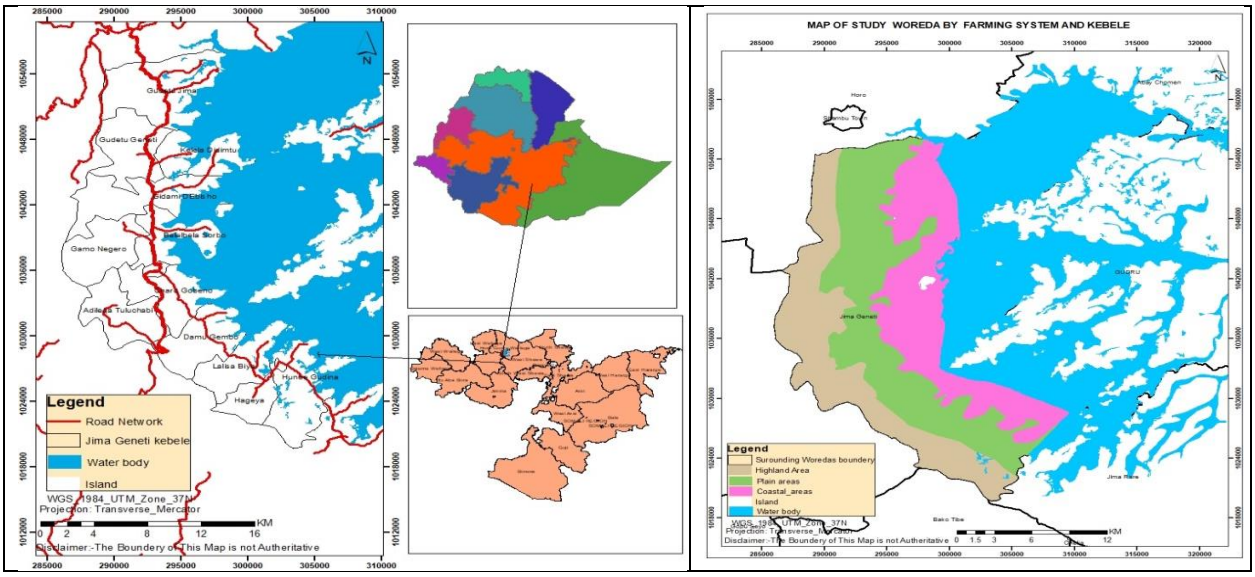
Source: Own framework (2019)

MATERIAL AND METHODS

The study area: Jimma Geneti woreda is located 287 Km away from Addis Ababa on the way to Nekemte asphalt road and 27Km away from *Shambu* town (Horro Guduru Wollega zone capital). The total number of the projected rural population was 78, 981 (Male = 39,183 and Female= 39,798) (*Woreda* Finance and Economic Development office, 2017). The study woreda is divided into twelve rural *kebeles* (smallest administrative unit) (Fig. 2).

Figure 2: Map of the study area (Jimma Geneti Woreda)

Fig.2a: Woreda map by sample kebeles	Fig 2b: Woreda map by farming and kebeles



Source: Ethiopia mapping Agency, expert assisted (2021)

Data type and its sources: Quantitative type of data analyzed. Both primary and secondary data sources are used. Primary household-level data is collected using a survey questionnaire from 387 randomly selected households. The 387 sample size is determined using a sample determination method proposed by Krejcie & Morgan (1970). Secondary data from publications by government, international organizations, multidimensional poverty researchers, and thesis are also used as major data sources of this study.

Sampling design: According to Jimma Geneti woreda Office of Agriculture and Natural Resource (2018), except, the two towns Hareto and kidame Gebeya, twelve rural households (N= 8,075) are considered as the population size (N) of the research. The study utilized multi-stage sampling to select the final units which participated in the study.

Analytical Methods and Models: Two major steps are followed. First, is **our logistic model is reliable or how well the model is fitted?** While R-squared is used in the linear regression model, livelihood ratio is used for logit model assessment. The hypothesis of the study is that:
Null hypothesis (H0): always for all model slope coefficients are equal to zero or independent variables jointly measure nothing, i.e H0=0

The alternative hypothesis (H1): not equal to zero. We reject the null hypothesis if the computed model value is greater than the critical value at 99% confidence interval and accept the alternative hypothesis. Accordingly, below are the three alternative formula =e to compute the restricted livelihood ratio
ln L0 = n[P1 ln P1 + (1 − P1) ln(1 − P1)]……..(1)

Where n is the sample size, p1 is the dependent variable equal to 1, and 1-p1 is the dependent variable equals 0

Alternatively, **LR = 2[lnLR – lnL0]…….…… (2)**

Where LR is the livelihood ratio, lnLR is the restricted livelihood ratio, or when all the independent variables are removed but the constant remains. It is an unknown value to compute. But lnLo is unrestricted livelihood ration which is known from the odds ration output

The alternative to equations (1) and (2), equation (3) below is also used to compute the unknown value (i.e' restricted livelihood ratio/lnLR)

$$\textbf{R-squared}=1-\frac{\textbf{LnLo}}{\textbf{LnLR}}$$

$$\textbf{R-squared-1} = -\frac{\textbf{LnLo}}{\textbf{LnLR}}$$

-lnL0= (R-squared)lnLR

LnL0= - (R-squared)lnLR……(3)

Where, both R-squared or pseudo R2 value and the unrestricted livelihood ratio (lnLO) value can be obtained from the odds ratio outputs.

Step 2: specification of the model: Next section is about the specification of the logistic regression or logit model. Descriptive statistics: Self-reported primary data through survey questionnaires were collected in November 2019 from a sample of 387 households constituted from twelve kebeles of Jimma Geneti woreda. Both descriptive, inferential, and econometric techniques are used in the analysis of the data. That is, the socio-economic characteristics of the rural households' data captured through access to agricultural extension services survey questionnaire were analyzed using descriptive statistics (frequency, percentage, mean, and standard deviation). To see the overall significance of the model/ whether the explanatory variables are jointly determining the dependent variable or not was tested using inferential statistics, Chi-square test.

Econometric analysis: However, after diagnosis test of the post estimation of the multicollinearity problem was tested for logit model using Coefficients of contingency [chi-square /χ2 based measure of association] for categorical variables and Variance Inflation Factor (VIF) for continuous variables, econometric analysis of logit regression was used to analyze the determinant factors of rural households' access to agricultural extension services.

Model specification: Logistic regression, also called a logit model, is used to model categorical outcome variables. In the logit model, the log odds of the outcome are modeled as a linear combination of the predictor variables. Because the linear regression model is used only when the dependent variable is continuous, logistic regression is used for modeling where the dependent

variable is discrete. In this study, the dependent variable (access to agricultural extension services in the last 12 months preceding this study) is a dummy variable. When the dichotomous nature of such dependent variable is taken into consideration, factors influencing rural households' access to agricultural extension services can be estimated using the Probit or Logit models. This is because Logit and probit models translate the values of the independent variables (Xi), which may range from -∞ to +∞ into a probability for (Yi) which ranges from "0" to "1" and compel the disturbance terms to be homoscedastic. This makes the selection between the two models very sticky as both models provide equally efficient parameters. The forms of probability functions depend on the distribution of the difference between the error terms associated with a choice. The probit models assume the existence of an underlying latent variable for which a dichotomous realization is observed (Maddala, 2002) and (Abbey & Admassie, 2004), thus given the model:
Probability functions

$$Y_i^* = \beta_o + \sum_{j=1}^{k} \beta_j X_{ij} + \varepsilon_i$$,…….…… (4) Latent variable [not observable]

Where; Yi* = Latent variable (not observable) and Yi = Dummy variable (observable) defined as

{1 if yi' > 0 and 0 other wise..... (5) Dummy variable [observable]

Logit model estimating the probability of a household to be either [access AEs =1, otherwise 0]: In linear probability model, the dichotomous dependent variable is expressed as a linear function of the explanatory variables. Although one can estimate the linear probability model by the standard Ordinary List Square Methods as a mechanical routine, the result will be beset by several estimation problems. A linear probability model may generate predicted values outside the admissible 0-1 bound, which violate the basic tenets of probability. The logistic distribution has the advantage over others in the analysis of dichotomous dependent variables. The logistic distribution is extremely flexible, relatively simple from the mathematical point of view, and lends itself to meaningful interpretation. However, Pindyck and Rubinfeld (1981) acknowledged that the logit model that is based on the cumulative logistic probability function is computationally easier to use than the other types and will be used in this study. Following Gujarati (1999), the logistic regression model characterizing adoption by the sample households is specified as:

$$P_i = F(Z_i) = F\left[\alpha + \sum_{i=1}^{m} \beta_i X_i\right] = \left[\frac{1}{1+e^{-(\alpha+\sum \beta_i X_i)}}\right]$$ ……..…… (6)

Where, e = represents the base of natural logarithms (2.718…), Xi= represents the ith explanatory variable, Pi=the probability that an individual makes a certain choice (in this study saying yes or no), and α and βi= are parameters to be estimated. It should be noted that the estimated coefficients do not directly indicate the effect of change in the corresponding explanatory variables on the probability (P) of the outcome occurring. Rather the coefficients reflect the effect of individual explanatory variables on its log of odds. The positive coefficient means that the log-odds increase as the corresponding independent variable increases (Neupane, Sharma, Thapa, 2002). The coefficients in the logistic regression are estimated using the maximum likelihood estimation method. The logistic distribution function for the determinants of households' access to agricultural extension services can be specified as:

$$[1-P_i]=\left[\frac{1}{1+e^{Z_i}}\right] \quad \text{..... (7)}$$

Where, Zi=β0+βiXi, Zi represents Logistic Distribution Function
Using equation (16) and (17), the odds ratio becomes

$$\left[\frac{P_i}{1-P_i}\right]=\left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right]=e^{Z_i} \quad \text{..... (8)}$$

Alternatively,

$$\left[\frac{P_i}{1-P_i}\right]=\left[\frac{1+e^{Z_i}}{1+e^{-Z_i}}\right]=e^{\left[\alpha+\sum_{i=1}^{m}\beta_i X_{ii}\right]} \quad \text{..... (37)}$$

That is, to estimate the probabilities of households' access to extension services or non-access in this study, the logit model [binary logistic regression] will be used since the results are similar to probit. The logit model [binary logistic regression] is selected because it is important to identify the relationship between the dichotomous dependent variables and any form of explanatory variables, the model doesn't have restrictive distribution assumptions and also the model is used by other researchers such as Abdallah and Abdul-Rahman (2016).Taking the natural logarithms of equation (19) will give the logit model as indicated below

$$Z_i=\ln\left[\frac{P_i}{1-P_i}\right]=\alpha+\beta_1 X_{1i}+\beta_{2i}X_{2i}+----+\beta_m X_{mi} \quad \text{..... (9)}$$

If we consider a disturbance term, ui, the logit model

$$Z_i=\alpha+\sum_{i=1}^{m}\beta_i X_{ii}+U_i \quad \text{..... (10)}$$

OR

$$Log\left(\frac{P_i}{1-P_i}\right)=\sum\beta_j X_{ij}+\varepsilon_i$$

Where; P = P [Y = 1] denotes, the probability that a household has access to agricultural extension service, P = P [Y = 0] denotes, the probability that a household has no access to agricultural extension service, Pi =represents the conditional probability that a household has access to extension service, (1 –Pi) =denotes the conditional probability that a household has no access to extension service, βj's=are vectors of coefficients to be estimated, Xj's =are vectors of explanatory variables (See, Table 5, first column), and εi= the error term. In general, the logistic regression model including the disturbance term can be expressed as:

Zi = β0+ β1X1+ β2X2+ β3X3+ β4X4+ β5X5…+ βnXn + Ɛi……..... (11)
Where; Zi=is a function of an explanatory variable (X), β0=is an intercept, β1, β2…βn, =are the slopes of the function, Or, β0, β1 X1, β2 X2, β3 X3, β4 X4, β5 X5,…, βn Xn)= coefficient parameters, Xi= is the vector of explanatory variables (predictors), and Xi...Xn represents major factors influencing household participation in agricultural extension services in the last 12months considered as independent variables, and Ɛi =error term. Therefore, the above econometric model was used to analyze the data in this study. The parameter of the model was estimated using the iterative maximum likelihood estimation procedure. This yields unbiased and asymptotically efficient and consistent parameter estimates.

