THE IMPACT OF AGRICULTURAL EXTENSION SERVICES ON THE FARMERS' AGRICULTURAL PRODUCTIVITY AND INCOMES BEFORE (2012) AND AFTER DEVOLUTION (2016/2017). A CASE STUDY OF KITUI COUNTY

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ABSTRACT

Agriculture supports the livelihoods of rural people in developing countries, including Kenya. Agriculture is the mainstay and driver of the Kenyan rural economy. Despite the critical role of agriculture in Kenya, poor access to extension support services persists. The study was carried out to evaluate the impact of agricultural extension services on the farmers' agricultural productivity and incomes before (2012) and after devolution (2016/2017) in Kitui county, Kenya. A total of 70 extension officers and 99 farmers were sampled from Kitui County using a stratified random sampling approach. Secondary information sources such as national and county ministries' reports and existing literature were reviewed to supplement the primary data. A questionnaire was the main tool used for data collection in this study. Data obtained were analyzed through descriptive and inferential statistics stochastic frontier analysis. The sampled smallholder maize farmers who had access to agricultural extension services had their yield productivity increase by 16.4%. The devolution of agricultural extension services resulted in a significant improvement in agricultural productivity and farmer's income by 27.2% and 13.8%, respectively. This study recommends that more campaigns with focus on women's groups and elderly farmers should be held in the vast Kitui County to create awareness about the devolution of agricultural extension services. Therefore, adequate funds should be allocated to the devolved agricultural extension services, for example, a specified percentage of the agriculture sector budget as a way of enhancing overall agricultural productivity and households' incomes.

1.0 INTRODUCTION

Agriculture supports the livelihoods of rural people in developing countries (World Bank, 2021). The contribution of agriculture to the Gross Domestic Product (GDP) in sub-Saharan Africa is approximately 30% (Jayne & Sanchez, 2021). In developing countries, more than 90% of the rural population depends on rain-fed agriculture for food security and income (Hlophe-Ginindza & Mpandeli, 2021). The contribution of the agriculture sector to the GDP in East Africa is about 40%, being a source of livelihood for approximately 80% of the region's residents (Amwata *et al.,* 2018; Amwata, 2020). In Kenya, agriculture (practiced by approximately 75% of the rural population) is mainly rain-fed and geared towards subsistence purposes (Kogo *et al.*, 2021). The sector accounts for 33% of GDP and 80% of national rural employment (GOK, 2019). According to Kenya's Agriculture Sector Transformation and Growth Strategy, agriculture may be a very effective means of enabling people to earn a living and a useful tool for the country's economic development (GOK, 2019). The Kenya Vision 2030, together with the Big Four Agenda, recognizes the agriculture sector as an economic pillar focused on the promotion of food security and employment creation (Wanderi & Makandi, 2019). Consequently, it influences the country's poverty incidence levels, nutrition, and health, as well as the overall quality of life (Ayieko *et al.*, 2021). To achieve its goals, the agriculture sector should be supported concerning productivity (MOALF & C, 2017).

It is generally agreed that the provision of agricultural extension services can enhance agricultural productivity in Kenya (Kogo *et al.*, 2021). Agricultural extension can support and facilitate people who are engaged in agriculture through the provision of agro-advisories, bridging the skills and technology gaps for improved livelihoods and well-being (GOK, 2019). Extension services may involve both government agencies as well as private sector actors. In some cases, extension is also provided by NGO's and producers/farmers organizations. Extension can extend research and technology knowledge to rural farmers, which by extension can improve their welfare. Modern extension services include technology transfer, facilitation, training/learning, linkages to markets, and enhancement of partnerships for the benefit of farmers (Davis, 2008). According to the Strategy for Revitalizing Agriculture (SRA), agricultural extension is considered a useful tool in poverty alleviation (MOALF&C, 2017). Consequently, the declining effectiveness of the public extension service can be considered a major factor that impedes agricultural growth and development. The Strategy for Revitalizing Agriculture (SRA) (GOK 2004), proposed key reforms in the extension systems geared towards linkages between research and technology generation points, the extension system, and farmers - the final beneficiaries. The Strategy for Revitalizing Agriculture proposed six policy areas that were to be given first-hand priority - public extension system being among them (Alex *et al.*, 2002; Katz, 2002). There is an ongoing debate that private extension service is more efficient than public extension in service delivery.

