Effect of availability, access and utilization of agricultural extension technologies on the food security situation of smallholder farmers in Uasin Gishu County, Kenya

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Abstract- Despite the importance of the agriculture sector to the economy, limited access to agricultural extension information has resulted in poor decisions on agricultural production and related activities thus, affecting achievement of food security. This study through a survey of 397 households sought to examine how availability, access and utilization of agricultural extension services affect smallholder farming household's food security in Uasin Gishu County, Kenya. Data was collected using questionnaires and interview schedules and analysed using descriptive and inferential statistics. Pearson Correlation was used to measure the strength of association while Ordinal regression was used to predict the behaviour of variables and the parameters of the regression model. The results revealed a significant positive relationship between the availability and access to extension services and food security (rho=0.200, 0.108 and 0.623 respectively, p-value>0.05. The ordinal analysis reveals an insignificant (0.812 and 0.369, p-values>0.05) and positive relationships between respondent households' access and utilization of agricultural extension services and food insecurity respectively. The study recommends more outreach to small-holder farmers by extension services through creation of community-based extension services. For greater buy-in of the extension packages, smallholder farmers should be involved in the identification and delivery of the extension packages.

Index Terms- Household, food security, agricultural extension technologies, agriculture

I. Introduction

At the centre of global debates, agriculture is recognized as a fundamental driver of economic growth and poverty reduction for many developing countries and a priority area for investment and countries food security. Global food security is largely dependent on productivity of 570 million farms that vary widely by size, production system, product, resource base, level of technology, productivity among other factors (FAO, 2018). Ninety percent (90%) of these are family enterprises. In low- and middle-income countries, 95 percent of farms are less than five hectares, though larger farms occupy most of the land area (FAO, 2014). In Sub Saharan Africa and Asia alone, more than 500 million smallholder farmers are responsible for more than 80% of food supply and quite often are left behind in structural and rural transformation (Guneralp et al. 2017). These have implications on smallholder farmers who need to adapt to become more productive and diversified in the presence of climate change and other nature-based changes.

Farmers have continuously adapted and innovated over time in response to changing conditions, opportunities, and global demand for food and other agricultural products. Continued farm-level innovation will be essential to meet an expected 59-98% increase in global demand for food between 2005 and 2050 (FAO,2018).

Worldwide, agricultural extension has been recognized as a formal institution with legal structural arrangements with various approaches relying on government extension, private services and other stakeholders on pluralistic systems (Etwire et al., 2013). In many countries across the world, agricultural extension was institutionalized and organized in the 1960s and 1970s (Swanson, 2008). However, in most cases, farmers differ in their access to and utilization of agricultural information from extension service providers and other agricultural sources. Such diversity among farmers could be related to various personal, social, economic, or institutional factors. Understanding reasons behind such diversity and farmers current level of access and utilization of agricultural information is of paramount importance. Smallholder farmers and rural producers are among the populations most vulnerable to climatic shocks and weather- related disasters, and their vulnerability is compounded by market fluctuations, poor governance, conflict, and disease (Christoplos, 2010). Agricultural transformation that meets global food needs will require integrated agricultural extension systems, generally based on access and utilization of information (Mellor, 2017).

A characteristic of the revitalization of the agriculture sector has been the recognition that past efforts have failed in part because of the weak extension and advisory services. A fundamental aspect of this process is recognizing that agriculture, and specifically the processes of providing effective extension and advisory services (EAS), involve much more than technical solutions.

Agricultural extension brings about positive behavioural changes amongst smallholder farmers. It provides information on

crucial issues such as food storage, processing, farm management, and marketing (Rivera et al. 2001). According to Zwane (2012), agricultural extension must be seen in terms of agricultural performance through improving production and profitability amongst farmers; rural community development and comprehensive non-formal community education for smallholder farmers.

Extension and advisory services may provide an opportunity for strengthening the resilience of rural and farming households by increasing their access to tangible and intangible resources, such as inputs and knowledge, hence food security (Spielman, Ekboir, Davis & Ochieng. 2008). Agricultural extension involves farmer education and training, imparting new knowledge on agricultural practices and application of scientific research.

According to Ijatuyi, Omatayo & Mabel (2017), agricultural extension is the function of providing need and demand-based knowledge in agronomic techniques and skills to improve production, income and quality of life. The method of delivery is systematic and participatory. By providing access to information and technologies for innovation and skills development, agricultural extension contributes to addressing rural development challenges. It also facilitates linkages between farmer-based organizations and other relevant actors to ensure smallholder farmers are adequately given relevant information and skills (Davis & Heemskerk, 2012).