Dependent and independent variables: The dependent variable in this model is a binary variable in which 1 stands for participant households in agricultural extension services in the last 12 months and 0 otherwise. Several explanatory variables influence the dependent variable. These independent variables that were expected to affect/determinants of rural households' access to agricultural extension services are shown in (see, Appendix 1, Table.1). The dependent variable of this study is rural households' access to agricultural extension services. It is a dummy variable represented by 1 if sample households are accessed/ YES, otherwise 0/NO. Indeed, access to agricultural extension services is assumed to be influenced by six demographic, six socio-economic, and seventeen policy-related independent variables listed (See, Table 1).

Table 1: Variables and their descriptions/ measurement for analyzing rural households' access to AEs (N=387)

Variables	Nature	Value/Description/M	Expected sign
DEPENDENT VARIABLE			
Access to agricultural extension	Dummy	1 if accessed and 0	
INDEPENDENT VARIABLES			
Age of the HHs head	Continuous	Number /actual age	Negative
Capability to work	Dummy	1 if capable 0	Positive
Kebele/"ganda" of the HH head	Categorical		Positive
Religion/"amanta" of HH head	Categorical		Negative
The literacy level of the HH head	Categorical		Positive
Access to agricultural training	Dummy	1 if trained 0	Positive
Access to credit service	Dummy	1 if trained 0	Positive
Access to irrigation use	Dummy	1 if trained 0	Positive
Distance to input supply	Continuous		Positive
Access to telephone	Dummy	1 if accessed 0	Positive
Livestock holding (TLU)	Continuous		Positive
Poverty			Negative

RESULTS AND DISCUSSIONS

Current status of agricultural extension services in the study area

Access to agricultural extension training

One of the channels of disseminating agricultural extension services from public or private extension delivery to rural households is training: a method targeting to bring behavioral change to rural households. Table 2, below presented the status of sample households' access to agricultural extension training, frequencies, places, usefulness, and problems related to farmland.

Table 2: Access to agricultural extension training (N=387)

Access to agricultural extension training by sample heads	Response options	Response result		
		N	%	Total
In the last 12 months, do you get access to agricultural extension training?	Accessed	261	69.79	374
	Non-accessed	113	30.21	
How often the agricultural extension training was delivered in a year?	Once per year	75	27.27	275
	Twice per year	92	33.45	
	More than twice per year	108	39.27	
Where is the place of the agricultural extension training?	FTC	153	51.17	299
	Kebele house	24	8.03	
	On-farm	6	2.02	
	FTC and kebele house	35	22.71	
	All	81	27.09	
Do you agree that the agricultural extension training was useful?	Strongly agree	173	51.18	338
	Agree	34	10.06	
	Undecided	45	13.31	
	Disagree	72	21.30	
	Strongly disagree	14	4.14	
What major problem/s your agricultural farmland does face?	Poor soil fertility	66	19.94	331
	Soil erosion	69	20.85	
	Both	196	59.21	

Source: Computed from own field survey (2019)

Table 10.2 results show that while 261/69.79% accessed, 113/30.21% of sample households were not accessed to agricultural extension training delivered in the last 12 months preceding this study. Open-ended survey questionnaire concerning why non-accessed to agricultural extension training delivered in the woreda was raised. Results show that lack of motivation by development agents and lack of participatory and need-based agricultural extension training by government workers, distance, and poor quality of FTCs are among the list of data captured through an open-ended questionnaire. Consistent results were reported. For example, several studies (Moris, 1991; Benor *et al*., 1984; EEA/EEPRI, 2006; Wambura *et al*., 2012; Mwamakimbula, 2014) have been conducted on factors impacting agricultural extension training programs, thereby, resulted to inaccessibility of most rural households.

One of these factors was related to development agents and unilateral public extension delivery systems. The major task of development agents (DAs) is to provide capacity-building agricultural extension training to households followed by practical demonstrations on their farmland. However, in most studies (Moris, 1991; Benor *et al*., 1984; Mwamakimbula, 2014) lower salary levels and fewer resources for field extension agents, and lack of knowledge about participatory extension approaches by extension agents contributed to the inequitable provision of agricultural extension training to rural households. Asfaw *et al*.(2012) found that less contact of rural households with extension agents hamper their accessibility to effective agricultural extension training. Besides,

Benor *et al*. (1984) and Asfaw *et al*.(2012) revealed rural households' access to agricultural extension training was constrained by a lack of participatory and need-based agricultural extension training monopolized by the government or ministry-operated extension system. Weak links between research and extension and inadequate government support affected rural households' participation in agricultural extension training (Wambura *et al*., 2012).

Furthermore, seven major systematic bottlenecks appear to prevent more-farmer-oriented tailoring service delivery showing inadequate performance of FTCs in Ethiopia such as limited involvement of farmers in FTC management, insufficient resources for FTCs, most FTCs have non-long-term plans for sustainability, inadequate incentives to motivate and retain development agents, limited knowledge and skill of development agents, limited training to farmers and inadequate incentives for model farmers for their time to support resource-poor farmers (MoA & NR, 2017). Concerning the poor quality of FTCs [insufficient resources and quality construction] in the study area, field observation during data collection was carried. For example, Hagaya kebele FTC wall was constructed from poorly fixed corrugated iron sheets (not hallow concrete blocks). During the data collection training, the researcher observed the internal facilities in the FTC. No agricultural farm tools for demonstration of practical on-farm activities. Inside the compound of the FTC, no demonstration of animal production (improved cattle with varieties for fattening and dairy, no demonstration samples of modern beekeeping, and others) except the production of Teff and Maize on a small plot of land in the compound of the FTC. Insufficient resources for FTCs (MoA & NR, 2017) were evidenced in the study area that potentially prevents sample households from their access to agricultural extension training delivered in the last 12 months before this study.

The frequency of agricultural extension training delivered is about how often sample households are accessed to agricultural extension training per year during the 12 months preceding this study. Results show that while 108(39.27%) sample households responded trained more than twice per year, 92(33.45%) and 75(27.27%) accessed the training twice per year and once per year respectively. According to Federal MoA & NR (2019) document, the length of agricultural extension training should be "short term package training" (p.8). Indeed, a long stay of rural households on training either in FTCs or in kebele houses harms their production and productivity. It harms their production by the loss of a long time at the expense of labor and time investment on agricultural production and productivity. That is, distancing rural households for long hours and long days from their close supervision of on-farm products could reduce their production and productivity due to their absence from their close follow-up and timely weeding out and harvesting of their products. Despite how long short is training package is unclear, breaking down the provisions of intensive and extensive agricultural extension training to rural households throughout the calendar and being accompanied by on-farm land training seems plausible. In such away, it could be expected to ensure the effectiveness of agricultural extension training provided, other factors remain constant.

A place of the agricultural extension training delivered is related to FTCs, kebele house, on-farm, or a combination of these places. As reported by the sample households of the study area most of the agricultural training delivered to sample households of the study area were took place in FTCs

(153/51.17%). However, another agricultural extension training was reported to take place at kebele house (24/8.03%), FTC and kebele house (35/11.71%), and all (81/27.09%). Secondary data sources from MoA & NR (2019) show that accessing farmers to agricultural extension training "on FTCs improve skill and knowledge so that they accept and implement improved agricultural practices and technologies on their plots to increase agricultural production and productivity"(p.8). The same document revealed that conducting agricultural extension training and demonstration of improved technologies and best practices on model farmers' farm improve their skill, which is critically important to increase agricultural production and productivity. However, out of the total 299 sample households of the study area who responded to the item (place), only 6(2.01%) of them responded that such training was carried out on- farmland, implying that on-farm centered agricultural extension training [practice based training] is found less emphasized that put the effectiveness of the extension services in question in the woreda. Therefore, sample households need-based provision of agricultural extension training coupled with working agricultural research centers and practical implementation of theoretical lessons delivered in either FTCs or in kebele households can improve sample households of the study area production and productivity.

The usefulness of agricultural extension training delivered denotes the potential benefits sample households gained from being accessed to agricultural training*:* For the use of agricultural extension training delivered to rural households, 173(51.18%) of the, strongly agreed the training is useful to them. An open-ended survey questionnaire was raised to sample households who responded strongly agree and agree to the agricultural extension training delivered in the woreda. Responses show that training on modern fattening benefits them in the form of consumption and financial income for fertilizer payment, children's education costs, and family medical costs. Indeed, agricultural extension training packages [modern fattening, animal production, crop production, weed control, dipping techniques, vegetation production, soil and water conservation, etc.] for rural households have multiple chains of benefits for them throughout the farming calendar. For example, training on modern fattening delivered to rural households enables them to promote modern fattening of cattle and ruminant animals either for household-level consumption or for commercial purposes. For household-level consumption, as responded it ensures the food security of household members. Besides, the financial income from the sale of fattening animals encourages rural households to participate in livelihood diversification, thereby, reduce rural households' vulnerability to multidimensional poverty and other shocks. In general, secondary data sources from the MoA & NR (2019) show that accessing farmers to agricultural extension training improves the capacity of farmers.

Access to agricultural extension services

Agricultural extension service refers to the process of extending need and demand based knowledge and skill from a center of learning to those in needs (farmers and other actors) to solve their immediate problems (soil infertility, pesticides, soil erosion, and others) and increase production and productivity of farmland thereby achieve quality life. Nevertheless, due to anthropogenic and/or natural causes, the farm-land of rural households could face multiple

problems. For example, on an item related to farm land-related problems, sample household underscored the presence of both poor soil fertility (66/19.94% and soil erosion (69/20.85%) problems on their farm-land, suggesting the production, productivity, and effectiveness of agricultural extension service delivery to sample households has been questionable. Farm-land of the rural households is one of their natural assets (Ellis, 1999; 2000a; DFID, 1999; Odero, 2006; Houweling, 2009; Barbier & Hochard, 2014; Garedew, 2017). No doubt that poor soil fertility and soil erosion problem on the farm-land of rural households affect their production and productivity. One of the purposes of the agricultural extension service package is to access rural households to agricultural extension service delivery packages, thereby; enhance soil fertility through the utilization of technologies adoption and soil erosion control mechanisms like conservation measures. Based on this background information, 266(71.31%) sample households responded they are accessed to agricultural extension services in the last 12 months preceding this study. However, 107(28.69%) responded non-accessed to the agricultural extension services. Sample households' access to agricultural extension services (types & frequencies) (Table 3).