In most African countries, extension services were focused on increasing agricultural productivity, farmers' training, and technology transfers (Dhehibi *et al*., 2020). Some of the approaches that extension services adopted included the Integrated Rural Development Program, training and visits, and farmer field schools. In Africa, agricultural extension was reported to have had a significant and positive effect on farmers' knowledge and skills, the adoption of superior technologies, and an increase in productivity (Danso-Abbeam *et al.*, 2018). In Ghana and Mali, use of extension approaches such as FFS was, however, argued to have been an elite driven activity that excluded the poor and less educated (Davis, 2008).

Agricultural extension history in Kenya dates back to the early 1900s (Cheruiyot, 2020). The first remarkable success of agricultural extension in Kenya was introduction of hybrid maize technology in the 1960s and 1970s through integrated approaches and projects (Nagarajan *et al.*, 2019). The integrated approach that Kenya adopted had shortcomings of ineffective management, inappropriate coordination, poor communication among project implementers and low engagement of the community (Ngigi & Busolo, 2019). According to Olayemi *et al*. (2021), use of the T&V approach in agricultural extension helped improve the quality of staff (officers) through training and the establishment of enhanced linkages in Kenya. However, the T&V approach was implemented among the more educated and productive farmers in better-off areas. Due to poor development of the T&V approach, the system did not incorporate the voices of farmers, thereby resulting in a lack of accountability and unresponsiveness to the needs of farmers. Consequently, sustainable agricultural productivity impact was not recorded, let alone the existence of a positive return on the investment (Gautam & Anderson, 1999).

The performance of the public agricultural extension service in Kenya has been a subject of discussion for years (Gautam & Anderson, 1999). The agricultural extension service has been perceived as a top-down approach, with extension officers designing extension programmes without farmers' involvement. Quite often, these officers tend to apply these designs to different regions without considering the different agro-ecological zones. It is considered a major contributor to the poor performance of the agricultural sector (Republic of Kenya, 2005). Consequently, there has been an effort to reform the public agricultural extension service in order to make it cost effective, broad-based, participatory, sustainable, accountable, and responsive to farmers' needs. Smallholder

farmers do not only require advice necessary for increased productivity, but also linkages to markets, support in value addition, and diversification of incomes.

1.2 Statement of the Problem

There is documented empirical evidence of a relationship between decentralization and service delivery (Ahmad *et al.*, 2008; Besley *et al.*, 2007; Freinkman & Plekhanov, 2009; Kannan, 2013). Unfortunately, most studies have focused on developed countries and a few on selected developing countries of Asia and Latin America. The relationship between decentralization and service delivery in the context of sub-Saharan Africa particularly in Kenya is scarce (Balunywa *et al.*, 2014; Tshukudu, 2014). A good extension system is tailored to the local context (GOK, 2012). The governance system in Kenya is dedicated to making devolution work thereby encouraging local participation in the planning and development program of the government. The citizens are also expected to facilitate service delivery through taxes (GOK, 2011). It follows that it is more reasonable to design programs that fully satisfy the farmers if they are to pay for extension services given to them. The devolution of agricultural sector in Kenya presents an opportunity to increase farmer participation as well as ensure that extension services are delivered in a way that benefit farmers to the maximum. Unfortunately, the agricultural sector faces challenges; extension officers are few and not adequately facilitated; they are unable to reach many farmers (GOK, 2011). There is inadequate literature on this topic leading to significant knowledge gaps as far as the impact of devolution of the agriculture sector on delivery of agricultural extension services and agricultural productivity in Kitui County is concerned. Given the importance of extension services as a tool for improved household food security and income, this study is therefore justified, urgent, and very critical.

1.3 Purpose of the Study

The purpose of this study was to assess the impact of agricultural extension services to the farmers' agricultural productivity and incomes before (2012) and after devolution (2016/2017).

1.4 Objective of the Study.

To assess the impact of agricultural extension services on the farmers' agricultural productivity and incomes before (2012) and after devolution (2016/2017).

1.5 Hypothesis

The following hypothesis guided this current study.

Ho: There is no significant contribution of devolution of agricultural extension services to the farmer's agricultural productivity and income.