The Kenyan government has placed food security a key sector and driver towards achieving vision 2030. It is one of the big four agenda of the present government administration. Based on the role that smallholder farmer, who produce food on an average of 0.3-1 ha of land, plays in securing the country's food security, it is critical that they have access to agricultural extension services. The agricultural extension services are expected to equip farmers with skills and knowledge of existing and modern farming technologies to enhance their agricultural productivity.

Agriculture being the economic mainstay of Uasin Gishu County, contributes greatly to food security and household income. Even though the County has good soils and favourable climatic conditions, her agricultural productivity is yet to realize its full potential. In the recent past, the sector has been experiencing production, economic and social challenges. The challenges range from prolonged droughts or rains, new pests and diseases and soil acidity to an aging farmer population. These challenges have led to huge on-farm and post-harvest losses (WFP, 2016), continued low adoption of modern farming practices leading to low farm productivity increasing susceptibility to food insecurity. This trend is likely to repeat itself in the coming years despite many initiatives and actions by various stakeholders. These actors aim at disseminating innovations and knowledge through the agricultural extension services.

The 2014 Kenya Demographic and Health Survey reported that thirty two percent of households in Uasin Gishu County experienced food shortages, mainly common in the months May to August (KDHS, 2014). While prevalence of stunting was 31.2% with 11.5% of children under-five being underweight. This is largely attributable to less diet diversification with overdependence on Maize. Likewise, smallholder farmers are experiencing agricultural production decline as arable land sizes are decreasing, rising cost of agricultural inputs, declining soil fertility (Chukwu, 2014). The gradual decline in Agricultural production by smallholders' farmers has necessitated a call for reform in agricultural extension which will allow for a greater role by other players.

The above scenario is expected to increase, given the changing climate. The County has been experiencing rainfall variability compromising productivity and food security in the County with climate projections indicating even greater challenges in the coming years if not addressed through more support to farmers to strengthen their coping mechanisms.

II. METHODOLOGY

Study area

The study was conducted in Uasin Gishu County as it is one of the high agricultural potential County in Kenya. The County lies between longitudes 34° 50' East and 35° 37' West and latitudes 0° 03' South and 0° 55' North. It borders Trans Nzoia County to the North, Elgeyo Marakwet County to the East, Baringo County to the South East, Kericho County to the South, Nandi County to the South West and Kakamega County to the North West. The County covers an area of 3,345.2 Sq. Km within the Lake Victoria catchment zone and all its rivers (Sosiani, Kipkaren, Kerita, Nderugut, Daragwa, and Sambu) drain into Lake Victoria. The County's climate is conducive for agriculture, has a few tourist attractions and home to a large and growing consumer market. Eldoret, rated as the second fastest growing town in Kenya is the administrative and commercial centre of the County. The County is made up of six sub-County and six constituencies: Turbo, Soy, Ainabkoi, Moiben, Kessess and Kapseret. The sub-County are further subdivided into fifty-one locations and ninety-seven sub-locations. There are 30 electoral Wards. Soy Constituency has the highest number of Wards with seven wards, Turbo has six, Moiben and Kapseret have five each, Kesses has four and Ainabkoi has the least with three Wards.

Study design

This was a descriptive research design. This research design was chosen because it involves many people and describes population characteristics by selecting unbiased sample (Banerjee & Chaudhury, 2010). This design was also useful in enabling the researcher to collect quantitative data among large population of smallholder farmers in the selected Sub Counties of Uasin Gishu for the purpose of generalization. The design involved a survey of key variables guided by the study objectives. The qualitative data was used to triangulate the quantitative information and give a clear picture of the phenomenon on the ground.

Target population

The target population refers to the specific group relevant to the study. In this study, the target population were small holder farming households, a list of which was provided by the County Government of Uasin Gishu Department of Agriculture, a population of 101,409. Due to research limitations, two Sub Counties were selected purposively, these are Soy and Turbo. The two Sub Counties have 30,018 number of small holder farming households.