Table 3: Sample households' access to agricultural extension services

Sample households' access to agricultural extension services (access, types, and frequencies)	Access					**Frequencies**			
	Accessed		Non-accessed		Total	Once per year	Twice per year	Three & above/yr	Total
	N	%	N	%		N(%)	N(%)	N(%)	
Access: Do you access agricultural extension services in the last 12 months?	266	71.31	107	28.69	373				
Types: What are some of the agricultural extension services did you get accessed in the last 12 months? ACCESS TO:	YES		NO		TOTAL				
	N	%	N	%					
1. Provision of vaccine	249	64.34	138	35.66	387	98(44.55%)	96(43.64%)	26(11.82%)	220
2. Pest infestation	263	67.96	124	32.04	387	154(67.54%)	58(25.44%)	16(7.02%)	228
3. Weed control	288	74.42	99	25.58	387	119(53.36%)	82(36.77%)	22(9.97%)	223
4. Feeding technique	218	56.33	169	43.67	387	90(50.28%)	63(35.20%)	26(14.53%)	179
5. Weather problem	137	35.40	250	64.60	387	83(72.17%)	18(15.65%)	14(12.17%)	115

Sample households' access to agricultural extension services (access, types, and frequencies)	Access					**Frequencies**			
	Accessed		Non-accessed		Total	Once per year	Twice per year	Three & above/yr	Total
	N	%	N	%		N(%)	N(%)	N(%)	
6. Modern agricultural /farm inputs	261	67.44	126	32.56	387	143(69.42%)	45(21.84%)	18(8.74%)	206
7. Credit services	139	35.92	248	64.08	387	88(73.95%)	17(14.29%)	14(11.76%)	119
8. Irrigation use	218	56.33	169	43.67	387	109(59.56%)	51(27.87%)	23(12.57%)	183
9. Dipping technique	166	42.89	221	57.11	387	89(61.38%)	34(23.45%)	22(15.17%)	145
10. Milking technique	136	35.14	251	64.86	387	83(68.60%)	23(19.01%)	15(12.40%)	121
11. Use of organic manures	217	56.07	170	43.93	387	114(61.29%)	49(26.34%)	23(12.37%)	186
12. New seed varieties	254	65.63	133	34.37	387	126(62.38%)	50(24.75%)	26(12.87%)	202
13. Crop production	238	61.50	149	38.50	387	114(56.44%)	48(23.76%)	40(19.80%)	202
14. Vegetable production	222	57.36	165	42.64	387	100(53.19%)	50(26.60%)	38(20.21%)	188
15. Modern poultry production	193	49.87	194	50.13	387	103(60.95%)	33(19.53%)	33(19.53%)	169
16. Modern beekeeping production	154	39.79	233	60.21	387	91(62.33%)	36(24.66%)	19(13.01%)	146
17. Market linkage	89	23.00	298	77.0	387	59(64.84%)	19(20.88%)	13(14.29%)	91
18. Soil and/ or water conservation practices	226	58.40	161	41.60	387	107(59.44%)	55(30.56%)	18(10%)	180
19. Modern dairy production	134	34.63	253	65.37	387	71(55.91%)	37(29.13%)	19(14.96%)	127
20. Modern fattening [cow/shoat]	156	40.31	231	59.69	387	84(60.87%)	35(25.36%)	19(13.77%)	138
21. Farm book	51	13.18	336	86.82	387	32(68.09%)	11(23.40%)	4(8.51%)	47

Source: Computed from own field survey (2019)

According to Ijatuyi *et al*. (2017), agricultural extension services encompass a wider range of learning activities: agriculture, health, and business organized for rural households. In the current study area, twenty-four different types of agricultural extension services (Table 3) were identified

and responded to which types and how often sample households accessed. Each presented and discussed next.

Weed control, pest infestation, agricultural /farm inputs & seed variety services

For weed control, secondary sources from Woreda Agriculture and Natural Resource Office (2017/2018) show that weeds of different varieties are some of the on-farm challenges of sample households that have been increasing the wastage of their farm products. As a result, to control the spread of weeds on the farmland of sample households, herbicide like 2-4D was distributed for 3,420 farmers in 2017 and 2,461 farmers in 2018(Woreda Agriculture and Natural Resource Office (2017/2018) implying chemical sprays. In conformity, results of the primary data source show that 288(74.42%) samples respond accessed to weed control extension services; 119(53.36%), 82(36.77%), and 22(9.97%) accessed once per year, twice per year and three and above per year respectively during 12 months preceding this study. Chemical sprays against weeds by rural households have serious health and environmental threat. It could also decline the demand for their agricultural products spoiled with inorganic material. Organic agricultural products have a more local and global market. Struggle to control weed shouldn't be against the principle of sustainable rural development. The sample households should prioritize alternative chemical-free weed control, for example, traditional way of hand weeding. It is a difficult task for sample heads having large farm size, But possible to cope up working in "*Debo*" and/or "*Idir*".

Pest infestation-related extension service is another type of agricultural extension service sample households accessed. Results of the same table reveal while 263 (67.96%) are accessed once per year (154/67.54%), 58(25.44%) twice per year, and 16(7.02%) three and above per year, 124(32.04%) of them respond non-accessed to pest infestation related extension service in the last 12 months preceding the current study. Secondary data sources show that 263 farmers in 2017 and 150 farmers in 2018 were accessed to the provision of pesticides control (in kg/lt)(Woreda Agriculture and Natural Resource Office (2017/2018). Similarly, pest infestation with chemicals should not be encouraged by sample households. Local people have their reservoir of knowledge on how to get rid of pets. Due consideration is required by the sample households on the application of scientific knowledge with their rich experiences against pest control. Development agents on each kebele are expected to identify and promote community knowledge-based control of pets.

Furthermore, as reported by 66/19.94% of sample households, their farmland has been facing poor soil fertility. Application of agricultural/farm input (fertilizer) has the purpose of soil fertility improvement. Development agents have played a significant role in providing agricultural extension services related to fertilizer usage. In conformity to this, 261(67.44%) sample households responded they are accessed once per year (143(69.42%), 45(21.84%) twice per year, and 18(8.74%) three and above per year to modern agricultural/farm inputs, while 126(32.56%) not. This primary data is triangulated with the secondary data source and reveals that in 2017 5,309 farmers and 2018 5,563 farmers were accessed to fertilizer named NPS+B and accessed 8,314 farmers in 2017 and 5,471 farmers in 2018 to Urea (Woreda Agriculture and Natural Resource Office (2017/2018). Despite chemical fertilizers (NPS+B) could boost land productivity, no doubt

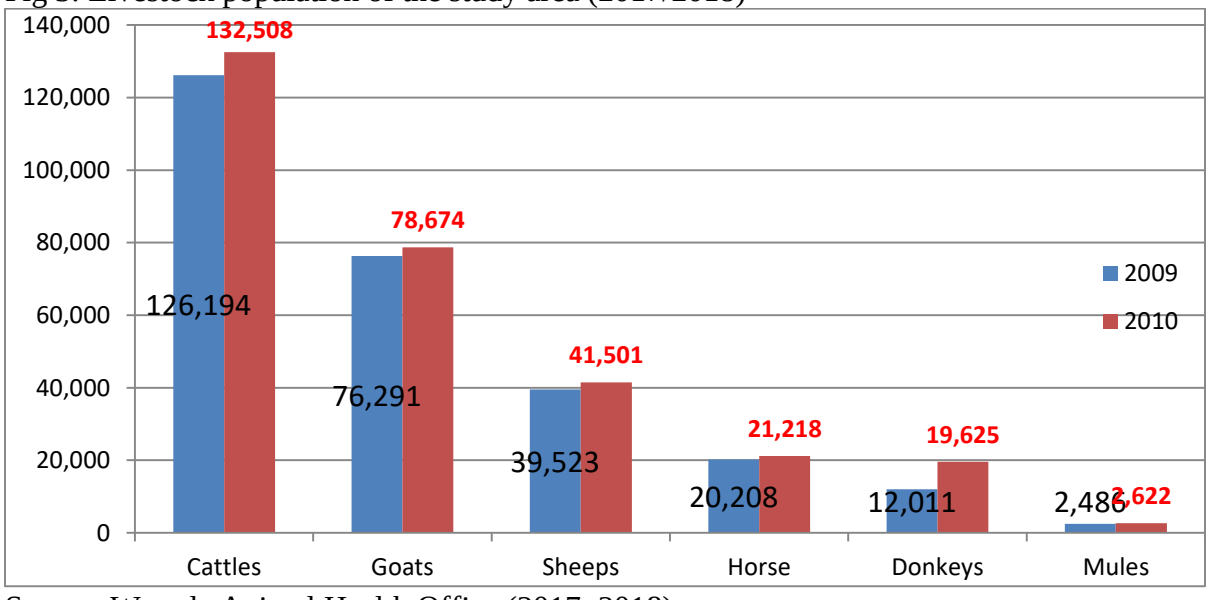
in the long-run could devastate the land and create serious environmental threats. Such application of chemical input is against the notion of sustainable rural development. This study suggests alternative non-chemical fertilizers (manure and cow dungs).

Improved new seed varieties are found among the accessed agricultural extension package by sample households (254/65.63%) once per year (126(62.38%), 50(24.75%), and 26(12.87%). For example, in 2017 335 Qtl and in 2018 285 Qtl improved wheat variety and in 2017 506 Qtl and in 2018 555 Qqtl improved maize variety distributed (Woreda Agriculture and Natural Resource Office (2017/2018). However, 133(34.37%) sample households who participated in this study are not accessed to such new seed varieties (high yield variety seeds). High yield variety seeds are essential for increased productivity of hectors. Despite the presence of an inequitable distribution of high yield variety seeds (Wheat and Maize) among sample households, even the amount of Quintals distributed in 2017/18 seems insignificant as compared to the big number of sample households in the woreda. Indeed, it has been repeatedly reported that at the national level there exists a shortage of high yield variety, broken seeds, and delay/untimely in distribution (Spielman *et al*., 2010) as one of the major challenges of effective agricultural extension services in Ethiopia.

Vaccines, crop production, soil and water conservations, and vegetable production services

Dominated by cattle population, the current study area is known for its varieties of livestock production like goat, sheep, horse, donkey, and mule (Fig 3).

Fig 3: Livestock population of the study area (2017/2018)



Source: Woreda Animal Health Office (2017; 2018)

The figure shows increasing trends of the number of livestock in the woreda in 2017 total was 276,713 animals and in 2018 total of 296148. Vaccination and treatment of livestock among agricultural extension service delivery packages. It is very critical to keep sample heads animal

health. Results of Table 10.2 show that out of the total 387 sample heads who participated in the current study, 249(64.34%) of them respond accessed to the provision of vaccination for their livestock 98(44.55%) once per year, 96(43.64%) twice per year and 26(11.82%) three and above per year 12 months before this study. However,138(35.66%) of samples found non-accessed to animal vaccination extension service. When triangulated with secondary data sources from Woreda Health Office (2017) it was found that there are a total of 19 animal health staff and 3 C-type and 4 D-type animal health infrastructure in the woreda. For the provision of vaccinations is was found that in 2017 a total of 67,546 animals were vaccinated, i.e., 32,841 animals vaccinated pest and CBPP, 20,208 animals vaccinated blackleg, 2,486 animals vaccinated Hemorrhagic septicemia, and 12,011 animals vaccinated anthrax implying that only 24.4% of livestock were vaccinated in the woreda in 2017 alone. A total of 209,167(75.6%) livestock were not vaccinated in the same reporting year. In 2018, a total of 296,148 (100%) animals i.e, 26,250 animals vaccinated blackleg, 37,500 animals vaccinated Hemorrhagic septicemia, and 12,000 animals vaccinated anthrax, and others 220,398 in the woreda; besides, in 2017 16,500 animals treated against Trypanosomiasis, 196, 000 animals treated against the internal parasite, 38,880 treated against the external parasite, 36,500 animals undertook operation and in 2018 16,500 animals treated against Trypanosomiasis, 190,000 animals treated against the internal parasite, 60,000 treated against the external parasite, 150 animals undertook operation (Woreda Health Office,2018).

