Vol. 17(2), pp. 283-291, February, 2021
DOI: 10.5897/AJAR2020.14902
Article Number: BDD826566044
ISSN: 1991-637X

http://www.academicjournals.org/AJAR

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African Journal of Agricultural Research

Full Length Research Paper

Effects of land fragmentation on farm efficiency in three agro-ecological zones of Embu County in Kenya

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Received 12 April, 2020; Accepted 5 January, 2021

This paper is based on a study that was carried out to evaluate the effect of land fragmentation on farm efficiency in three agro-ecological zones of Embu County in Kenya from July 2017 to March 2018. The study used data collected from 384 farm-households that were randomly selected from three agro-ecological zones (AEZs) in the Embu County, using the multistage stratified sampling method. The AEZs were the Sunflower-Cotton Zone, the Coffee Zone and the Tea Zone, based on the official classification system in Kenya. Farm technical efficiency was measured using non-parametric data envelopment analysis. The multinomial regression analysis was used to evaluate the effect of farm size and other factors on farm efficiency. Farm size was found to have a negative and significant effect on farm efficiency in the Coffee Zone (*$p=0.013$, $\beta=0.879$*) and Tea Zone (*$p=0.046$, $\beta=1.016$*), but was insignificant in the Sunflower-Cotton Zone. However, the study revealed that the impact of farm size on farm efficiency varies within and across different agro-ecological zones. Other key factors that were found to significantly affect farm efficiency in combination with farm size are distance to market outlet, household head's level of education and age and farm access to credit and irrigation water. Similarly, the impact of these factors was found to vary in and across the three zones. For improvement of farm efficiency in the study area, this study recommends that the remaining large farms in the Tea Zone be managed as smaller semi-autonomous blocks. Other recommendations made were increasing access to agricultural education, markets, credit and irrigation water.

Key words: Land fragmentation, farm size, agro-ecological zones, technical efficiency, mixed farming.

INTRODUCTION

Land fragmentation, which is a common agricultural phenomenon in many countries, is a subdivision of a single large farm into a large number of separate small land plots. Land fragmentation can be attributed to a multiplicity of owners where one parcel is subdivided into small landholdings owned by many individuals or to a multiplicity of parcels where one person owns many small parcels (Sundqvist and Anderson, 2006). The main causes of land fragmentation are increased population, government land redistribution policy and urban encroachment to agricultural land (Bullard, 2007). Others are cultural laws of land inheritance and the social attachment to land in most societies, which has encouraged land subdivision. As a result of continuing

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land fragmentation in most countries, a great deal of effort has been devoted in an attempt to evaluate the impact of reduced farm-size on farm efficiency and livelihoods.

Farrell (1957) categorized efficiency into three types: technical, allocative and economic efficiency. Farm technical efficiency refers to the farm's ability to obtain maximum output from available resources and technology (Sanusi and Ajao, 2012), allocative efficiency refers to the ability of the farm to produce at least cost combination of inputs (Adedeji et al., 2011), while economic efficiency refers to minimum unit cost by combining resources in optimal proportions based on factor prices.

A farm is economically efficient if it has obtained both technical and allocative efficiencies. Economic efficiency is a product of technical and allocative efficiencies (Nwauwa and Omonona, 2010).

There has been no unanimity among previous studies on the effect of farm size and efficiency. This has rendered the results of the studies not conclusive enough to inform the policies targeting land fragmentation. Several studies have found a positive relationship between farm size and efficiency (Nganga et al., 2010; Alam et al., 2011; Padilla-Fernandez and Nuthall, 2012; Beshir et al., 2012; Ali and Samad, 2013; Geta et al., 2013; Paltasingh and Goyari, 2018; Dessale, 2019). On the other hand, several studies have found a negative relationship between farm size and efficiency (Dhehibi and Telleria, 2012; Bardhan and Sharma, 2013; Mburu et al., 2014; Abate et al., 2019; Okello et al., 2019; Okeyo et al., 2020; Mwangi et al, 2020).

The current study identified two research gaps in the previous studies. One of the gaps was the failure of the studies to evaluate the influence of agro-ecological factors on the relationship between farm size and efficiency. This gap was also pointed out by other studies (Tadesse and Krishnamoorthy, 1997; Geta et al., 2013; Byiringiro and Reardon, 1996). The other gap was the use of single enterprises to assess the efficiency of mixed farming systems such as those commonly found in Kenya. This gap was also identified by various other studies (Llewelyn and Williams, 1996; Thiam et al., 2001; Beshir et al., 2012).