Sample Size and Sampling Technique

The study used multistage purposive and simple random sampling. In the first stage, Uasin Gishu County was selected purposively based on it being an agricultural County with presence of small holder farmer commonly referred to Kenya grain basket. The second stage involved purposive selection of Turbo and Soy Sub-County; these sub-Counties have a relatively high concentration of small holder farmers. The third stage involved purposive selection of wards, namely: Sugoi, Kaptebee and Ngenyilel in Turbo Sub County and Soy, Kipsomba and Barsombe in Soy Sub County. The wards have a cumulative smallholder household population of 30,018, as reported in the County Development Plan of 2018.

A random sample of 397 households were selected and interviewed, 201 from Turbo and 196 from Soy sub-County. This sample was determined using the formula specified by Cochran's. Cochran's formula is considered appropriate in situations with large population. The formula is as shown below

$$n_0 = \frac{Z^2pq}{e^2}$$

Where:

- e is the desired level of precision (i.e. the margin of error- 5%)
- p is the (estimated) proportion of the population which has the attribute in question (50%)
- q is 1 – p.

Using the confidence level of 95% $((1.96)^2 (0.5)90.5)) / (0.05)^2$ we get a minimum of 385.
A random sample of 397 respondent households were interviewed.

Data collection instruments, pretesting and procedure

Data was collected by use of semi-structured questionnaires. The questionnaire was organized into closed and open-ended questions and used Likert scales to obtain scores on several statements measuring respondent perception on various areas of study interests such as availability, accessibility, utilization of agricultural extension services and state of household food security in the respondent households. A pilot study was done to test for reliability of the questionnaires. The questionnaire was administered to a random sample of 32 farming household heads randomly selected from Kesses sub-County in Uasin Gishu.

Six key informants were also interviewed. These were the four ward administrators and two Sub County agricultural officers. These informants had a breath of information on available agricultural extension services, farming practices and food security situation in the sub County. Information from these officers was used to triangulate information obtained from the smallholder farming households.

The questionnaires were administered using the Computer Assisted Personal Interviewing (CAPI) method whereby data was aggregated in the survey platform on Open Data Kit (ODK). CAPI has numerous benefits including quicker turnaround time as it integrates data collection, data entry, editing coding and cleaning into a single process. In addition, it improves data quality and reduces the researchers stress.

3.8 Data Analysis and Presentation

The data was analysed using the Statistical Package for Social Sciences (SPSS version 23). The data was analysed both quantitatively and qualitatively using descriptive and inferential statistics.

Frequency tables and percentages were used to present the socio-economic characteristics and the agricultural livelihood activities. The Pearson Rank Correlation Coefficient analysis was used to examine the type and strength of relationships of the independent variables- agricultural extension services access, availability and utilization on the dependent variable- respondent household food security. The analysis of variance (ANOVA) F-test was used to test the significance of the overall model with a confidence level of 95%.

3.11 Ethical Considerations and Data Management

Approval to conduct the study was sought from University of Eldoret, Kenya, with information relayed to the County Department of Agriculture and the Ward administrators. The study adopted the principle of voluntary participation for the sampled participants; none of participants were coerced into participating in the research. Further, the participants were informed about the purpose of the study and that their confidentiality was guaranteed.

III. RESULTS

Availability of Agricultural Extension Services

Majority (90.3%) of the respondents were aware of the agricultural extension services available to them with 71.3% knowing where to get the services. County government extension officers were ranked most available with their services sought most often (87%). This was followed by national government (40%) whereas few respondents sought extension services from the cooperative societies (Table 1).

Table 1 Agricultural Extension Service Providers

Providers for agricultural extension services	Never %	Rare %	Don't Know %	Often %
National government	37.4	15.2	5.5	40
County government	4.3	4.5	3.5	87
NGOs	43.4	12.9	17.7	26
Cooperative society	32.9	36.5	20.6	10
Private company	42.9	16.7	10.4	26

N = 397 Source: Survey Data 2018

Access to Agricultural Extension Services

Based on the research results, it was found that majority of the respondents (95%) agreed to have access to agricultural extension services. Two hundred and ninety (73%) attended agricultural extensions training with most of them (53%) having attended once a month. The summary of the above information is illustrated in Table 2 below.

Table 2 Agricultural Extension Services and Training Attendance

Indicators of access	Percentage
Access to agricultural extension services	
Yes	95
No	5
Attended Agricultural extension training	
Yes	73
No	27
Attendance in a month	
Once	53
Twice	10
Thrice	1
Other	36

N = 397. Source: Survey Data, 2018

Utilization of Agricultural Extension Services

Results on the utilization of lessons from agricultural extension service show a majority reporting that it was very useful and useful, (76%) of which them (60%) reported that it is very effective and effective in improving agricultural productivity. On utilization, more than half have medium to high utilization (57%). The results are as summarized in Table 3 below.