2.0 LITERATURE REVIEW

According to the Republic of Kenya (2004); ASDS (2010) and ASTGS (2018), agricultural extension is a major contributor of agricultural productivity, farmers' incomes, and household well-being and thus a key tool in the fight against poverty as underscored in the national agriculture strategy and policy documents. Strategy for Revitalizing Agriculture (SRA) was a response to the poor economic situation in the country (1992–2000). Strategy for Revitalizing Agriculture (2004), clearly identified extension services as a key area that required immediate action and one among the six interventions that required fast-tracking. The effectiveness of the agricultural extension services (especially public extension) was identified as a key factor that was identified to affect the growth of the Kenyan agricultural sector. Strategy for Revitalizing Agriculture (SRA) suggested some

reforms of the extension service system that were aimed at creating better linkages between research, extension, and farmers (the beneficiaries). Similarly, GoK (2019) recognizes the contribution of extension in promoting agricultural productivity and contributes significantly to poverty reduction through boost in food crops production and incomes of semi-arid and high rainfall areas of Kenya. Smallholder farmers have traditionally benefited from the government extension system since independence (Bourne *et al*., 2021). The Ministry of Agriculture has for many years prioritized on food crops through agricultural extension services. Several agricultural dissemination methods and approaches have been implemented in Kenya since its independence (Kiptot & Franzel, 2019). Some of the key approaches in Kenyan history include field days, farmer field schools, mass media, information desks, training and visits, common interest groups, demonstrations, and agricultural shows/exhibitions. Use of these approaches was criticized for not reaching as many farmers as possible as well as low technology adoption (Dixon, 2010). Some of the reasons for this trend were the low numbers of extension officers against an increasing number of farmers. Coupled with poor infrastructural support, the few available extension officers were not able to have a meaningful impact on the large population of farmers (Ireri *et al*., 2021). Commodity-based extension is a profit motivated system that is operated by government parastatals, out grower companies, cooperatives and mainly deals with cash crops. Commodity-based systems work best when all parties (parastatals, outgrower companies, and cooperatives) benefit from the extension expenditures. There is vertical integration of all aspects of production and marketing in terms of research, advisory, and material support. After the implementation of structural adjustment programmes (SAPs) in the 1980s, the Kenyan government came under considerable pressure to scale down their dominant role in national economies (FAO, 1997). This included reducing the budget allocation to agricultural extension and a cut in the number of extension staff. Consequently, extension services had their budgetary allocations reduced from six percent to about two percent of the overall country's annual budget (GoK, 2005). This compromised the effectiveness of the public agricultural extension service in the country (Gautam &Anderson, 1999).

The National Agricultural Extension Policy (NAEP) was formulated in the year 2001 to help in improving the delivery of extension services (Toroitich, 2021). The National Agricultural Sector Extension Policy (NASEP) (2012) is aimed at diversifying, decentralizing, and strengthening extension services in Kenya while ensuring their sustainability and significance to farmers. The National Agricultural Extension Policy was to harmonize extension work and create a meaningful coordination mechanism between the government and other stakeholders in the agricultural sector. The National Agricultural and Livestock Extension Programme (NALEP) and the NALEP Implementation framework were products of NAEP. However, NAEP is criticized as being ambiguous and does not spell out the specific roles of various stakeholders in extension service delivery (Republic of Kenya, 2005).

3.0 RESEARCH METHODOLOGY

3.1 Research Design

The study used an *ex post facto* descriptive survey design. This design was appropriate for the study because it enables the description and exploration of the effect of devolution of agricultural sector on the delivery of extension services in the selected study area. This type of design involves data collection after a naturally occurring event. It involves collection of information from a sample that has been drawn from a population that has received a natural treatment not designed by researcher (Fraenkel *et al.,* 2012). The study describes the factors that affect the devolution of extension services. This design is appropriate for the study since it facilitates the collection of information from a sample of a population in order to describe their characteristics as they relate to the facts

(Kerlinger, 1979). In this study, the characteristics of the sampled extension agents were described and delivery of services clearly documented. In addition, the design provided an accurate descriptive analysis of the characteristics of a sample, which can be used to make inferences about the population.