The results generated by such studies cannot therefore be used to adequately inform policies targeted towards land reforms in mixed farming systems located in different agro-ecological zones in sub-Saharan Africa.

The purpose of this study was to evaluate the impact of land fragmentation on farm efficiency across three different AEZs, using data collected from Embu County in Eastern Kenya as a case study. Farm size was applied as an indicator of land fragmentation.

This study measured farm efficiency using multiple enterprises which were selected for each agro-ecological zone on the basis of the proportion of land they occupy and their contribution to total farm income.

The study tested the null hypothesis that farm size in combination with selected socio-economic and institutional factors has no statistically significant effect on farm efficiency in the three agro-ecological zones.

MATERIALS AND METHODS

Description of study site

Embu County is located in the central part of Kenya and borders Kirinyaga County to the West, Tharaka-Nithi, Kitui and Machakos counties to the East, South-East and South, respectively. Figure 1 shows a map of Embu County showing the AEZs and its location in Kenya. Agro-ecological zoning refers to division of an area into land units which have similar characteristics that are related to crop suitability, potential production and environmental factors. An AEZ is thus a land resource mapping unit, defined in terms of climate, land form, soils and land cover, and having a specific range of potentials and constraints for land use (FAO, 1996). The AEZs in Embu County ranges from highland zones bordering Mount Kenya to low midland zones bordering the semi-arid regions of Kitui and Machakos counties. The three AEZs in which the study was conducted were the Tea Zone, Coffee Zone and Sunflower-Cotton Zone, following Jaetzold et al. (2010) categorization of the AEZs in Kenya. The Tea Zone comprises Low Highland Zones 1 and 2, and some parts of Upper Midland 1. The Tea Zone receives average annual rainfall ranging from 1400 to 1800 mm, which is the highest among the three zones. The annual mean temperature in the Tea Zone ranges from 15.8 to 18.9°C. Tea, maize, beans and macadamia are the main crops grown in the Tea Zone (Jaetzold et al., 2010). The Coffee Zone comprises Upper Midland Zones 1 to 3, with annual rainfall ranging from 1200 to 1400 mm and annual mean temperature ranging from 18.9 to 20.7°C. The main crops grown in the Coffee Zone being coffee, maize, beans, bananas and macadamia. The Sunflower-Cotton Zone comprises Upper Midland Zone 4 and Lower Midland Zone 3. The Cotton Zone receives the lowest amount of annual rainfall (900 - 1200 mm) among the three AEZs, with annual mean temperature ranging from 20 to 22°C. Maize, beans and mangoes being the main crops grown in the Sunflower-Cotton Zone (Jaetzold et al., 2010). Despite the high potential for sunflower and cotton in this zone, very little of these crops was being grown during the period of this study.

Sample size

Farm efficiency in the study area was measured using data collected from a sample comprising 384 farms drawn from the three AEZs. The sample size was determined using the following formula (Cochran, 1977):

$$N = \frac{z^2 p(1-p)}{d^2} \quad (1)$$

where N denotes the desired sample size, z is the standard normal deviate at the required confidence level, p is the proportion of the target population estimated to have the characteristic being measured, 1-p is the proportion of the population without the characteristic being measured and d is the level of statistical significance set.

The standard normal deviate was set at 1.96 which corresponds to 95% confidence level. Since there was no available estimate of the proportion of the target population with the desired characteristics, 50% of population was assumed to have the