Table 3 Utilization of Agricultural Extension Services

Variable	Percentage
Usefulness of AES training program	
Very useful	18
Useful	58
I don't know	16
Somehow useful	8
Effectiveness of AES	
Very effective	11
Effective	49
Fair	38
Less effective	3
Utilization of AES	
No Utilization	2
Low utilization	42
Medium utilization	50
High utilization	7

N = 397 Source: Survey Data 2018

The level of utilization of agricultural extension services was determined by inquiring about the application of various extension packages available. These packages include seed preparation, fertilizer application, weeding frequency, pesticides and herbicides use, harvesting and storage, spraying livestock, land use planning, farm record keeping and value addition. It was observed that all these packages were utilized mostly on occasional basis as seen on Table 4 below.

Table 4 Utilization of Agricultural Extension Services

Variable Agricultural extension service package	Level of utilization of Agricultural Extension services offered			
	1	2	3	4
	%	%	%	%
Seed preparation and sowing	23	18	34	25
Fertilizer application	11	19	46	24
Weeding	10	19	47	24
Pesticide and herbicide use	11	13	53	23
Harvesting and storage	8	27	45	20
Spraying livestock	8	21	35	36
Land use planning	14	35	36	15
Farm record keeping	26	27	28	19
Value addition and marketing	39	25	24	12

N = 397 Source: Survey Data 2018

The analysis above revealed rare utilization of seed preparation and sowing (23%), farm record keeping (26%) and value addition and marketing (39%) advice.

In conclusion, irregular farm visits were a contributor to the respondents' complaints about invisibility of agricultural extension agents. The key informant interviews reported that the limited farm visits are as a result of lack of provision of transport. Even though, the study is in consensus with the discussions from the key informants that majority of the smallholder farmers have limited contact with extension personnel on a regular basis, it largely depends on the farmers demand for extension and taking initiative to attend the extension events or visiting the offices for advice, more attention is required to reduce the escalating rate of irregular visit, since that would translate to a significant number of smallholder farmers being accessed.

The researcher observes that even after communicating the information, some of the smallholder farmers may not afterwards translate the information into action. In the same vein, most of the smallholder farmers are conservative and are not ready to take up new ideas for implementation. Consequently, smallholder farmers are often blamed for poor adoption of extension services and success and/or failure is based on the level of adoption without considering the effectiveness of extension delivery approaches

Utilization of Agricultural Extension Service and Household Food Satisfaction

The results show that among the households surveyed a higher percentage (39%) seldom had problems in satisfying their food needs, (31%) had never had problems, and (18%) sometimes had problems while (11%) always had problems in their food satisfaction. Cross tabulation was performed to establish the

utilization level of the extension agricultural extension service and the link to smallholder farming household food security.

A higher percentage of households (19%) with medium level of utilization of agricultural extensions services never experienced any problem in satisfying food needs 12 months prior to the survey. A small percentage of those who had never utilized (1%) agricultural extensions services always had problems in satisfying food needs while (6%) with medium level of utilization reported to always being dissatisfied with their food security as shown in Table 5 below.

Table 5 Cross tabulation between AES Utilization and Food Satisfaction

Agricultural extension utilization	Household food satisfaction 1 %	2 %	3 %	4 %	Total %
No utilization	2	3	1	1	6
Low utilization	11	14	8	4	37
Medium utilization	16	19	8	6	49
High utilization	3	4	1	1	8
Total	31	39	18	11	100
Pearson Chi-Square	4.722			p-value	0.858

N = 397. Source: Survey data 2018

There is no statistically significant (p-value=0.858>0.05) relationship between the level of utilization of agricultural extensions services and food satisfaction during the 12 months preceding the study. (Pearson Chi-Square=4.722).

Among the households surveyed, 89% did not change food consumption patterns in the past 12 months before the data collection as compared to the previous year. A higher frequency of households with medium level of utilization (46%) did not change their food consumption. One percent of households with no and high levels of utilizations changed their food consumption level. As shown in Table 6 below, there is no link between the level of utilization and changes in food consumption levels.