Besides, animal production, crop production is another key livelihood source of rural households in the study area. Related extension services are also necessary to enhance the production and productivity of sample households. Respondents are asked whether they are accessed or not by such type of extension service. Accordingly, while 149(38.50%) respond non-accessed 238(61.50%) respond accessed to crop production extension services in 114(56.44%) once per year, 48(23.76%) twice per year, and 40(19.80%) three and above per year in the last 12 months before this study. Study area sample households' access to adopted soil and/ or water conservation practices-related extension service is also essentially required agricultural extension package. Because soil conservation practices using either biological or physical conservation practices or both enable households' farmland from serious erosion that could abandon soil fertility. Losses of soil fertility of rural households' farmland have a direct negative impact on their production and productivity. Similarly, water conservation practices have also profound contributions to rural households' productivity and production and above environmental sustainability. Indeed, 226/58.40% sample households respond accessed to such extension services

Coupled with crop and animal productions related agricultural extension services to rural households' their access to vegetable production-related extension services have also a significant role in securing rural households' survival/food security and balanced diet/nutritional security at the household level and in Rural households. From the same Table, 222(57.36%) sample households found access to vegetable production-related agricultural extension services in the woreda. Took place on vegetable farm plots of rural households in Gamo Negero and Balbala Sorgo Kebeles. Accordingly, through Agricultural Growth Program/AGP II, 20-25 rural households were organized to promote Avocado plant and other vegetable production (Photo 1,

below) on Balbala river that crosses two adjacent kebeles (Gamo Negero and Balbala Sorgo) and at the end flows to Fincha'a Lake.

Photo 1: Gamo Negero and Balbala Sorgo rural households' Avocado plant

Source: Photo taken by the researcher during data collection (November 2019)

Irrigation use, feeding technique, use of organic manures, and poultry production services

Rural households' access to irrigation use-related extension service is also a very critical component of the full extension package. According to Woreda Irrigation Office (2018) in Jimma Geneti woreda, the main source of water for irrigation practice is surface water (river such as Sayel and Jabo rivers in Hunde Gudina kebele, Jarra river in Lalisa Biya kebele, Gida river in Dambu Genbo, and Charo Gobeno kebeles, Wandi river in Charo Gobeno kebele, Jawe river in Gidami Dabsho kebele, Balbala river in Gamo Negero and Balbala Sorgo kebeles, and other rivers and springs), traditional schemes developed by individual farmers, flood recession, modern schemes developed by the government, and pump schemes for commercial purpose. Accordingly, 218(56.33%) respond that they are accessed to irrigation use extension service. Irrigation activities in the woreda have a mitigating role against the negative impacts of insufficient rainfall. As 277(71.58%) sample households MPI severely poor, availability of several potential rivers [flows into Fincha'a Lake] for irrigation in the woreda seems paradoxical and revealed underutilization of such rivers for large scale irrigation uses.

Accessing rural households to animal feeding technique-related extension service matters most for sample households who have cattle and small animals for household consumption during festivals and/or commercial purposes. Good quality livestock and small animals depend on their type, frequency, and quality of feed supply to them by owners themselves. In the woreda,218(56.33%) sample households responded they are accessed to feeding technique extension services once per year (83/72.17%), twice per year (18/15.65%), and 14(12.17%) sample households are accessed

three times and above per year 12 months before the current study. Moreover, as part of agricultural extension services 217(56.07%) and 193 (49.87%) sample households responded accessed to the use of organic manures and modern poultry production extension services respectively. However, 170(43.93%) and 194(50.13%) non-accessed to the use of organic manures and modern poultry production extension services respectively.

Lack of accessing rural households to use of organic manures [manure is organic matter that is used as organic fertilizer in agriculture where most manure consists of animal feces; other sources include compost and green manure] related extension services undoubtedly impacted the production and productivity of sample households in the study. Besides, it encourages sample households' excessive dependency on inorganic fertilizers (UREA and DAP). In turn, could impact the health of sample households and the long-term fertility of their farmland. Still, the lack of intensive extension services to sample households on modern poultry production could have its contribution of sample households stay in MPI severely poor and less participation in other livelihood options. The climate change issue and variability in weather don't guarantee sample households' sustainable livelihood sources. Thus, due emphasis to access sample households to use of organic manures and modern poultry production shouldn't be an issue circumvented for tomorrow and other days. Urgent extension services are required, too.

Dipping technique[4], modern fattening, and beekeeping and credit services

Rural households' access to dipping technique-related extension services is another type of agricultural extension package. Livestock is the crucial asset of sample households' in the study. Apart from the presence of internal animal diseases like blackleg, Hemorrhagic septicemia, and anthrax in the woreda, external animal parasites like ticks are common in the woreda that can be effectively controlled through the dipping technique. In a brief sense, a plunge dip (or simply, a dip) is a bath designed to immerse livestock in liquid pesticide (control pests or other treatment. Typically a dip is designed as a narrow channel about the width of the animal (photo 2) through which the animals walk, immersing them in the progressively deeper liquid until the animal is completely immersed (apart from its head so it can breathe).

[4] **Dipping technique:** *is the immersion of the livestock in mixed chemicals against external animal parasites like ticks*

Photo 2: Cattle being treated against ticks in a plunge dip

Source: https://en.wikipedia.org/wiki/Plunge_dip

Then the channel becomes progressively shallower until the animal exits. Because many animals can walk through the channel one after another, it is an efficient method of delivering pesticide or other liquid treatments to a large herd. Despite the merit of the dipping technique (control ticks), the majority of sample households' (221/57.11%) found non-accessed to such a crucial agricultural extension package. Such lack of agricultural extension service raised a concern about the effective implementation of the national participatory extension system strategy in the woreda. The woreda animal health office is the sole responsible government body for the provision of the dipping technique.

Animal fattening [cow/shoat] extension service has two objectives: fattening for commercial purposes, for consumption purposes, and usage of in farming activities like plow with oxen. Animal fattening is most popular for commercial purposes to earn better financial income for the sale of these animals. In the study area, traditionally rural households undertake to fatten their animals by extra land left for open grazing and using salt combined with agricultural products. A combination of local animal fattening and the scientific method of modern animal fattening seems indispensable. In this case, accessing rural households' modern animal fattening technique in the form of extension service is unquestionable. However, out of 387 sample households' involved in this study majority of them (231(59.69%) responded non-accessed.

Weather problem, milking technique, and dairy production services

In Jimma Geneti woreda there are different agricultural calendars like March-April months are agricultural calendars for land clearing by sample households in the woreda. Sowing (planting) activities are carried in the months from May-August. However, months from June-August are for weed control. Harvesting is usually carried out from December-January followed by storing from January-February. Agricultural calendars go cyclically as described above. However, rural households of the study area have been impacted by weather problems during these seasons, due to the weather variations (untimely rain, heavy rain, floods, shortage of rain, delay for sawing, or other problems). Through weather-related extension services, development agents are responsible

for timely alerting sample households before the loss of any agricultural products. Sample households are asked whether they are accessed to weather problem-related agricultural extension services during the two years preceding this study. Results of Table 10.2, above show that 137(35.40%) sample households report they are accessed of which 83(72.17%) households accessed once per year, 18(15.65%) accessed twice and 14(12.17%) accessed three and above per year. However, the majority of sample households (250/64.60%) responded non-accessed to weather-related agricultural extension services in two years before this study. Such lack of basic weather-related agricultural extension services by the majority of sample households put under question the effectiveness of full packages of extension services that could be used as a reasonable evidence to infer that weather problems have potentially impacted agriculture and livestock productions of majority of sample households.

Milking technique and modern dairy production-related extension services are another potential agricultural extension packages required to be delivered to rural households. Apart from agricultural production, Jimma Geneti woreda is well known for its animal production. For examples, secondary data source revealed that were 126, 194 in 2017 and 132,508 in 2018 cattle population in the woreda (Fig 3). Besides results of Fig 3 cross-reading of primary data presented in Table 10.4 (below) with Table 10.2 (above) results show that majority of sample household (226/58.40%) owned local cow (low and poor quality milk and dairy yield) and only 20(5.17%) sample households owned cross breed cow (high and good quality milk and dairy yield)(Table 4).

Table 4: Summary statistics: Types, Number (TLU), and equivalent value (ETB) livestock holding

Types of livestock	Livestock ownership Observation, N (%)			Number of livestock owned (Mean) in TLU					Mean equivalent value of livestock owned (Mean) in ETB				
	YES	NO	TOTAL	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Local Cow	226(58.40)	161(41.60)	387	387	.584	.494	0	1	253	11,601	6,560	600	32,000
CBW@	20(5.17)	367(94.83)	387	387	.052	.223	0	1	12	16,500	12,755	2,000	50,000

@CBC: Crossbreed cow, Source: Own computation from field survey (2019)

For sample households access to related agricultural extension services on milking techniques and modern dairy production, regardless of the presence of the large livestock population in the study area Table 2 result revealed that majority of sample households (251/64.86%) and 253 (65.37%) are non-accessed to such extension services in the last two years preceding this study, suggesting that more due emphasis is given to weed control related agricultural extension service delivery (only 99/25.58% sample households are non-accessed but most of them (288/74.42%) are accessed). While it is important to give due emphasis to agricultural production (weed control extension service), rural households of the study area access to milking technique and modern dairy production extension services have paramount importance in enhancing their get rid of multidimensional poverty, enhancing their choices of alternative livelihood strategies and, thereby, ensure their sustainable livelihood sources. Otherwise, better households in terms of their multidimensional poverty status and alternative livelihood sources could relapse to MPI severely poor or stray in such dehumanizing phenomenon. That is, the full package of agricultural extension

services is indispensable in the study area. For the detailed lists of what "full agricultural extension service packages" comprises (MoA, 2019:13).

Access to market linkage and farm book extension services

Rural households' linkage to nearby markets has a profound contribution for rural households to get their fruits from such tiresome agricultural activities. Development agents are the frontline agricultural staff responsible for increasing rural households' access to agricultural extension services for both subsistence and commercial productions by rural households. The aim is to increase agricultural production and productivity. In the woreda, most of the rural households' agricultural production is substance-oriented production. Surplus agricultural products are reserved for either the next calendar seed or a small proportion taken to nearby markets in exchange for their children's education, family health, and fertilizer cost. Linking rural households is to market is expected to be one of the components of agricultural extension service delivery in the woreda. According to the primary data collected from 387 samples who participated in this study, only 89(23%) respond they accessed market linkage once per year (59/64.84%), twice per year (19/20.88%), and three and above per year (13/14.29%).

The federal ministry participatory agricultural extension document gave due emphasis to the market-oriented production system (MoA, 2019). However, majority of sample households (298/77%) unacessed to market linkage extension services in the woreda. Consistent finding related to market linkage shows that insufficient understanding of market-oriented production system, limited focus on strategic commodities in the extension services, limited knowledge and skills of extension staff to facilitate value chain development, ineffective linkage among value chain actors, and limited access to market information and collective marketing hampered the effectiveness of market-related agricultural extension services in Ethiopia (MoA & NR, 2017). Access to farm-book-related extension service is among the twenty-four extension packages expected to be delivered to sample households of the study area. Farm-book is a novel information communication tool for the agricultural extension that enables extension agents to assess the productivity and profitability of farming enterprises in a faster and more reliable manner, to increase farmers' incomes and achieve food security (Tana & McNamara, 2016). Sample households are asked to respond to this type of agricultural extension service. An interesting result shows that rural households of the study area accessed farm-book service very insignificantly (only 51(13.18% accessed), where the majority (336/86.82%) unacessed.