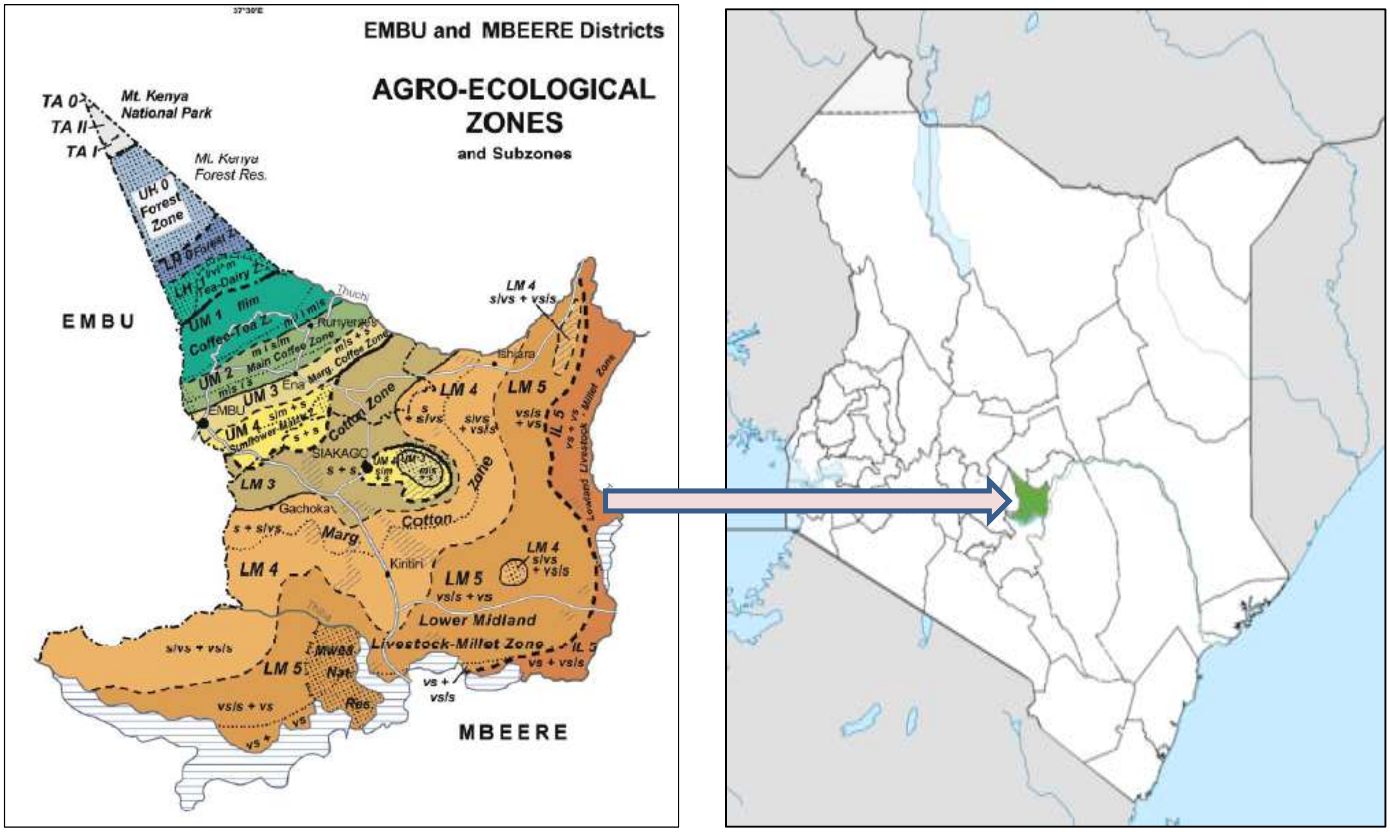

Figure 1. A map of Embu County in Kenya.

desired characteristic. The level of statistical significance corresponding to 95% confidence level is 0.05. The sample size (N) was therefore calculated as follows:

$$n = \frac{(1.96)^2(0.5)(1-0.5)}{(0.05)^2} = 384 \quad (2)$$

Sampling procedure

The study used a combination of a multi-stage cluster sampling and probability proportionate to size sampling procedures. One administrative location was randomly selected from each of the 4 administrative divisions randomly selected from each of the three agro-ecological zones, making a total of 12 administrative locations selected from the study area. One administrative sub-location was randomly selected from each of the 12 locations, followed by random selection of one administrative village from each sub-location and therefore making a total of 12 villages selected from the study area. The proportion of the village population relative to the total for all the villages was used to determine the number of farms to be interviewed in each village. The number of farms to be interviewed in each village was determined using the following formula:

$$m = \frac{n_i}{N_v} N \quad (3)$$

where m is the number of households to be interviewed in each village, n_i is the total number of households in the i^{th} village (i=1,2,…,12), N_v is the total number of households in the selected villages and N is the sample size (=384).

In total 134 households were selected for interview in the Sunflower Zone, 133 in Coffee Zone and 117 in the Tea Zone making a total of 384 households.