Table 6 Cross tabulation between AES Utilization and Food Consumption Changes

Agricultural extension utilization	Household change in food consumption Yes %	No %	Total %
No utilization	1	5	6
Low utilization	5	32	37
Medium utilization	5	46	50
High utilization	1	6	7
Total	11	89	100
Pearson Chi-Square	1.947	p - value	0.583

N = 397. Source: Survey data 2018

There is no statistically significant (p-value=0.583>0.05) relationship between the level of utilization of agricultural extensions services and changes in food consumption.

Eighty-eight (88%) of the respondents did not experience food shortages while only. Thirty two percent of respondents with low utilization and 45% with medium level of utilization of agricultural extensions services did not experience food shortages. The households who experienced food shortages across the levels of utilization is 12% as shown in Table 7 below.

Table 7 Cross tabulation between AES Utilization and Food Shortage

Agricultural extension utility	Household experiencing food shortage in the past 12 months prior to the survey Yes %	No %	Total %
No utilization	1	5	6
Low utilization	5	32	37
Medium utilization	6	45	51
High utilization	1	6	7
Total	12	88%	100
Pearson Chi-Square	1.689	p- value	0.639

N = 397. Source: Survey data 2018

There is no significant (p-value=0.639>0.05) relationship between the level of utilization of agricultural extensions services and food shortage experienced.

In general, utilization level of the extension agricultural extension service has no link to smallholder farming household food security in Uasin Gishu County.

Correlation Analysis between Availability and Access to Agricultural Extension Services and Food Security.

Correlation analysis was performed to determine the strength of relationships between availability and access to agricultural extension services and respondent household food security.

Table 8 below summarizes the correlations between availability and access to the agricultural extension's services and food security. There is a significant positive relationship between the availability of extension services, attendance of extension training programmes and monthly frequency of attendance (rho=0.200 and 0.108 respectively). Also, there is a significant negative correlation between availability of extension services and knowledge about its understanding by the households (rho=-0.237). This shows that increasing the availability of extension services and attendance to training programmes increases accessibility and therefore contributes to household food security.

Table 8 Correlation Analysis between Availability and Access to Agricultural Extension Services and Food Security

Variables	1	2	3	4	5
1. Food shortage	1				
2. Availability AES	.043	1			
3. Access to AES	-.040	-.237**	1		
4. Attend AES training	.028	.200**	-.189**	1	
5. Attendance Frequency	.010	.108*	-.146**	.268**	1

** Correlation is significant at 0.01 level (2-tailed) * Correlation is significant at 0.05 level (2-tailed)
Source: Survey 2018

Correlations Analysis between Utilization of Agricultural Extension Services and Household Food Security

Correlation analysis was also performed on utilization of extension services and food security, Table 4.20, to determine the strength of relationships.

Table 9 Pearson correlation analysis on Utilization of Agricultural Extension Services and Food Security

Variables	1	2	3
Food shortage	1		
AES is useful	.023	1	
AES utility	.039	-.525**	1

* Correlation is significant at 0.05 level (2-tailed). Source: Survey Data 2018

The analysis in Table 9 above revealed a significant positive relation between utilization of agricultural extension services and improvement of household's food security (rho=0.623). This means that the utilization of agricultural extension services improves household wellbeing through improved agricultural productivity. There is a statistically significant negative relation between usefulness of the utilization of Agricultural Extension Services and their level of utilization (rho=-0.525), meaning that usefulness of Agricultural Extension Services depends on the level of utilization.

Ordinal Regression Analysis between Availability and Access to Agricultural Extension Services and Food Security

Pearson Chi-square statistic is not significant with a *p*-value= 0.812 > 0.05 level hence the null hypothesis is not rejected. The parameter estimates in Table 10 below summarizes the effect of each predictor. There is insignificant (p-values>0.05) positive relationship between respondent's households' availability and access to agricultural extension services and its effect on food shortage while households' attendance to extension training programs and knowledge on where to get extension services shows inverse relation.

The odds of availability of extension services 0.581 as compared to non-availability of these services, (β=-0.581). The odds that those who attend extension training programs to experience food shortages decreases by 14% as compared to those who didn't attend, (β=0.139). The odds that those who attends extension training programs once per month to experience food shortages is 0.059 as compared to those who attends twice or thrice per month, (β=0.059).

$$y = 0.581x_1 + 0.213x_2 + -0.139x_3 + 0.059x_4 + 2.017$$

In conclusion, households' access to agricultural extension services influence the state of their food security even though not significant as seen in Table 10 below.