Due to the current skill gap of development agents in the woreda, the financial capability of the woreda to avail farm-book to development agents, and above all difficulty of access to the internet in rural Jimma Geneti woreda, the researcher doubt and reserved to accept the response of 51 sample households. Let alone at the woreda level, even at the national and regional level such new ICT not yet institutionalized in the agricultural extension system. This can be evidenced by the document of federal MoA & NR (2017) that states poor utilization of ICT-based extension services is one of the challenges of agricultural extension services. In Sub-Saharan Africa, with all its challenges, South Africa has started the application of farm-book by development agents in the

country (Tana & McNamara, 2016) that Ethiopia should learn from the experiences of South Africa.

Overall, from the above descriptive results and discussions, most sample households in the study area are found non-accessed to multiple crucial agricultural extension services like weather problem (250.64.60%), credit service (248/64.08%), dipping technique (221/57.11%), milking technique (251/64.86%), modern poultry production (194/50.13%), modern beekeeping production (233/60.21%), market linkage (298/77%), modern dairy production (65.37%), animal fattening (231/59.69%), and farm book (336/86.82%). Besides, while the majority of sample households are accessed to some specific extension services, low and inequitable distribution of agricultural extension services among sample households observed.

Challenges of agricultural extension service and support strategies

There are several contributing challenges grouped as agricultural knowledge and information system challenges, institutional challenges and other challenges related to FTCs, gender, market and farmer's orientation challenges presented and discussed next, respectively.

Agricultural knowledge & information systems

Agricultural knowledge & information systems related challenges are among the challenges that hampered the effectiveness of agricultural extension services in Ethiopia in general and current study area in particular. Some of the agricultural knowledge and information challenges include unhealthy perception of farmers towards agricultural extension services, public sector-based extension delivery approach. i.e. lack or the limited number of private sectors, ineffective dissemination of agricultural technologies, weak links between agricultural research and farmers extension problems, inadequate consideration to farmers needs and priorities in research agenda setting and extension package development, delay or untimely provision of extension services, and low education level of farmers (Qamar, 2005; Moris, 1991; Asfaw *et al*., 2012; MAFC, 2007; Abdullah & Samah, 2013; MoA & NR, 2017) (Table 5).

Table 5: Agricultural knowledge & information systems challenges

Agricultural knowledge & information systems challenge to ensure effective agricultural services in Jimma Geneti woreda	Response options (5-Point Likert Scale)										Total
	5.Strongly agree		4.Agree		3.Undecided		2.Disagree		1.Strongly disagree		
	N	%	N	%	N	%	N	%	N	%	
Unhealthy perception of farmers towards agricultural extension services	130	33.77	60	15.58	31	8.05	39	10.13	125	32.47	385
Public sector-based extension delivery approach. i.e. lack or limited number of private sectors	130	34.03	84	21.99	43	11.26	71	18.59	54	14.14	382
Ineffective dissemination of agricultural technologies	164	43.04	81	21.26	24	6.30	34	8.92	78	20.47	381
Weak links between agricultural research and farmers extension problems	175	45.69	70	18.28	28	7.31	48	12.53	62	16.19	383
Inadequate consideration to farmers needs and priorities in research agenda setting and extension package development	150	39.27	63	16.49	22	5.76	69	18.06	78	20.42	382
Delay or untimely provision of extension services	122	31.69	60	15.58	34	8.83	66	17.14	103	26.75	385
Low education level of farmers	124	32.46	83	21.73	38	9.95	44	11.52	93	24.35	382

Source: Computed from own field survey (2019)

Table 5, above revealed that the unhealthy perception of farmers towards agricultural extension services in the study area is strongly agreed by 130(33.77%) sample households. In contrary, 125(32.47%) strongly disagreed that unhealthy perception of farmers towards agricultural extension services in the study area is a challenge to promote effective agricultural extension services. Unhealthy perceptions of farmers towards agricultural extension services is mostly manifested by their non-adopting such services. No matter the extreme the extreme opinions of current respondents, extension literature (Qamar, 2005; Abdullah & Samah, 2013) consistently reported that rural households' weak perception, i.e., due to lack of need-based agricultural extension services (Haynes *et al*., 2010; GFRAS, 2012; Syngenta Foundation of Sustainable Agriculture, 2016) unwillingness to adopt modern agricultural extension services could affect its success in contributing towards household-level food security. During imperial periods (1930-1973) for instance, scholars like Kassa (2003) and Gebremedhin *et al*. (2006) reported that unsustainability of the extension programs and projects (WADU, CADU, and MPP, etc.), agricultural extensions are known as the Comprehensive Package Program (CPP) and the Minimum Package Program (MPP) were mainly donor-driven initiatives targeting wealthy smallholders and those engaged in commercial agriculture, lack of common perceptions between technology generators and extension personnel made ineffective agricultural service delivery in the country. As a way forward, Mvuna (2010) suggests one of the most effective ways to strengthen the extension services could be if, and only if, farmers have a positive perception and appreciate the significance of the extension services in their localities.

Public sector-based extension delivery approach. i.e., lack or the limited number of private sectors is reported by 130 (34.03%) as a challenge to effective agricultural extension services in the study

area. Different scholars found consistent findings that a uni-lateral approach to agricultural extension services to the end-users could affect its effectiveness. For example, inadequate manpower, limited finances, one-way communication, and insufficient or even absence of monitoring and evaluation were a challenge to agricultural extension services in Ethiopia during the Imperial periods (Kassa, 2003; Gebremedhin *et al*., 2006). Besides, public delivery and public finance which essentially comprises the traditional government agricultural extension greatly diminished outreach and constrained by a lack of sufficient funding and lack of need-based approach consequently affect its effectiveness (Anderson and Crowder, 2000). Depending on their own ideological orientation, agricultural extension service delivery in Ethiopia [imperial, "Derge" and FDRE] is highly dominated by public delivery and financing (Kassa, 2003; Gebremedhin *et al*., 2006; Tilahun, 2008; Spielman *et al*., 2010; Davis *et al*., 2010). To ensure food security, a government-dominated agricultural extension service delivery and financing was reported in "ineffective" (Webb *et al.*, 1992 as cited in Abuselam, 2017) and "futile"(Tilahun, 1999) and hence searching for an appropriate blend of public and private sector roles is required to accelerate and implement effective agricultural extension services at the national and Jimma Geneti woreda levels. Besides, one of the most effective ways to strengthen the extension services is to bring about ownership of the extension service by farmers and make extension workers more accountable (Mvuna,2010).

Ineffective dissemination and delay or untimely provision of extension services are also strongly agreed by 164(43.04%) and 122(31.69%) of sample households as a challenge to effective extension service delivery, respectively. Especially, delay in agricultural inputs (fertilizers and high yield variety seeds) supply and broken seeds, Spielman *et al*. (2010) reported consistent finding. Furthermore, weak links between agricultural research and farmers is another challenge that is strongly agreed by 175(45.69%) sample households as a cause of ineffective agricultural extension service delivery. Several consistent findings were reported by Kassa (2003), Gebremedhin *et al*. (2006), MoA & NR (2017), and Fentahun *et al*. (2017). Inadequate consideration of farmers' needs and priorities in research agenda setting and extension package development is another challenge. Previous studies show that inadequate representation and participation of farmers during the imperial period was a challenge to agricultural extension services in Ethiopia (Kassa, 2003; Gebremedhin *et al*., 2006).

Current primary data also revealed that inadequate consideration to farmers' needs and priorities in research agenda setting and extension package development is strongly agreed by 150(39.27%) sample households as a challenge to effective implementation of agricultural extension services in the study area. The low education level of farmers to quickly adopt modern agricultural extension services is also strongly agreed by 124(32.46%) sample households as a challenge to the effectiveness of agricultural extension service delivery. Integrated Functional Adult Literacy (IFAL) could a potential opportunity to improve the literacy level of sample households. This in turn requires a coordination effort between woreda agriculture and natural resource and education offices in the study area.

Institutional challenges

Institutional challenges such as **i**nstitutional arrangements, coordination, and linkages among key agricultural development partners related challenges/problems (include lack of vibrant linkage and poor alignments, lack of coordination and communication between agricultural sectors and HLIs/ATVETs, and weak responsibility and accountability system in linkage platform), human resource development-related challenges/problems (include limited demand-based training at HLIs and ATVET, poor staffing and high staff turnover, and lack of clear chain of command) and monitoring, evaluation &learning related challenges/problems 9include weak monitoring, learning, and evaluation system and weak accountability and responsibility system) are some of the institutional challenges of effective agricultural extension service delivery (Qamar, 2005; Moris, 1991; Asfaw *et al*., 2012; MAFC, 2007; Abdullah & Samah, 2013; MoA & NR, 2017) (Table 6).

Table 6: Institutional challenges

Institutional challenges to ensure effective agricultural services in Jimma Geneti woreda	Response options (5-Point Likert Scale)										Total
	5.Strongly agree		4.Agree		3.Undecided		2.Disagree		1.Strongly disagree		
	N	%	N	%	N	%	N	%	N	%	
Institutional arrangements, coordination, and linkages among key agricultural development partners related challenges/problems											
Lack of vibrant linkage and poor alignments	167	43.60	94	24.54	16	4.18	42	10.97	64	16.71	383
Lack of coordination and communication between agricultural sectors and HLIs/ATVETs	185	48.30	77	20.10	16	4.18	52	13.58	53	13.84	383
Weak responsibility and accountability system in linkage platform.	172	45.62	62	16.45	24	6.37	60	15.92	58	15.38	376
Human resource development-related challenges/problems											
Limited demand based training at HLIs and ATVET,	148	39.15	60	15.87	16	4.23	53	14.02	101	26.72	378
Poor staffing and high staff turnover	147	38.99	59	15.65	27	7.16	68	18.04	76	20.16	377
Lack of clear chain of command.	164	43.62	68	18.09	28	7.45	52	3.83	64	17.02	376
Monitoring, evaluation &learning related challenges/problems											
Weak monitoring, learning and evaluation system	177	46.70	51	13.46	20	5.28	50	13.19	81	21.37	379
Weak accountability and responsibility system are identified as a measure bottle	170	44.74	56	14.74	21	5.53	53	13.95	80	21.05	380

Source: Computed from own field survey (2019)

Institutional arrangements, coordination, and linkages among key agricultural development partners' related challenges/problems include lack of vibrant linkage and poor alignments, lack of coordination and communication between agricultural sectors and HLIs/ATVETs, and weak responsibility and accountability system in linkage platform. Table 10.10, above revealed that lack of vibrant linkage and poor alignments, lack of coordination and communication between agricultural sectors and HLIs/ATVETs, and weak responsibility and accountability system in linkage platform are strongly agreed by 167(43.60%), 185(48.30%) and 172(45.62%) sample households, respectively that these challenges affected the implementations of full packages of agricultural extension services in Jimma Geneti woreda. During the imperial period, because the agricultural extension was donor-driven, Kassa (2003) and Gebremedhin *et al*. (2006) similarly reported that the extension system was one-way communication and insufficient during this period. During "Derge" regime, because agricultural development was primarily anchored in the ideological orientation of the military government (primacy to cooperatives and state farms led), individual peasant producers were largely deprived of access to credit services and improved inputs revealed that expediting agricultural development proved futile during "Derge" regime(Tilahun, 1999). Federal MoA & NR (2017) have reported consistent findings with the current results, i.e., lack of vibrant linkage and poor alignments, lack of coordination and communication between agricultural sectors and HLIs/ATVETs, and weak responsibility and accountability system in linkage platform are some of the major challenges affecting Ethiopia's agricultural extension service delivery. Hence, the discussions imply that to fully implement effective agricultural extension services to rural households and bring about the desired change, it is essential to share roles and responsibilities among implementing partners, individuals, and leadership at all levels. Sharing roles and responsibilities are not an end by itself unless accountability measures are put in place at different levels. To this end, agricultural extension staff, leadership, as well as professionals, should be accountable for the shared tasks and responsibilities.