Data collection

The study used the survey method to collect cross-sectional data from the sampled households. The data that was used to measure farm efficiency which included crop and livestock outputs, the inputs used and their respective prices, were collected from each farm in the sample. Each household in the sample provided data on household socio-economic characteristics and its access to institutional services. To capture the annual farm outputs and inputs, data was collected during the two crop growing seasons from March to August and September to February.

Empirical models

The data envelopment analysis (DEA) was used in the current study to measure farm technical efficiency. The DEA model was developed by Charnes et al. (1978). The model is a non-parametric approach that develops a frontier of "best practice" from empirical observations of farm inputs and outputs without apriori specification of the functional relationship between the outputs and inputs (Mohapatra, 2014). The DEA model determines a frontier of 'best practice' by minimizing inputs per unit of output (or maximize output per unit of inputs) using a linear programming procedure. The relative efficiency of each farm is determined by comparing it with the 'best practice' frontier (Gorton and Davidova, 2004).

The main advantages of DEA model is that unlike the parametric model, apriori specification of the technology's functional relationship is not required, and the model can also be used in multiple-input and multiple-output situations (Sharma et al, 1999). The use of DEA model technique was therefore found to be suitable in the study area where there is limited understanding of production processes and mixed farming systems or multiproduct farms are most common. To determine the farm technical efficiency, this study used Data Envelopment Analysis Programme (DEAP) Version 2.1. DEAP is a linear programming computer software which was developed by Coelli (1996) to compute the efficiency of a firm given the levels of outputs produced and the associated inputs used.

Farm technical efficiency for each farm in the sample was measured using three selected farm enterprises and three inputs. The choice of the enterprises used in each AEZ was based on the average percentage acreage accounted by the enterprises in the sample. In the Sunflower Zone, maize, beans and mangoes which accounted for 37, 26 and 23%, respectively were selected. Maize (38%), coffee (29%) and bananas (22%) were selected in the Coffee Zone. In the Tea Zone, tea (54%), maize (15%) and coffee (12%) were selected. The three major farm inputs used in determining the farm efficiency were land (ha), labour (MD) and fertilizer (kg).

The farms in each AEZ were categorized into four categories on the basis of farm technical efficiency: low (0-<0.25), moderately low (0.25-<0.50), moderately high (0.50-<0.75) and high (0.75-1.00) efficiency categories. The effect of socio-economic and institutional factors that were hypothesized to affect farm efficiency was determined using multinomial logit regression analysis. The multinomial logit model is based on a random utility model and is a generalization of binary logit model. Unlike the binary logit model, the multinomial logit model can be used to analyze relationships involving dependent variables which are classified into more than two categories (Verbeek, 2012). If the utility derived from one of the alternatives, which is referred to as the reference alternative, is equated to zero then the probability that individual i chooses the j^{th} alternative is given by Verbeek (2012):

$$(P(y_i = j) = \frac{\exp(x_{ij}\beta_j)}{1+\exp(x_{i2}\beta_2)+\cdots+\exp(x_{im}\beta_m)} \quad (4)$$

where P(yi = j) denotes the probability that the i^{th} individual chooses the j^{th} alternative (j = 1,2,…,M), X_{ij} denotes a vector of explanatory variables specific to the i^{th} individual under the j^{th} alternative, β denotes the coefficients of the model to be estimated.

The function is estimated using maximum likelihood estimate. If only two alternatives are considered, the function becomes the standard binary logit model.

The β-coefficient shows the effect of a given explanatory variable on the probability that an individual chooses a given alternative. A negative β-coefficient for a particular explanatory variable, under a given alternative, implies that the probability of the alternative being chosen is reduced if the variable is increased. A positive β-coefficient for a particular explanatory variable, under a given alternative, implies that the probability of the alternative being chosen is increased if the variable is increased. The 1- β provides the effect of change in a particular variable on the probability that the reference alternative is chosen (Pindyck and Rubinfeld, 1981). The multinomial logit analysis also provides the odd-ratio which is the ratio of the probability that an individual chooses a particular alternative to the probability that the reference category is chosen (Bogale and Shimelis, 2009).