Table 10: Ordinal Regression Analysis between Accessibility to Agricultural Extension Service and Household Food Security

Parameter		Estimate	Sig.
Threshold	(Household food security= 0)	2.017	.698
Location	Availability of extension services (x_1)	.581	.906
	Understanding access to AES (x_2)	.213	.757
	Attend AE training (x_3)	-.139	.883
	Frequently attend AES	.059	.828

Model Chi-Square = 64.011 Chi-square = .812
Nagelkerke's R^2=0.018 Significance = .371
Cox and Snell's R^2= 0.010
McFadden's R^2=0.013
Source: Survey Data 2018

Ordinal Regression Analysis between Utilization of Agricultural Extension Services and Household Food Security

The Pearson Chi-square statistics is not significant (p-value = 0.369>0.05), hence the null hypothesis is not rejected.

The parameter estimates below summarizes the effect of each predictor. There is insignificant (p-values>0.05) positive relationship between utilization of agricultural extension services and its effect on food shortage while usefulness of the utilization of extension services shows an inverse relation. The odds ratio (β=-0.513) represents the risk of food shortages decreasing by 51.3% for those who view utilization of agricultural extension services as very useful as compared to other households whose thoughts were otherwise. The risk of exposure to food insecurity is 0.650 times for those with no utilization of extension services (β=0.650). Furthermore, the odds of exposure to food shortages is 0.920 for those who rated utilization of extension services helps in improvement of household's wellbeing (β=-0.920).

$Y = -0.513x_1 + 0.65x_2 + 0.92x_3 + 0.1.81$

Therefore, the utilization of agricultural extension services will influence the state of household food security even though not significant as shown in Table 11 below.

Table 11: Ordinal Regression Analysis between AES Utilization and Household Food Security

Parameters		Estimate	Sig.
Threshold	[household food security= 0]	.181	.927
Location	AES attending useful (x_1)	-.513	.334
	AES utility (x_2)	.650	.232

AES improves wellbeing	.920	.106

Model Chi-Square = 3.148 Chi-square = .369
Nagelkerke's R^2=0.018 Significance = .371
Cox and Snell's R^2= 0.010
McFadden's R^2=0.013
Source: Survey Data 2018

DISCUSSIONS

Availability of Agricultural Extension Services

The findings reveal availability and multiplicity of agricultural extension service providers. The main player is the County government of Uasin Gishu., whereas others include private sector, NGOs and cooperatives. This finding concurs with Chowa, Garforth & Cardey, (2013) who argue that government services can be supplemented by NGOs and the private sector.

In a study by Bhatta & Doppler, (2011), reported that Agro-vets and farmers' cooperatives tended to offer quality and timely services to farmers, and that NGO staff members possessed better technical competencies and achieved better results than public extension officials. The players used varied extension approaches and delivery systems. They include farmer field schools, training and visit (T&V), farmer to farmer and commodity approach in the form of contract farming. The most commonly used were training and visits (58%) followed by farmer to farmer approach (25%). It is not clear from this study if the training and visit reported by the beneficiaries has the same features as the one initially conceived and promoted by World Bank which had the extension agent supporting a contact farmer with the expectation that farmers would learn from them. The agricultural officers reported that the most common approach used is demonstrations through field days. In this approach various technologies are demonstrated in a farm setting. However, participation was low with even lower participation from women farmers.

Another approach that is preferred is the farmer to farmer, where information is passed from farmer to farmer and reinforced through farmer field days so as to disseminate the technologies and good agricultural practices. The delivery system included: field days, mass media, telephone, farmer field schools, demonstrations, common interest groups, agricultural shows and exhibitions. Among the methods, demonstration with hands-on experience was the most preferred. The most available agricultural package was crop production as reported by 91% of the respondents. Even with reported availability of extension service by 90.3% of the respondents, only 58% indicated that the extension service was useful with occasional utilization of the knowledge on the available packages of seed preparation and sowing, fertilizer application, weeding, pesticides and herbicide use, harvesting and storage, livestock spraying, land use planning, farm record keeping, value addition and marketing.

The challenges facing agricultural extension services include limited visits by extension agents and coupled with limited knowledge of the demand led approach currently being used in extension service. This indicates that the farmers have not been made aware of the changes in the delivery of extension to demand driven. A study in Wareng district by Kipkurgat & Tuigong (2015) in the same County, also noted that farmers did not receive enough information and that extension officers were limited in number. Similar studies in Africa found that a major barrier to extension service availability was lack of transport by extension (Khaila, et al. 2015; Mkwambisi et al. 2013). However, it is noted that there was significant relationship between availability of extension and food security.