3.2 Study Area

This study was undertaken in Kitui County in Kenya (located in eastern region - lower part, about 160 km east of the country's capital city). Kitui County lies between 0°10' and 3°0' south in terms of latitudes and 37°50' and 39°0'east in terms of longitudes. The county is the sixth largest in Kenya in terms of land area (approximately 30,496.4 square kilometres) – however, about 6,369 Km2 is part of Tsavo East National Park. The county is bordered by Taita Taveta (South), Makueni (West), Machakos (Northwest), Tana River (East), Embu and Tharaka Nithi (North). Administratively, Kitui County has eight sub-counties: Mwingi Central, Mwingi West, Kitui Central, Kitui East, Kitui Rural, Kitui South, Kitui West and Mwingi North. The county has a total of 40 administrative wards and 247 local villages. The county has a population of 1,136,187 according to 2019 census comprising 262,942 households

3.4 Population of Study.

The study population consisted of farmers and extension officers. The target population was all farming households (262,942) and extension officers (228) in Kitui County.

3.5 Sample size determination and Sampling Procedure

To come up with an appropriate sample size, the Nassiuma (2000) formula for Sample size determination was used.

n = NC2 ÷ C2 + (N-1) e2

Note:

n=sample size;

N=population size;

C=Coefficient of variation which is ≤30%;

e=margin of error which is fixed between 2-5%).

The study sample was calculated at 20% coefficient of variation and 2% margin of error. Twenty percent coefficient of variation was used to ensure that the sample was wide enough to justify the results being generalized for the Kitui County. Higher coefficients of variation were not used to avoid very large samples due to limitation of research funds. Two percent margin of error was used because the study used an ex-post facto survey, whereby the independent variables could not be manipulated, and hence necessitating a relatively higher margin of error. Population size was 228 extension officers and 262,942 households in Kitui County.

3.6 Calculation of sample size

Farmers

n = NC2 ÷ C2 + (N-1) e2

n = 262942× 400 ÷ 400+ (262942- 1)4

105176800 ÷ 1052164 = 99.96

Extension officers

n = NC2 ÷ C2 + (N-1) e2

n = 228× 400 ÷ 400+ (228 - 1)4

91200 ÷ 1308 = 69.72

3.7 Stochastic Frontier Analysis

The study considered the technical efficiency of the smallholder farmers as the outcome variable in measuring the influence of devolution of agricultural extension services on farmers' agricultural productivity (Wassie, 2014). In this study, technical efficiency refers to the ability of a given level of inputs to produce maximum output at the frontier, and any deviation from these frontier outputs is considered as technical inefficiency (Coelli *et al*., 2005).

The study employed a threefold Blinder–Oaxaca (B-O) decomposition of Stochastic Frontier Analysis (SFA) in analyzing influence of devolution of agricultural extension services on farmers' agricultural productivity. The B-O decomposition developed by Blinder (1973) and Oaxaca (1973) is popular in the decomposition of differences in outcome variables based on different groups in a counterfactual manner (Jann, 2008). Further, Stochastic Frontier Analysis (SFA) introduces the stochastic term to represent the effect of statistical noise into the deterministic model to form a composite error term and thus a superior method of productivity analysis.

Several studies have employed B-O decomposition to assess differences in agricultural productivity due to adoption of devolved agricultural extension services, while numerous others have employed the Stochastic Frontier Analysis (SFA) method in agricultural productivity (Nonthakot & Villano, 2008).

4.0 RESULTS

Impact of devolution of agricultural extension services on farmers' agricultural productivity

The table below summarizes the relative crop productivity in 2017 cropping year (after devolution) and 2012 cropping year (before devolution). From the study results, there was an increase in the yield of major crops in the year 2017 compared to the year 2012.

Crop yield in bags per acre in year 2012 and 2017

Crop/acre	Year 2012	Year 2017
Maize	7.56	8.80
Beans	1.67	2.31
Green gram	5.28	9.05
Mangoes	17.21	18.89
Oranges	2.22	3.22
Cow peas	3.02	4.36
Pigeon peas	2.22	3.28
Cassava	1.29	1.89

Test of Hypothesis

Objective was translated into the following hypothesis:

Ho: There is no significant contribution of devolution of agricultural extension services to the farmer's agricultural productivity.