Human resource development-related challenges/problems include limited demand-based training at higher learning institutions/HLIs and agricultural technical and vocation education and training/ATVET, poor staffing and high staff turnover, and lack of clear chain of command. As shown in Table 10.10, the above problems related to agricultural extension human resource is another challenge. In the current study, results also show that limited demand-based training at higher learning institutions/HLIs and agricultural technical and vocation education and training/ATVET, poor staffing and high staff turnover, and lack of clear chain of command are strongly agreed by 148(39.15%), 147(38.99%), and 164(43.625) respondents, respectively that these factors have been among the challenges of rural households' access to full packages of agricultural extension services in the woreda. In Ethiopia, government-led- Agricultural extension has long-standing history: imperial period extensions (Kassa, 2003; Gebremedhin *et al*., 2006; Ketsela, 2006a; Abate, 2007), "Derge" regime extensions (Davis *et al*., 2010) and extension since1991 (MoA & NR, 2017). The challenges of the agricultural extension are also deep-rooted to these historical periods of the country. For example, inadequate manpower of agricultural extension during the Imperial period was a big challenge (Kassa, 2003; Gebremedhin *et al*., 2006). During the "Derge" regime, Degife & Nega (2000) wrote that the limited number of workers was a critical challenge to agricultural extension. Furthermore, the federal MoA & NR (2017) states

that the lack of an effective human resource development system is found a challenge for the effectiveness of agricultural extension services in the country since 1991. All the above discussions suggest a needing for the development of modernized agriculture and extension system that requires a competent, energetic, and dynamic workforce in the sector both at the national and woreda level.

Monitoring, evaluation & learning-related challenges/problems include weak monitoring, learning, and evaluation system and weak accountability and responsibility system: Table 10.10, above revealed that weak monitoring, learning, and evaluation system and weak accountability and responsibility system are strongly agreed by 177(46.70%) and 170(44.74%) sample households, respectively that they are also a challenge to an effective intervention of rural households' access to full packages of agricultural extension services. Similar studies by Kassa (2003) and Gebremedhin *et al*. (2006) revealed the absence of monitoring and evaluation of agricultural extension services during the imperial periods. That is, agricultural extensions known as the Comprehensive Package Program (CPP) and the Minimum Package Program (MPP) during imperial periods were mainly donor-driven initiatives targeting wealthy smallholders revealing a lack of monitoring and evaluation system (Davis *et al*., 2010; Fentahun *et al*., 2017). Since 1991, Federal MoA & NR (2017) reported consistent findings, too. In fact, at all its intervention levels, rural households' access to full packages of agricultural extension service has its implementation plan. Monitoring, evaluation & learning has to be one of the integral components of the detailed implementation plan of the service. Such monitoring, evaluation & learning plan has several merits. With the monitoring plan, it is possible to assess the success of the service at different levels of the monitoring ladder-like input monitoring, activity monitoring output monitoring, and outcome monitoring. Besides, the achievement of the objective of the services could be assessed using mid-term evaluation, terminal evaluation, and post-evaluation tools. However, the learning gained from the implementation of the rural households' access to full packages of agricultural extension services could be used as a scale-up of the services in the wider context.

The monitoring, evaluation, and learning gained from the implementation of the rural households' access to full packages of agricultural extension services could be ineffective without exercising participatory monitoring, evaluation, and learning activities that involve all the relevant stakeholders in general and the rural households (end-users) in particular. Such a participatory approach to extension service monitoring and evaluation shoulders responsibility and accountability on all stakeholders and enhance its effectiveness. These descriptions suggest the need for participatory monitoring, evaluation, and scale-up of the lessons gained from the services, otherwise open doors to other subsequent challenges that require other support mechanisms and strategies with huge costs.

Other challenges and support mechanisms/strategies

In the preceding sub-section of this chapter, multiple challenges have been hampered the effectiveness of rural households' access to agricultural extension services in the study area. This section also identified other challenges and corresponding support mechanisms for ensuring agricultural extension services. To capture the opinion of sample households about which support mechanisms could enhance the effectiveness of agricultural extension services in the study area,

nine different support mechanisms/strategies such as empowering extension workers, gender equality in extension services, linking extension services to food security dimension, availability of diverse, nutrient-dense and market-oriented foods, diverse diet, stability, utilization of nutrients, WASH services and pluralistic and need-based agricultural extension services were identified from the related literature (Table 7)

Table 7: Other challenges (FTCs, gender, market, and farmers' orientation challenges)

Other challenges and support mechanisms/strategies to ensure effective agricultural services in Jimma Geneti woreda	Response options (5-Point Likert Scale)										Total
	5.Strongly agree		4.Agree		3.Undecided		2.Disagree		1.Strongly disagree		
	N	%	N	%	N	%	N	%	N	%	
FTC related challenges											
Limited involvement of farmers in FTC management	240	62.99	29	7.61	8	2.10	38	9.97	66	17.32	381
Insufficient resources for FTCs	206	54.65	94	24.48	13	3.39	35	9.11	35	9.11	384
Most FTCs have no long-term plans for sustainability	207	54.05	50	13.05	22	5.74	51	13.32	53	13.84	383
Lower salary level and fewer resources for field agricultural extension agents	257	66.75	54	14.03	21	5.45	18	4.68	35	9.09	385
Untrained and unequipped extension agents in the villages	83	21.84	43	11.32	38	10.00	57	15.00	159	41.84	380
Lack or less frequency of extension agents contact with rural households	130	33.85	45	11.72	31	8.07	73	19.1	105	27.34	384
Despite their role to support farmers, most extension agents view their role primary as distributing fertilizer and credit	97	25.39	47	12.30	20	5.24	50	13.09	168	43.98	382
Inadequate incentives to motivate and retain DAs	168	44.44	29	7.67	34	8.99	47	12.43	100	26.46	378
Gender-related challenges											
Poor gender and youth mainstreaming in extension programs planning, implementation and in monitoring, learning and evaluation	186	48.56	95	24.80	32	8.36	29	7.57	41	10.70	383
Shortage of gender disaggregated data,	138	35.94	112	29.17	35	9.11	45	11.72	54	14.06	384
Socio-cultural constraints	149	38.90	90	23.50	41	10.70	67	17.49	36	9.40	383
Inadequate nutrition sensitive extension service,	183	47.78	59	15.40	26	6.79	57	14.88	58	15.14	383
Market-related challenges											
Insufficient understanding of market-oriented production system	223	5.07	60	15.63	26	6.77	31	8.07	44	11.46	384
Limited focus on strategic commodities in the extension services	155	40.58	102	26.70	26	6.81	58	15.18	41	10.73	382
Limited knowledge and skills of extension staff to facilitate value chain development,	134	35.36	49	12.93	27	7.12	64	16.89	105	27.70	370

Other challenges and support mechanisms/strategies to ensure effective agricultural services in Jimma Geneti woreda	Response options (5-Point Likert Scale)										Total
	5.Strongly agree		4.Agree		3.Undecided		2.Disagree		1.Strongly disagree		
	N	%	N	%	N	%	N	%	N	%	
Ineffective linkage among value chain actors	127	33.51	74	19.53	34	8.97	63	16.62	81	21.37	379
Limited access to market information and collective marketing,	190	49.74	96	25.12	24	6.28	24	6.28	48	12.57	382
Farmer's oriented challenges											
Limited involvement of different stakeholders in the provision of extension services	214	55.73	56	14.58	15	3.91	51	13.28	48	12.50	384
Low cooperation and collaboration between public and NGOs in extension services provisions	192	50.26	75	19.63	32	8.38	30	7.85	53	13.87	382
Poor involvement of cooperatives in extension service delivery	197	51.30	94	24.48	10	2.60	35	9.11	48	12.50	384
Support mechanisms/strategies											
Empower extension workers	299	78.48	32	8.4	17	4.46	11	2.89	22	5.77	381
Working towards gender equality /gender transformative approach in agricultural extension services	271	70.94	52	13.61	19	4.97	15	3.93	25	6.54	382
Building agricultural extension services on food security dimensions	290	76.52	55	14.51	11	2.9	10	2.64	13	3.43	370
Improving the availability of diverse, nutrient-dense and market – oriented foods	284	74.54	58	15.22	18	4.72	15	3.94	6	1.57	381
Improving access to diverse diet	268	70.53	80	21.05	14	3.68	8	2.11	10	2.63	380
Safeguarding stability	289	75.85	52	13.65	21	5.51	7	1.84	12	3.15	381
Optimal utilization of nutrients	293	76.70	51	13.35	15	3.93	10	2.62	13	3.40	382
WASH services	275	72.18	68	17.85	14	3.67	11	2.89	13	3.41	381
Pluralistic and need-based agricultural extension services	291	76.58	49	12.89	21	5.53	8	2.11	11	2.89	380

Source: Computed from own field survey (2019)

FTC-related challenges and support mechanism/strategy: Sample households' of the study are requested to respond to the availability of FTC training in or around their kebele. Out of the total 370 sample households, 287(77.57%) responded "Yes" and 83(22.43%) responded "No". Another related question on the status of coordination of FTC training was raised. Out of 383 respondents, while 260(67.89%) of them strongly disagreed, 123(32.11%) disagree with the statement that says strong coordination of FTC training that show us the presence of several challenges within the FTCs that contributed to the ineffectiveness of agricultural extension services in the woreda.

Federal MoA & NR (2017) national agricultural extension strategy document identified several challenges of agricultural extension services in the country, for example, limited involvement of farmers in farmers' training center/FTC management, insufficient resources for FTCs, and most

FTCs have no long-term plans for sustainability. In 2019, through questionnaire primary data was collected from sample households from twelve *kebeles* to see whether these challenges are also the cases of Jimma Geneti woreda or not. Results of Table 10.7, above show that 240 (62.99%), 206 (54.65%), and 207(54.05%) of the respondents are strongly agreed there exist limited involvement of farmers in farmers' training center/FTC management, insufficient resources for FTCs, and most FTCs have no long-term plans for sustainability in the woreda, respectively. In fact, in the agricultural extension system, the major objective of the FTCs are to be hubs of knowledge and information sharing [specifically promote improved technologies, good practices, and self-managed FTCs] between farmers, extension agents, and agricultural research institutions. They serve as an entry point for rural farmers' behavioral changes, thereby, paves the way towards modern and commercial agriculture. Nevertheless, in a situation where there exists limited involvement of farmers in farmers' training center/FTC management, insufficient resources for FTCs, and no long-term plans for sustainability by FTCs, no doubt that the effectiveness of agricultural extension services at the household level is futile and ineffective. Ineffectiveness of agricultural extension services in the woreda could result in food insecurity at the household level.