Accessibility of aagricultural eextension sservices by respondents

The other objective of this study was to examine level of utilization of agricultural extension services for smallholder farming households. The findings show a mix of players referred to pluralistic agricultural service. The providers are the County government extension service, reported to be the most available, whereas others include national government, non- governmental organizations, cooperatives and private sector actors. The agricultural extension packages provided included crop and livestock production, market linkages, fertilizer application and weed and pest management.

The most common package was crop production, which was reported to bear fruit given the high percentage of respondents reporting to have enhanced their production although this was not measured. Among the problems facing extension services were few officers, untimeliness of services, and low level of awareness of the service by farming households and poor-quality service. This concurs with Ong'ayo, (2017) who reported that lack of facilitation of agricultural extension officers in terms of transport which limits coverage of the extension officer, timeliness and quality of agricultural extension services hindering farmers access. This research shares that agricultural extension involves building capacity of smallholder farming household in the study area to help them make informed decisions on food security. However, the effectiveness of agricultural extension services is highly dependent on the ability and competence of extension agents to transfer information to the smallholder farmers, and this research focused on establishing the effects of agricultural extension services on access and utilization of agricultural knowledge by smallholder farmers.

Utilization of Agricultural Extension Services by Respondents

The study revealed that agricultural extension activities have high impact (66%) on adoption of new technology and the level of understanding of marketing issues (64%). The above findings are confirmed by Sinkaiye (2005) who averred that the role of agricultural extension agents is building the capacity of smallholder farmers and helping them make informed decisions so as to achieve better household food security status.

As indicated by Al-Sharafat, Altarawneh & Altahat, (2012), the effectiveness of agricultural extension services is dependent on the efficacy of agricultural extension agents in disseminating information to the smallholder farmers. Therefore, the implication here is that effective agricultural extension is significant towards achieving food security among smallholder farming households.

Respondents Household Food Security Situation

Considering the multidimensionality of food security as defined by the World Food Summit, (1996), a modified form of food security measurement was adopted for this study. To assess the food security situation among the respondents' households; a household level measure was used based on several questions. The questions capture different aspects of food insecurity. This allows for classification of respondents onto different levels of food

situations. To avoid the influence of seasonal effects, the state of food security measurement covered the last 12-months prior to the survey.

The responses on the series of the questions enabled the categorization of households into a dichotomous group of food secure and insecure. The food security indicators used for this study were; whether the household had to go a whole day without food (NOFOOD); eat small meals (SMLMEAL); worried that the household would not have enough food (WORRY); not eat foods they preferred (PREFER) and ate limited variety of food (LIMVAR). From the results, it was established that 10% of the households surveyed were food insecure in the 12 months prior to the survey thus September 2017 to October 2018. Many households (90%) did not change their consumption patterns in the period with most of them reporting to have taken three meals even though the means many not necessarily be adequate in quality and quantity.

From the inferential analysis, it is observed that those with no utilization of extension services are 65% likely to be exposed to food insecurity, while the risk of food insecurity for those who reported extension services being useful decreases by 51.3% compared to those who think otherwise. These results are similar with other studies that have reported extension services influence on the state of household food security but not significantly.

Studies have mixed results on the impact of extension and improved productivity. They reckon that extension impacts are difficult to show because of attribution issues. There are many factors that affect farmer's agricultural performance leading to difficulty in quantifying the cause and effect (Anderson, 2007). Birkhaeuser et al. (1991) review of extension studies found that 36 studies out of 48 showed significantly positive effects on knowledge, adoption and productivity.

This study showed an insignificant relationship between availability and utilization of agricultural extension and respondent household food security. Generally, almost all smallholder farmers involved in the study required and acquired agricultural extension knowledge related to different agricultural activities. They required capacity and knowledge for value addition to their agricultural produce. Most smallholder farmers appreciated the fact that the usage of agricultural knowledge increased agricultural production thus improving their livelihoods. It was also evident that smallholder farmers are able evaluate extension services based on adequacy, availability, and timeliness. It is acknowledged that other multidimensional factors such as household demographics, high prices of agricultural inputs, diminishing land resources coupled with poor agricultural practices among others affect food security (Wachira, 2014; Ayanda, 2014).

IV. CONFLICT OF INTEREST

The authors declare no conflict of interest

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