The hypothesis was tested through blinder Oaxaca decomposition of the translog stochastic frontier model. This study used the translog stochastic frontier model in the estimation of the agricultural productivity (technical efficiencies scores) as well as the influence of selected factors on agricultural productivity. The maximum likelihood estimates of parameters of the stochastic frontier production function (SFPF) and inefficiency model were simultaneously obtained.

Results in Tables below show truncated normal (first column), half normal (second column) and specification of the inefficiency term (μ_i) was assumed and estimated. Land size (X_1) and expenditure on extension services (X_2) have the expected positive impact on household maize yield.

Maximum Likelihood Estimates for the stochastic frontier model

	Truncated normal		Half normal	
	Coef.	SE	Coef.	SE
Dependent variable (Maize yield in year 2017)				
Constant	0.137**	0.031	0.163**	0.031
Ln Land size (X_1)	0.328**	0.029	0.318**	0.029
Ln Expenditure on extension (X_2)	0.246**	0.016	0.247**	0.016
0.5 x Ln Land size (X_1) 2	0.034**	0.008	0.036**	0.008
0.5 x Ln Expenditure on extension (X_2)2	0.025**	0.003	0.026**	0.003
Ln Land size (X1) x Ln Expenditure on extension (X2)	0.004**	0.001	0.004**	0.001
(σ)2	0.321**	0.009	0.321**	0.012
γ	0.855**	0.037	0.831**	0.042
Log-Likelihood		133.24		135.81
Chi		29.95		35.62
Prob Chi^2		0.000		0.000
N		98		98

Note: ** significant at 5% level - p ≤0.05

Maximum likelihood estimator was used to estimate the coefficients for technical inefficiency (Table below). All variables were significant except the age of the household head and levels of education (lower primary; upper primary, and secondary).

Maximum Likelihood Estimates for the inefficiency model

	Truncated normal		Half normal	
Variable	Coefficient	SE	Coefficient	SE
Constant	1.245**	0.127	1.187**	0.133
HH gender (male)	-0.024**	0.005	-0.055**	0.011
HH Age (years)	0.023	0.411	0.031	0.413
HH Education (no formal education)	0.336**	0.126	0.304**	0.134
HH Education (lower primary)	0.019	0.058	0.024	0.059
HH Education (upper primary)	-0.012	0.024	-0.018	0.028
HH Education (secondary)	-0.115	0.139	-0.132	0.141
HH Education (tertiary)	-0.279**	0.007	-0.288**	0.012
Crop diversification index	-0.348**	0.028	-0.359**	0.029
Enterprise diversification index	0.430**	0.126	0.433**	0.127
Extension services (1 = Yes)	-0.347**	0.039	-0.352**	0.044
HH Income	-0.083**	0.042	-0.093**	0.047
Non-farm activities (1 = Yes)	-0.152**	0.031	-0.156**	0.032
N		98		98

Note: ** significant at 5% level - p ≤0.05

From the analysis, the coefficients for gender (male) of the household head, level of education (tertiary), crop diversification index, extension services, income, and non-farm activities had a negative influence and were statistically significant at 0.05 alpha level. On the other hand, the coefficient for level of education of the household head (no formal education) and enterprise diversification index had a positive influence and were statistically significant at 0.05 alpha level.
Farm-specific indices of technical efficiency were estimated assuming both half normal and truncated normal specification on the inefficiency component of the composed error term.
The results reveal that there is substantial technical inefficiency among the sampled smallholder farms concerning maize farming. The main implication of this result is that farmers could increase their output by 40.13% on average without using additional resources, simply by improving their technical efficiency.

Farm-specific indices of technical efficiency scores

	Truncated – Normal		Half – Normal	
Efficiency indices range	Frequency	Percentage (%)	Frequency	Percentage (%)
0.1-0.2	1	1.0	2	2.0
0.2-0.3	19	19.4	24	24.5
0.3-0.4	16	16.3	21	21.4
0.4-0.5	5	5.1	6	6.1
0.5-0.6	2	2.0	3	3.1
0.6-0.7	10	10.2	8	8.2
0.7-0.8	18	18.4	14	14.3
0.8-0.9	27	27.6	20	20.4
Mean		59.87		57.35
SD		15.57		15.43
Minimum		1.87		1.96
Maximum		92.18		89.72
N		98		98

Blinder-Oaxaca (B-O) aggregate decomposition of Maize productivity

Description	LnYield	Percentage
Adopters	2.203	
Non-adopters	2.009	
Difference	0.194 (24.89)**	52.3%
Decomposition		
Explained	0.053	27.2%
Unexplained	0.141	72.8%

The B-O decomposition further showed that the gap in maize productivity between adopters and non-adopters of devolved agricultural extension services resulted because of the differences in observable characteristics (explained component of the B-O decomposition).