Effectiveness of FTCs in general and agricultural extension services, in particular, could be meaningless unless otherwise, supported by well-paid, skilled, trained, and experienced agricultural extension workers if not, could aggravate the challenges of the present status of FTCs in the woreda described in the above paragraph. As agricultural development workers are in the womb of the local community, sample households strongly agreed that lower salary level and fewer resources for field agricultural extension agents (257(66.75%), untrained and unequipped extension agents in the villages (83/21.84%), lack or less frequency of extension agents contact with rural households (130/33.85%), most extension agents view their role primarily as distributing fertilizer and credit (97/25.39%), and inadequate incentives to motivate and retain extension workers (168/44.44%) affected the effectiveness of the agricultural extension services in the woreda. Similar studies on challenges of the effectiveness of extension services were also reported by Benor *et al*.(1984), Moris (1991), Qamar (2005), Asfaw *et al*. (2012), Wambura *et al*. (2012), and MoA & NR (2017). For example, Moris (1991) pointed out that a lower salary level and fewer resources for field extension agents as compared to those at the "headquarters" represent the major factors that lower the effectiveness and efficiency of extension systems in most developing countries.

Concerning the support mechanism/strategy related to extension workers out of the total 381 responses, 299(78.48%) of them strongly agreed that well empowerment of agricultural extension workers could ensure the effectiveness of agricultural extension services in the woreda. Indeed, agricultural extension agents are the frontline staff of agricultural development intervention programs. They are responsible to build the capacity of rural farmers, through training, demonstrations, and extension services. They are also a response to bridge the information flow between agriculture office/ research institutions and the end-users of agricultural extension. Despite these facts, agricultural extension workers are unskilled and lack the practical experience to effectively implement the agricultural extension packages. As a result, agricultural extension services are ineffective in ensuring food security at national and households' levels in Ethiopia (Abuselam, 2017). Hence, empowerment of agricultural extension workers' through their access to capacity and technical building training, incentives, better salary, transport facilities, housing, and others could be among the measures that could curb the current low status of agricultural extension services in the woreda. Mwangi (1998) and Rivera *et al*. (2001) reported similar findings that empowerment of extension workers contributed to the extension services. Nevertheless, on

the other end of the Likert Scale only 22(5.77%) sample households strongly disagreed that it couldn't.

Gender, youth, and nutrition mainstreaming related challenges/problems and support mechanisms/strategies: Equality between men and women facilitate the effectiveness of extension services. However, gender blind delivery of agricultural extension could hamper its effectiveness (Gurmessa *et al*., 2011; Cathetine *et al*., 2012). Similarly, in the study area Table 10.7, above show that poor gender and youth mainstreaming in extension programs planning, implementation, and monitoring, learning and evaluation (186/48.56%), shortage of gender-disaggregated data (138.35.94%), socio-cultural constraints (149/38.9-), and inadequate nutrition-sensitive extension service (183/47.78%) strongly agreed that among other challenges affecting the effectiveness of extension delivery in the woreda. Similarly, it was reported that because of the inability of women to access the necessary agricultural inputs and services, female farmers produce 23% less per hectare than their male counterparts in Ethiopia (MoA & NR, 2017).

Working towards gender equality /gender transformative approach in agricultural extension services is found as another support mechanism/strategy used to increase the effectiveness of agricultural extension services. The approach provides opportunities to women with non-food supports such as tools, technology, and training expected to reduce workloads of women, so that, able to effectively accessed to access agricultural extension services like their male counterparts. Despite 13(3.43%) strongly disagreed, results of the current study also revealed that 271(70.94%) sample households strongly agreed to the statement working towards gender equality /gender transformative approach in agricultural extension services could support the effectiveness of agricultural extension services in the woreda. Besides, such support has multiple impacts in the form of significant availability of food security, nutritional security, and livelihood security (GFRAS, 2015; 2016).

Market linkage and value chain development-related challenges/problems and support mechanisms/strategies: The success of promoting improved technologies, good agricultural production, and productivity, and leading to poverty reduction, livelihood diversification, and livelihood security is difficult without due consideration of value addition and marketing to agricultural products. Agricultural extension researchers and organizations (Mattee, 1994; Mvuna, 2010; Churi *et al*., 2012; Wambura *et al*., 2012; MoA & NR, 2017) identified several indicators of rural households' market linkage and value chain development-related challenges that have been contributing to the ineffectiveness of agricultural extension services delivery that aimed to improve the well-being of rural households such as insufficient understanding of market-oriented production system, limited focus on strategic commodities in the extension services, limited knowledge and skills of extension staff to facilitate value chain development, ineffective linkage among value chain actors, and limited access to market information and collective marketing.

Similarly, the Ministry of Agriculture Food Security and Cooperatives/MAFC of Tanzania (2007) reported that Tanzania suffers from low agricultural productivity due to many factors including an inadequate extension system leading to ineffective dissemination of technologies, poor market linkages, weak links between research and extension, and inadequate government support. In Ethiopia, weak market linkage and value chain development affected the effectiveness of agricultural extension services in the country (MoA & NR, 2017). Cognizant to the previous studies, sample households of the study area strongly agreed that insufficient understanding of market-oriented production system, limited focus on strategic commodities in the extension

services, limited knowledge and skills of extension staff to facilitate value chain development, ineffective linkage among value chain actors, and limited access to market information and collective marketing have been among the other factors that contributed to the ineffectiveness of agricultural extension service delivery system in Jimma Geneti woreda.

As a response strategy, *building agricultural extension services on food security dimensions* was one of the support mechanisms to ensure the effectiveness of agricultural extension service in the woreda. Within the context of the four pillars of food security (availability dimension, access dimension, utilization dimension, and stability dimension) FAO (2006) strongly underscored the integration of agricultural extension services within these food security dimensions could enhance its effectiveness. Sample households' opinion scale also revealed the same. For example, out of the total 379 respondents of this specific item 290(76.52%) strongly agreed to FAO (2006) that encompassing agricultural extension service to food security dimension support its effectiveness. Even though it is not automatic, the integration of agricultural extension services to food security dimensions can be done on different platforms. For example, *improving the availability of diverse, nutrient-dense, and market-oriented foods* [availability dimension and utilization dimension] are among the others. Such support strategy is strongly agreed by 284(74.54%) respondents of the study area that it contributes to the effectiveness of agricultural extension services. Indeed, according to FAO, IFAD, & WFP (2013), rural people in low-income countries are more likely to consume monotonous diets with inadequate diversity. This is not exceptional in the study area that sample households consume monotonous diets (Teff in common) with limited nutritional values. Besides, sample households of the study area produce crops and rear animals some even with no market demand. These factors could discourage rural households in general and affect the effectiveness of extension services, suggesting the need for integrating the availability of diverse, nutrient-dense, and market-oriented foods within the rural agricultural extension services in the study area. Bushamuka *et al*. (2005) and MoA & NR (2017) found consistent findings.

Integration of agricultural extension services to access dimension of food security (*improving access to diverse diet*) is another platform to ensure its effectiveness. Most sample households of the study area (268/70.53%) strongly agreed with this statement. Access to a diverse diet as a mechanism of ensuring the effectiveness of agricultural extension services is about rural households' ability to secure foods required to meet their dietary needs or nutritional security needs. This suggests us that if due emphasis to the production of diverse diet by rural households is given the demand for such products could also increase. In turn, demand for related agricultural extension services increased, too. By implication having integrated production and access to a diverse diet, the effectiveness of rural agricultural extension services in the woreda could be enhanced. In other words, if extension development agents increase awareness of rural households to produce diverse diets or nutrient-dense foods and create market linkages for these products, the success of agricultural extension services could be also increased. Only 10(2.63%) responded strongly disagreed with this mechanism.

As an alternative support mechanism, *safeguarding stability* (stability dimension of food security) is also strongly agreed by (289/75.85%) sample households. It is about the ability of a rural household to access diverse foods required for the healthy and active living of all members throughout the year. Beyond its merit [safeguarding stability dimension of food security] to facilitate the effectiveness of agricultural extension service, this support mechanism strongly agreed by the majority of the sample households of the study area helps to enhance food insecurity of rural households during lean periods (June, July, and August) by encouraging them to produce

diverse foods through rainwater harvesting, drip irrigation, water management practices and varietal selection throughout the year. A similar support mechanism was suggested by other studies (Bardhan, 1980; SPRING, 2016, MoA & NR, 2017).

FAO (2006) suggests *optimal utilization of nutrients* as a support mechanism to facilitate the effectiveness of agricultural extension services. This suggestion is found strongly agreed by (293/76.70%) of sample households of the study area, implying that through awareness creation to rural households about their unique nutritional needs, by integrating the idea of optimal utilization of nutrients rich food to agricultural extension packages, it could motivate them to adopt extension packages. *Water, Sanitation, and Hygiene (WASH) services* as a support mechanism were suggested by WHO (2015) and SPRING (2016) as an alternative mechanism of ensuring agricultural extension service delivery. Similarly, 291(76.58%) sample households strongly agreed to the suggestion of WHO (2015) and SPRING (2016) that it could help in promoting the effectiveness of the extension services. The logic behind this support mechanism is that insufficient access to clean water, inadequate sanitation, and lack of appropriate hygiene practices in rural areas could result in infectious diseases, thereby; hamper the food utilization dimension of agricultural extension service delivery. That is water, sanitation, and hygiene services should be an integral component of agricultural extension services in the woreda. By implication, integration of WASH services to agricultural extension services for rural households could curb the problem that potentially enhances the success of agricultural extension services.

Farmers oriented and stakeholder extension services related challenges/problems

Agricultural extension service in Ethiopia has a long-standing history. That is, commenced in the 1950s, "government-led- Agricultural extension programs in Ethiopia was started during the imperial period" (Kassa, 2003; Gebremedhin *et al*., 2006; Abate, 2007). Since then, it has been challenged by several bottleneck problems. Limited involvement of different stakeholders in the provision of extension services, low cooperation, and collaboration between public and NGOs in extension services provisions, and poor involvement of cooperatives in extension service delivery (MoA & NR, 2017) are among the others that have been contributing to the ineffectiveness of agricultural extension service delivery in the country, evidenced by the increased number of food-insecure households in the country reported by (Abduselam,2017) who assessed the food security situation in Ethiopia. In Jimma Geneti woreda, farmers oriented and multi-stakeholder extension services related challenges/problems such as limited involvement of different stakeholders in the provision of extension services, low cooperation, and collaboration between public and NGOs in extension services provisions and poor involvement of cooperatives in extension service delivery are also among the challenges that constrained the effectiveness of agricultural extension services, strongly agreed by 214(55.73%), 192(50.26%) and 197(51.30%), respectively. The result is consistent with the Federal MoA & NR (2017) agricultural extension strategy that suggested: "effective agricultural extension system needs to use a broad range of actors to provide inclusive extension services to improve the livelihoods of smallholders"(p.v). This support mechanism is broadly known as *pluralistic and need-based agricultural extension service* delivery. A total of 291(76.58%) sample households of the study area strongly agreed that pluralistic and need-based agricultural extension service delivery support mechanism could facilitate the effectiveness of agricultural extension services in the study area.

In light of the above discussion, Haynes *et al*.(2010) underscored that agricultural extension should not be the unilateral channel for dissemination of information from research to the farmer but should take the role of capacity building through education and developing knowledge in

partnership with farmers. Similarly, agricultural extension services should be the function of providing need- and demand-based knowledge in agronomic techniques and skills (Syngenta Foundation of Sustainable Agriculture, 2016), in such a way effective agricultural extension service improve rural households' livelihoods and well-being(GFRAS, 2012:2), thereby, eliminating extreme rural multidimensional poverty and illuminating their lives sustainably. Furthermore, John (2014) underpin that the extension service has been required for the transformation of subsistence farming to modern and commercial agriculture, thereby, it is critically important in promoting household food security, wealth and employment creation, and poverty reduction. Nevertheless, besides several challenges and problems that hampered the effectiveness of agricultural extension delivery in the study area, multiple determinants factors are also identified, analyzed, results and discussions made as follows.