In this study, the alternative dependent variables were the 4 efficiency categories: low, moderately low, moderately high and high. The explanatory variables were the farm size and other socio-economic and institutional factors hypothesized to affect efficiency. In the analysis, the high efficiency category was used as the reference category. The β-coefficient indicates change in the odds of a farm being in the low efficiency category rather in the high efficiency one that is associated with one unit increase in farm-size. The odd ratio (OR) is the ratio of the probability of a farm being in the low efficiency category to that of being in the high efficiency category. An OR greater than one indicates that the odds of a farm being in the low efficiency category is greater than that of being in the high efficiency one. The converse is true for an OR that is less than one.

RESULTS

Extent of land fragmentation

Table 1 gives the means and percentages of farms in selected farm size categories for the three AEZs and the total sample. In all the three AEZs, majority of farmers own less than 1 ha of land indicating high intensity of land fragmentation in the study area. The highest level of land fragmentation was in the Coffee and Tea AEZs where over 80% of farmers own less than 1 ha of land. The mean farm size for the total sample was less than 1 ha with mean farm size in Coffee and Tea AEZs being less than the sample mean.

Level of farm efficiency

The results on farm efficiency status in different AEZs in the study area are presented and discussed here. The findings are presented in the form of frequencies, percentages and the results of multinomial logit regression analysis. Table 1 shows the number and frequency of farms per efficiency category in each AEZ.

Table 1 shows that the level of farm technical efficiency in the study area was considerably low. Except for the Coffee Zone, over 50% of the farms in other AEZs were found to be in the low and moderately low (<0.5) efficiency categories. The Tea Zone was found to have the highest frequency of farms below 0.5 level of efficiency (87%), followed by the Sunflower Zone (85%). The Coffee zone had the lowest frequency (49%) and the highest frequency of farms in the high efficiency category (19%).

Effect of land fragmentation

Based on the study results, the effect of farm size and other factors affecting farm efficiency in the three AEZs are shown in Table 2. The detailed results of the MLR analysis results for the factors that were found to be significant in the three AEZs are given hereafter.

Table 1. Descriptive statistics of farm sizes in the study area.

Farm size	Frequency	Percentage
Sunflower AEZ (n=134, mean=1.27 ha)		
< 1 ha	73	54
1- <2 ha	37	28
> 2 ha	24	18
Coffee AEZ (n=133, mean= 0.56 ha)		
<1 ha	110	83
1- <2 ha	18	14
>2 ha	5	4
Tea AEZ (n=117, mean= 0.72 ha)		
< 1 ha	95	81
1- <2 ha	15	13
>2 ha	7	6
Total sample (N=384, mean=0.86 ha)		
< 1 ha	278	72
1- <2 ha	70	18
>2 ha	36	9

Source: Survey data (2018).

Table 2. The number of farms per efficiency category across the three AEZs.

Efficiency category	Range	Sunflower		Coffee		Tea	
		No.	%	No.	%	No.	%
Low	0.00 - <0.25	55	41	46	34	63	54
Moderately low	0.25 - <0.50	59	44	20	15	38	33
Moderately high	0.50 - <0.75	8	6	43	32	4	3
High	0.75 - 1.00	12	9	25	19	12	10
Total		134	100	134	100	117	100

Source: Survey data (2018).

Farm size

The results in Table 3 show that the effect of farm-size on farm efficiency was significant in all the three AEZs. The β-coefficient was positive in all the three AEZs, implying that farm size had a negative effect on farm efficiency for it increases the probability of a farm being in the low efficiency category rather than being in the high efficiency one. However, the effect of farm size on efficiency varied with the AEZs, being the highest in the Tea Zone and lowest in the Sunflower Zone. The Tea and Coffee zones receive more annual rainfall than the Sunflower Zone and thus have a higher agricultural potential.

Access to electricity

The effect of farm's access to electricity on farm efficiency was only significant in the Coffee Zone. The β-coefficient for access to electricity in the Coffee Zone was found to be negative, implying that access to electricity had a positive effect on farm efficiency for it decreases the probability of a farm being in the low efficiency category in favour of being in the high efficiency category. The odd ratio associated with farm's access to electricity indicates that access to electricity decreases the likelihood of a farm being in the low efficiency category.

Education

The effect of the head of household's level of education on efficiency was significant in all the three AEZs. The β-coefficient was negative in the Sunflower and Coffee zones, implying that education decreases the likelihood of a farm being in low efficiency category thus having a

Table 3. The results of MLR of effect of farm size and other key factors on farm efficiency.