Impact of devolution of agricultural extension services on farmers' farm income

The results in Table below show that there was a significant difference in incomes from all the major crops, with the farmers who were accessing devolved agricultural extension services receiving higher incomes than their counterparts who had no access to extension services.

Crop income (per acre) and livestock incomes (KSh.) in year 2017

		Adoption status				
	Crop names	Non-adopters	Adopters	Diff	t-value	P-value
Crop	Maize	14,597.62	18,900.00	4,302.38	2.08	0.040
	Beans	6,576.47	13,558.82	6,982.35	2.04	0.044
	Green gram	30,540.70	43,492.94	12,952.24	4.49	0.000
	Mangoes	8,631.58	10,834.48	2,202.90	2.00	0.048
	Oranges	1,714.29	3,285.71	1,571.42	2.02	0.046
	Cow peas	9,857.83	13,100.55	3,242.72	2.10	0.038
	Pigeon peas	6,373.47	12,986.96	6,613.49	2.37	0.020
	Cassava	2,050.25	9,250.15	7,199.90	4.66	0.000
	Overall crop income	**37,423.56**	**42,589.43**	**5,165.87**	**2.14**	**0.035**
Livestock	Dairy cattle	35,891.50	41,205.50	5,314.00	4.06	0.000
	Beef cattle	9,428.38	12,942.38	3,514.00	3.87	0.000
	Indigenous cattle	11,689.20	15,481.20	3,792.00	3.95	0.000
	Dairy goats	6,231.76	8,479.76	2,248.00	2.06	0.042
	Indigenous goats	4,382.10	7,280.10	2,898.00	1.75	0.083
	Poultry	7,208.90	10,656.90	3,448.00	2.14	0.035
	Sheep	5,590.44	7,438.44	1,848.00	1.70	0.092
	Donkeys	4,789.55	4,909.55	120.00	1.17	0.246
	Others	2,154.57	2,108.57	-46.00	0.20	0.841
	Overall livestock yield	**58,961.13**	**64,382.48**	**5,421.35**	**2.02**	**0.046**
Total		96,384.69	106,971.91	10,587.22	2.07	0.041

The crop income from farmers who were using devolved agricultural extension services increased by KSh.5165.87 per acre compared to farmers who were not using the services. The livestock incomes from farmers who were using devolved agricultural extension services increased by KSh.5421.35 per acre compared to farmers who were not using the services.
There was a significant mean difference between both crop and livestock incomes for farmers using devolved agricultural extension services and those not using the service.

Test of Hypothesis H_{Ob}

Objective was translated into the following hypothesis:
Ho_b: There is no significant contribution of devolution of agricultural extension services to the farmer's incomes.
The hypothesis was tested using simple linear regression. Table below shows the influence of devolution of agricultural extension services on farmer's income.

Linear Regression results for the influence of devolution of agricultural extension services on farmer's incomes

Variable	Coef.	SE.	T	P>t
Use of devolved agricultural extension services (1 = Yes)	0.27	0.03	10.538	0.001
Constant	2.98	0.21	14.4	0.001

Calculated $F_{(1, 96)} = 4.27$, Prob> F = 0.04, Critical $F_{(1, 96)} = 3.94$; Adj R-squared= 0.31

Results in Table above reveal that the coefficient for the use of devolved agricultural extension services was significant at 5%. The adjusted R^2 was above the statistical threshold of 5% confirming that farmers' income was significantly influenced by the use of devolved agricultural extension services.

5.0 DISCUSSIONS

Devolution of agricultural extension services and farmers' agricultural productivity

The findings of the current study, greater technical efficiency is associated with greater diversification in crops. Nguyen (2014) agrees with the study's conclusions that more varied agricultural farms in Vietnam are more productive. Non-diversified farms are not very productive in their agricultural activities as compared to diversified farms. Even though crop diversification calls for additional skills in terms of management, the results include better input utilization, production of better and marketable crops and less reliance on a single crop (Pingali, & Rosegrant, 1995)

Famers who have contact with agricultural extension services produce higher with greater technical efficiency (Elias *et al.*, 2013). Access to extension services avails useful advice about diversification and the adoption of appropriate modern farming technologies.