Determinants of rural households' access to agricultural extension services

Diagnosis tests of Multinomial Logit Model assumptions

Test for Consistence of Independence of Irrelevant Alternatives (IIA) assumption is tested and found that chi-square (28) value/ (b-B)'[(V_b-V_B)^(-1)](b-B) -12.42 indicate choices are independent in the sense that inclusion or exclusion of categories doesn't affect the relative risk of associated with repressors in the remaining categories. Besides, the pairwise correlation matrix of discrete variables and VIF of continuous variables revealed no multicollinearity problem) and the model can be used. Furthermore, the study is devoted to checking whether the model is reliable or not. Using equation (1). That is, how well the model fitted that data, Table 10 below presented a two-by-two classification table of the logit model. Its objective is to assess how good the fitted model is for prediction purposes.

Table 8: A two-by-two classification table of data for Logistic model for rural households' access to agricultural extension services

Logistic model for access to agricultural extension services

Classified	True		Total
	Observed positive (D)	Observed negative (-D)	
Predicted positive (above cutoff)	A=266	B=38	304
Predicted negative (below cutoff)	C=14	D=69	83
	280	107	387

Classified + if predicted Pr(D) >= .5
Total D defined as access to agricultural extension services !=0

Sensitivity = **(A/A+C)*100%** = (266/266+14))*100%= Pr(+1 D) = 95.00%
Specificity=**(D/D+B)*100%** =(69/69+38)*100%= Pr(-1 ~D) = 64.49%
Positive predictive value Pr(DI +) =87.50%
Negative predictive value Pr(~DI -) =83.13%

False + rate for value D Pr(+1 ~D) = 35.51%
False – rate for value D Pr(-1 D) = 5.00%
False + for classified + Pr(~DI +) =12.50%
False - for classified - Pr(DI -) =16.87%

Correctly classified **86.56%**

Note: **+**(predicted positive above cutoff), **-**(predicted negative below cutoff), **D**(observed positive) and-**D**(observed negative)
Source: Computed from own field survey (2019)

The goodness of fit" of a linear regression model attempts to get how well a model fits a given set of data, or how well it will predict a future set of observations for continuous variables. R and adjusted R2 are used but inapplicable in the logistic regression model because we don't have an equal variance assumption. Logistic regression analysis studies the association between a categorical dependent variable where the candidate predictor variables do not have to be normally distributed, linearly related, and have equal variances but can be dichotomous. Our dependent variable is access to agricultural extension services which is a dummy variable. To test how good the model is, we set the cutoff value as the probability of obtaining a 1 (e.g.: access to agricultural extension services). The cutoff value directly impacts the results generated for the classification tables. The default is set at .50, implying that an acceptable model would have an overall percentage correct greater than the cutoff value (*see*, Hosmer, Lemeshow, and Sturdivant, 2013). Note that while specificity is the percentage of $y_j = 0$ observations that are correctly classified, sensitivity is the fraction of $y_j = 1$ observations that are correctly classified (Hosmer *et al*., 2013). As expected, classification is sensitive to the relative sizes of each component group, and always favors classification into the larger group. In other words, higher sensitivity and specificity are a better fit for the model. Accordingly, Table 10, above revealed that 387 samples included in the analysis, 86.56 percent of them are correctly classified based on their household characteristics. Thus, the overall rate of correct classification is estimated to be 86.56, with 95% (266/280=95%) of the participants correctly classified (specificity) and only 64.48% (69/107= 69.48%) of the non-participants correctly classified (sensitivity).

Determinants and marginal effects of households' choices of livelihood strategies

Based on the results of Table 11 further assessment of the model is made to check the null hypothesis that state as:

> * *Null hypothesis (H0): always for all model slope coefficients are equal to zero or independent variables jointly measure nothing, i.e H0=0*
> * *Alternative hypothesis (H1): not equal to zero*

We used equation 1 to compute the unknown restricted livelihood ratio. That is, ln L0 = n[P1 ln P1 + (1 − P1) ln(1 − P1)] where ln L0 is the unknown restricted livelihood ratio of the model, n is the sample size (equals to 387), p1 is dependent variable equal to 0.7235 and 1-p1 is dependent variable equals to 0.2765 and 1-p1ln1-p1 is equal to -35545=-0.58962 and hence the value for ln L0 equals to -228.182, lnLR equals to -141.38254 and LR equals to 173.60. We rejected H0 because the computed model value (173.60) at 12 degrees of freedom is greater than the critical value (26.217 at 99% confidence interval level) from the chi-square distribution table, implying that the alternative hypothesis is true. That means the coefficients of the model are statistically different from zero revealing that the model is accepted.

Table 9: Determinants of rural households' access to agricultural extension services

Log-likelihood = -141.38254 (Unrestricted likelihood ratio)				Number of obs = 387 is the sample size (n) LR chi2(12) = 173.59 is Likelihood ratio (LR) or computed model value Prob > chi2 = 0.0000 Pseudo R2 = 0.38.4			
Independent variables (Xs) (A)	**Coefficients (B)**			**Odds ratios (C)**		**Marginal effects(D)**	
	βs	Std. Err.	p>/z/	or	p>/z/	dy/dx	p>/z/
Age of HH heads	.0127726	.0160038	0.425	1.012854	0.425	.0020102	0.423
Capability to work	1.425914	.9107956	0.117	4.161659	0.117	.2244121	0.118
Kebele/"ganda" of the HH head	-1.815848	.7395186	0.014**	.1626999	0.014	-.3890995	0.031
Religion/"amanta" of HH head	-.1237071	.3223473	0.701	.8836386	0.701	-.0194983	0.701
Literacy level of the HH head	.2399538	.3750056	0.522	1.27119	0.522	.0392587	0.538
Access to agricultural training	1.681034	.3545659	0.000***	5.371104	0.000	.3147721	0.000
Credit service	.9718305	.381744	0.011**	2.642778	0.011	.1410055	0.005
Irrigation use	1.358492	.3602289	0.000***	3.890324	0.000	.2248749	0.000
Distance to input supply	.012245	.3308045	0.970	1.01232	0.970	.0019261	0.970
Access to telephone	1.058168	.3427553	0.002***	2.881089	0.002	.1672882	0.002
Livestock holding (TLU)	-.0141782	.0359645	0.693	.9859218	0.693	-.0022314	0.694
Poverty	.12225	.2174835	0.574	1.130037	0.574	.0192399	0.574
Constant	-3.434707	1.364806	0.012	.0322349	0.012		

Note: ***, **, * significant at 1% (for significant p-value<0.01), 5% (for significant 0.01<p-value<0.05), and 10% (for significant p-value>0.05), respectively
Source: Computed from own field survey (2019)

Kebele/"ganda" of the HH head has negative (β=-1.815848) and significant (p-value=0.014<0.05 at 5% significant level) that has influenced rural household heads access to agricultural extension services, implying that the log of odds of being unaccessed increases by 16.3%, other factors constant. The marginal effect -.3890995 indicates that as the households' kebele increases by one more unit, the probability of being unaccessed to agricultural extension services decreases by 38.9%. On the contrary, Arias et al. (2016) who states as households' location/kebele was assumed to be positively and significantly influence their access to agricultural extension services, other factors remain constant found that location (kebele/village) is an important determinant of the likelihood of receiving agricultural extension services by rural households in Haiti. Furthermore, it was expected that rural households' access to agricultural extension training has a positive and significant association with rural households' access to agricultural extension services. As expected results revealed that access to agricultural training has positive (β=1.681034) and significant (p-value=0.000<0.05 at 1% significant level) that has influenced rural household heads access to agricultural extension services, implying that the log of odds of being unaccessed increases by 537%, other factors constant. The marginal effect .3147721 indicates that as the households' access to agricultural extension training increases by one more unit, the probability of being unaccessed to agricultural extension services also increases decreases by 31.5%. Morris (1991), Belay & Abebaw (2004), Abdallah & Abdul-Rahaman (2016), and Arias *et al*. (2016) revealed similar results.

Rural households' access to credit services was expected to have a positive and significant association with their access to agricultural extension services. As expected results revealed that rural households' access to credit service has positive (β=.9718305) and significant (p-value=0.011<0.05 at 1% significant level) that has influenced rural household heads access to agricultural extension services, implying that the log of odds of being unaccessed increases by 264%, other factors constant. The marginal effect .1410055 indicates that as the households'

access to agricultural extension training increases by one more unit, the probability of being unaccessed to agricultural extension services also increases by 14%. Irrigation use by rural households' was expected to have a positive and significant association with rural households' access to agricultural extension services. As expected results revealed that rural households' access to irrigation has positive (β=1.358492) and significant (p-value=0.000<0.05 at 1% significant level) that has influenced rural household heads access to agricultural extension services, implying that the log of odds of being unaccessed increases by 389%, other factors constant. The marginal effect .2248749 indicates that as the households' access to agricultural extension training increases by one more unit, the probability of being unaccessed to agricultural extension services also increases by 22.5%. Finally, it was hypothesized that rural households' having telephone has a positive and significant association with their access to agricultural extension services. As expected results revealed that rural households' access to telephone has positive (β=1.058168) and significant (p-value=0.002<0.05 at 5% significant level) that has influenced rural household heads access to agricultural extension services, implying that the log of odds of being unaccessed increases by 288%, other factors constant. The marginal effect.1672882 indicates that as the households' access to telephone increases by one more unit, the probability of being unaccessed to agricultural extension services also increases by 16.7%. Similar findings were reported by FAO (2009), Munyua, Adera, & Jensen (2009), and World Bank (2011).

CONCLUSION & POLICY IMPLICATIONS

The study is conducted in Jimma Geneti woreda (Ethiopia). Results revealed that out of the total 373 sample households who self-reported, 107(28.69%) found unaccessed to agricultural extension services. Besides other factors, weak links between agricultural research and farmers extension problems (45.69%), lack of coordination and communication between agricultural sectors and higher learning institutions/HLIs/ATVETs (48.30%), and lower salary level and fewer resources for field agricultural extension agents (66.75%) are found the major potential reasons/challenges that make sample households' unaccessed. Furthermore, Kebele/"ganda" of the HH head, access to agricultural extension training, access to credit service, Irrigation use, and rural households' having a telephone is the major determinant factors. Thus, based on the above results it is possible to conclude that rural households' access to agricultural extension services is not as it ought to be. Above it is found that the extension delivery is mostly non-participatory. Therefore, policy majors that could avert the above challenges and determinants are recommended Like for example, empowering extension workers and delivering pluralistic and need-based agricultural extension services.

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Authors Contributions: Conceptualization and design of the work, T.K.A; Data curation, T.K.A.; Formal analysis, T.K.A.; Methodology, A.S.T., and A.G.H.; pilot-testing, T.K.A.; writing-original draft preparation, T.K.A.; Writing-review & editing, A.S.T., and A.G.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was not funded by any funding organization. Rather, as self-sponsored P.H.D. candidate, T.K.A. covered all the non-refundable research costs.

Acknowledgments: Many people (Mr. Garomsa Dereje, head of woreda agriculture and the 36 development agents from the twelve kebeles) and organizations (woreda finance and economic development office, woreda health office, woreda water office, woreda education office, and World vision- Ethiopia Hareto branch office) has significant contributions in this study. We appreciate all of them. The 387 sample households that participated in this study also deserve our special thanks.

Conflict of Interest: The authors declare no potential conflict of interest.