Independent factor	Sunflower Zone			Coffee Zone			Tea Zone		
	β	Sign.	Odd ratio	β	Sign.	Odd ratio	β	Sign.	Odd ratio
Farm-size	0.665	0.050*	1.945	1.816	0.003**	6.150	4.094	0.000**	59.954
Electricity	-0.319	0.474	0.727	-3.064	0.003**	0.047	-0.675	0.326	0.509
Education	-2.980	0.001**	0.051	-2.372	0.049*	0.093	1.849	0.018*	6.354
Land tenure	-2.394	0.013*	0.091	1.924	0.084	6.846	-2.56	0.029*	0.077
Market Distance	2.009	0.003**	7.459	1.184	0.110	3.269	1.267	0.005**	3.554
Credit access	0.306	0.793	1.358	-1.884	0.015*	0.152	-3.796	0.011*	0.022
All-weather road	-1.714	0.003**	0.180	1.778	0.012*	5.917	1.843	0.258	6.316
Livestock value	0.737	0.474	0.727	-0.776	0.044*	0.460	-0.894	0.114	0.409
Off-farm occupation	1.358	0.219	3.889	-0.539	0.159	0.583	-3.747	0.040*	0.024

**Significance at 1% level, *significance at 5% level.
Source: Survey data (2018).

positive effect on efficiency. Contrary to expectations, head of household's level of education had a negative effect on efficiency in the Tea Zone. The nature of the effect of formal education on efficiency was therefore found to vary with the AEZs.

Land tenure

A land tenure that confers more rights to own and utilize the land operated was found to have a positive and significant impact on farm efficiency in the Sunflower zones, but was not significant in the Coffee Zone. The β-coefficient indicates that increased rights to land ownership and utilization decreased the odd of a farm being in the low efficiency category in the Sunflower and Tea zones. In both AEZs, the OR was less than one indicating that the likelihood of being in the low efficiency category was lower for a farmer who owns a land title deed than the one without.

Distance to market

The effect of the farm's distance to the market centre was found to be significant in the Sunflower and Tea zones, but was not significant in the Coffee Zone. The β-coefficient indicates that an increase in distance to the market increases the likelihood of a farm being in the low efficiency category, thus had a negative effect on efficiency. However, the effect was higher in the Sunflower Zone than in the Tea Zone.

Access to credit

The effect of access to credit was significant in the Coffee and Tea zones, but was not significant in the Sunflower Zone. The negative β-coefficient indicates that the farm's access to credit decreases the odds of a farm being in the low efficiency category and thus had a positive effect on efficiency. The effect of access to credit on farm efficiency was however found to vary with AEZs, being higher in the Tea Zone than in the Coffee Zone.

Distance to all-weather road

The effect of the farm's distance to all-weather road was significant in the Sunflower and Coffee zones but was not significant in the Tea Zone. The β-coefficient was negative in the Coffee Zone indicating that distance to all-weather road decreases the odds of a farm being in the low efficiency category, thus has a positive effect on efficiency. However, contrary to expectations, the β-coefficient was positive in the Sunflower Zone, implying a negative effect on efficiency. The study therefore found that the nature of the effect of distance to all-weather road varied with AEZs.

Livestock value

The effect of livestock owned was only significant in the Coffee Zone. The β-coefficient in the Coffee Zone was negative indicating that the odds of a farm being in the low efficiency category decreases with increased livestock in the farm. The OR indicates that in the Coffee Zone, the likelihood of a farm owning livestock being in the low efficiency category was lower than for a farm that does not own livestock.

Off-farm occupation

The effect of head of household's engagement in off-farm activities on farm efficiency was only significant in the Tea Zone. The β-coefficient in the Tea Zone indicates that the odds a farm being in the low efficiency category was lower for a household whose head engages in off-farm activities that earn off-farm income. The OR for off-farm occupation was less than one indicating that the likelihood of a farm being in the low efficiency category was lower for a farm that has other sources of income than the one that relies on farm income alone.