According to Langyintuo & Mekuria (2008), farmers who benefit from agricultural extension services often access key technical knowledge and skills on a wide range of crop husbandry practices that enhance their production and associated management practices – this enhances their level of productivity. Similarly, according to Elias *et al*. (2013), in their study in Ethiopia, agricultural extension services have the potential to increase farm productivity by about 20%. In their separate studies, Bozolu & Ceyhan (2007) and Mango *et al*. (2015) observed that the availability of agricultural extension services had a statistically significant positive influence on technical efficiency in Turkey and Zimbabwe, respectively

Male-headed households, according to the current study, have higher technical efficiency compared to their female counterparts. These results are consistent with Wongnaa (2016) who found that the male gender improves technical efficient of maize productivity in Ghana. Farmers' use of technologies that often enhance productivity such, as improved seeds and animal power is associated with the gender of the household head. Women are generally disadvantaged in land and property ownership due to socioeconomic and cultural considerations, and they do not have access to extension. This puts them at a further disadvantage in using productivity-enhancing technologies in their agricultural activities (Appleton & Scott, 1994).

According to the current study, household heads who have no formal education have lower technical efficiency compared to their counterparts with formal education (lower primary, upper primary, secondary and tertiary). The results of the current study agree with findings by Tabi *et al*.

(2010) who found that more educated farmers have better adoption of productivity-enhancing technologies since they can easily access their related information as well as comprehend their associated benefits. Less-educated farmers are often less able to get information about new technologies and are also poorer in the acceptance of such technologies (UBoS, 2010). In the same way, more educated farmers are better able to get extension-related information which by extension enhances their agricultural production. According to UBoS (2010), the level of education of a farmer influences their ability to afford and use several productivity-enhancing technologies in developing and less developed countries. More educated farmers are therefore more efficient in their understanding and use of superior farming technologies than their less-educated counterparts. Elsewhere in Ghana, Wongnaa (2016) noted that productivity (as measured through the level of technical efficiency) is associated with the level of education of farmers in maize farming.

The current study found that households with heads who have a tertiary level of education have higher technical efficiency compared to their counterparts with less than a tertiary level of education (no formal education, lower primary and upper primary, secondary). The results of the current study agree with Wongnaa (2016) who found that higher levels of education such as college and university education influenced the technical efficiency of maize farmers in Ghana. The finding of the current study also agrees with Rogers (2003) who found that complex technologies do not support and enhance the adoption of improved input. Education is a key factor that reduces the complexity of agricultural technologies. Tura *et al*. (2010) disagree with this current study, which found that households with more educated heads are less likely to adopt improved maize seed varieties.

According to the results of the current study, households with both crop and livestock enterprises have lower technical efficiency compared to their counterparts who are specialized in either crop or livestock according to the current study. This is consistent with the finding by Nguyen (2014), who found that specialized farms in Vietnam have lower productivity.

Results of the current study indicate that households with higher incomes have higher technical efficiency compared to their counterparts with less income according to the current study. This corroborates findings by Wongnaa (2016) who found that household income was a key factor in increasing the technical efficiency of maize farmers in Ghana. Similarly, Mpawenimana (2005) found that farmers who have more income can use improved agricultural technology and achieve higher productivity. For this reason, the use of productivity-enhancing technologies in maize farming is associated with high household incomes. Availability of income among the farming households closes the liquidity gaps faced by farmers in their purchase and use of agricultural inputs. This facilitates the timely application of agricultural inputs and enhances crop productivity and consequently, farming income (Oseni & Winters, 2009).

According to the findings of the current study, households engaging in non-farm activities have higher technical efficiency compared to their counterparts who are not engaged in non-farm activities. This disagrees with Amaza, *et al*. (2007) who found that farmers with larger families attach greater importance to nonfarm activities than those with smaller households. Consequently, most households engaging in non-farm activities have lower productivity.