DISCUSSION

The findings of this study have revealed that farm size has a negative effect on farm efficiency which implies that land fragmentation is likely to increase farm efficiency. These results are consistent with similar studies by Mburu et al. (2014), Karimov (2014), Abate et al. (2019) and Dessale (2019). The inverse relationship between farm size and efficiency could be attributed to use more of such resources as labour and fertilizer per unit of land in small farms (Tadesse and Krishnamoorthy, 1997). Another reason for relatively lower efficiency in large farms could be as the farm-size increases the managing ability of the farmer decreases (Abate et al., 2019). The other explanation would be the diminishing returns on land as its size increases, and the increasing cost of labour supervision as land to labour ratio increases (Assuncao and Ghatak, 2003). In addition small farms use the available land more intensively with less fallowing (Byiringiro and Reardon, 1996). The results of this study provide additional knowledge by revealing that the magnitude of the negative effect of farm size on farm efficiency varies with AEZs. The effect is more in AEZs with high agricultural potential than those with lower potential.

The results of this study also revealed that various socio-economic and institutional characteristics associated with the household head and the farm had significant effect on farm efficiency. The socio-economic factors that had significant effect on efficiency were formal education, land tenure and ownership of livestock. The effect of households head's level of formal education on efficiency was positive. The findings of this study are consistent with those from the previous studies by Nosiru et al. (2014), Bizimana et al. (2004), Mburu et al. (2014) and Paltasingh and Goyari (2018). The possible explanation is that attainment of education increases awareness of opportunities to increase farm production through adoption of modern technologies (Paltasingh and Goyari, 2018). Education attainment also increases the head of household's chances of securing off-farm employment, thus increasing the capital available for the purchase of farm inputs (Kuwornu et al., 2013). This study contributes to the existing body of knowledge by revealing that the nature and the impact of formal education on farm efficiency vary within and across different agro-ecological zones.

The current study revealed that land tenure status had a significant impact on farm efficiency which is consistent with the findings from the previous studies by Okezie et al. (2012) and Alam et al. (2011). Land tenure refers to the system of rights and institutions that governs access to and use of land (Maxwell and Wiebe, 1998). Possession of land title which confers the right to own and utilize the land being operated was expected to have a positive influence on farm efficiency. The possible explanation was that possession of title confers more land user rights and thus more likelihood for farms to undertake long-term investments (Bizimana et al., 2004). This study revealed that there were no significant variations in the impact of land tenure status across the agro-ecological zones in which it was found to be significant.

Based on the study findings, it was revealed that access to credit has a positive impact on farm efficiency in the study area. The findings are consistent with those from the previous studies by Kilic et al. (2009), Anyanwu (2013), Obare et al. (2010), and Al-hassan (2012). Use of credit increases farm investments and adoption of improved technologies thus increasing farm productivity (Osei et al., 2013). Access to credit loosens financial constraints thus ensuring timely acquisition and use of inputs and which results in increased farm efficiency. In addition, creditors may be more motivated to allocate resources efficiently to realize maximum returns in order to repay the credit (Obare et al., 2010). As the study's contribution to knowledge, the impact of access to credit on farm efficiency was found to vary across the agro-ecological zones in which it was found to be significant.

With regard to the impact of distance to the market, the study findings are consistent with those from previous studies by Omondi and Shikuku (2013), Otieno et al. (2014) and Okezie et al. (2012). The distance to the market centre determines the household's access to off-farm employment, input supply and output market (Gemechu et al., 2015). The market centre also serves as a source of market information for enhancing marketing of agricultural products (Al-hassan, 2012). This study reveals that there are significant variations in the impact of the distance to the market on farm efficiency across the agro-ecological zones in which it was significant.

Conclusions

The results of this study have revealed that land fragmentation would have the lowest impact on farm efficiency in the Sunflower Zone. Agricultural education, land tenure status and distance to market were found to have the highest impact on farm efficiency in the Sunflower Zone. For improvement of farm efficiency in the Sunflower Zone, this study recommends for provision of agricultural education, establishment of market outlets and issuance of title deeds to those without title deeds for the farms they operate.

In the Coffee Zone, the findings of this study have revealed that access to electricity and credit, and agricultural education had the highest impact on farm efficiency. This study recommends for increased access to electricity and credit, and provision of agricultural education to farmers for improvement of farm efficiency in the Coffee Zone.

The results of this study have also revealed that land fragmentation would have the highest impact on farm efficiency in the Tea Zone. Other factors that were found to have high impact on farm efficiency in the Tea Zone were access to credit and land tenure status. Based on these findings, this study recommends that the remaining large farms in the Tea Zone be managed as semi-autonomous blocks to increase the efficiency of labour management. The study also recommends for increased access to credit and issuance of land title deeds to those operating farms without title deeds.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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