The current research shows that there is substantial technical inefficiency among the sampled smallholder farms with respect to maize farming. Farmers could increase their output by 40.13% on

average without using additional resources, simply by improving technical efficiency. These estimates of technical efficiency are not consistent with the findings of Mwajombe & Mlozi (2015), Elias, *et al*. (2013), Amaza, *et al*. (2006), and Kudaligama &Yanagida (2000) who separately estimated the average technical efficiency levels ranging between of 65% and 78% in Tanzania, Bangladesh, Ethiopia, Nigeria and India.

This research's findings are consistent with Faguet (2014) who found that devolution of administration structure spurred the provision of public services to the less privileged and positively impacted on their level of income. Key among the beneficiaries of devolution in Kenya was farmers through the devolution of the agriculture sector. According to Faguet (2014), devolution leads to more unity between the people, leadership and the local administration personnel and therefore, enables them to comprehend their particular desires and preferences as to realistically mirror these in the development issues. Due to the decentralization of authority, devolution sufficiently allocates monetary assets and ensures effectiveness in the provision of services, especially to the less privileged and susceptible segments of the public where most smallholder farmers fall. The results of the current study also agree with Gunderson *et al.* (2014) who also found that the devolution of agricultural sector had realized better service delivery in the United States of America thereby guaranteeing greater incomes for farmers. Diverse needs and preferences across the United States justified the devolution, or decentralization, of many Federal Government programs to the State or local level (Rogers, 2003). The move toward devolution of the U.S. agricultural policy, due to significant differences across States in such areas as commodity production, production costs, income distribution, and opportunities for off-farm work already reflect an appreciation of the gains from devolution, with some programs accommodating differences in State and regional preferences (Goyal &Nash, 2017). This agrees with Muhumed & Minja (2019) who found that the household incomes were significantly improved among the farming households as a result of the devolution of agricultural extension services in Wajir County. As a result of the devolution of agricultural extension services, the Wajir County government was able to perfect the delivery of extension services, provide greater funding to the agriculture sector and facilitate inputs subsidy programmes (e.g. fertilizers and certified seeds). Consequently, as a result of devolution, there was an increase in food production, improved food security and enhanced farmers' incomes.

Devolution of agricultural extension services and farmers' incomes

According to the findings of the current study, devolution of agricultural extension services has a statistically significant contribution to the farmer's income. As a result, the aquaculture sector that has the potential of enhancing food security and employment creation in Laikipia County is now faced with declining productivity (Atsiaya, 2017).

The study findings agree with Muhumed & Minja (2019) who found that the devolution of agricultural activities in Wajir County had significantly improved agricultural productivity in the county. Due to the devolution of the agricultural activities, farmers in Wajir County can produce more at a lower cost due to support derived from the county government which comes in form of extension services, funds, and inputs (e.g. seeds and fertilizers) and credits. Due to closer attention to the sector by the county government, agricultural activities have started becoming fruitful resulting in greater food security due to an increase in productivity.

The results of the current study agree with Goyal & Nash (2017) who found that a devolved system of governance is associated with better public spending and more so in extension, provides a greater likelihood of supporting agricultural productivity. As part of its recommendation, the study proposed support for devolution as a move to raise agricultural productivity in sub-Saharan Africa.

The results of the current study agree with Birch (2018) who found that the greatest improvement in agricultural productivity, and on reducing poverty and malnutrition, may be achieved through greater support for devolution.

The results of the current study disagree with Mutuga (2018) who found that even after devolution, there is continued lack of support to aquaculture by the devolved county government to keep the sector on the growth path. Lack of inputs necessary for aquaculture and declining extension services had a negative impact on production.

6.0 CONCLUSION AND RECOMMENDATIONS

A substantial technical inefficiency among the sampled smallholder farms with respect to maize farming was observed. Farmers could increase their output by 40.13% on average without using additional resources, simply by improving technical efficiency. The mean agricultural productivity by adopters of devolved agricultural extension services was 52.3% greater than that of non-adopters. Adoption of devolved agricultural extension services resulted in significant improvement in agricultural productivity. On the other hand, there was a significant difference in incomes from all the major crops with the farmers who were accessing devolved agricultural extension services receiving higher incomes than their counterparts who were not using the service. Devolution of agricultural extension services has a statistically significant contribution to the farmer's income.

A determined budget support by Kitui County government to enhance agricultural extension services as a way of improving agricultural productivity and increasing farmers' incomes.

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