

Assessing the Impact of Land Fragmentation on Agricultural Productivity and Rural Development in Vihiga County, Kenya

Bonface Kibisu Mwendwa¹
Edward M. Mugalavai²
Samuel Soita China³

¹bonymk2001@gmail.com

²emugalavai@mmust.ac.ke

³schina@mmust.ac.ke

¹<https://orcid.org/0009-0002-1344-4957>

²<https://orcid.org/0000-0001-5289-8180>

³<https://orcid.org/0000-0003-0136-209X>

^{1,2,3}Masinde Muliro University of Science and Technology, Kenya

ABSTRACT

Increased population pressures affect land as it is divided again and again resulting in poor yields in agriculture. Therefore, the purpose of this study was to establish the Legislative changes and population growth as factors leading to land fragmentation in Vihiga County, Kenya. Following the Agricultural Production Function Model, the study was descriptively cross-sectional. The study was undertaken in Vihiga County. Purposive sampling together with the stratified random sampling technique was adopted to recruit participants to the study. The population was over 10,000 therefore sample determination was done using Fisher's formula which gave 384 peasant farmers with subdivided farms. Quantitative data were gathered using, Likert-scale questionnaires that were semi-structured, while qualitative data were gathered using interview guides. Quasi-experimental research design incorporated both quantitative and qualitative data that used both descriptive and inferential analysis. The study showed that 58 percent of the households had land of half-quarter to half acre, 71 percent. 3 percent of farmers are owning the land for farming. On the issue of land fragmentation 94 % of the respondents agreed that this was prevalent mainly as a result of inheritance. Also, 48% of subdivisions produced subdivided plots that were less than a quarter acre, therefore reducing the productivity of farm land and posing difficulty in managing it. While 84% of responded farmers had less than one acre of land, only 16% had more than one acre of land which was strongly indicating the level of land fragmentation. Additionally, on 66 percent of the agricultural: land size farmed was between a quarter and half an acre. It revealed that farm productivity had positive relation with larger land size ($r = 0.888$). Descriptive statistics and inferential tests showed a strong positive relationship between land size, land ownership and productivity found out that large block of size is productive. This also affected the investment in modern and mechanized farming practices with a correlation of -0.598 as the fragmentation was associated with low yields and low profitability or economic return with $r = -0.443$. Based on the findings of the study, the researcher concludes that land consolidation is crucial in increasing agriculture productivity and supports the policies dealing with efficient use of the limited land resources. This study recommended that in the event of addressing the issue of fragmentation prioritization of land consolidation and the encouragement of land ownership reforms to accommodate investments in different techniques in support of superior usage of land, thereby increasing agricultural, production and sustainability levels.

Keywords: Agricultural Productivity, Land Consolidation, Land Fragmentation, Land Ownership

I. INTRODUCTION

The global population currently stands at 7.3 billion, and is anticipated to rise 8.5 billion by 2030 (World Bank, 2021). This increase implies great demand on the remaining limited land, thus worsening the problem of land fragmentation which is always noted in developing countries. It is for this reason that the current global population is predicted to consume in excess of three billion tonnes of food and feeds (Food and Agricultural Organisation, 2009). A potential case of land fragmentation is not peculiar on the developing countries only but rather affects the world at large and in extension, results in the major deterioration of the rural incomes, agricultural advancement and the natural resource management (Ntihinyurwa & de Vries, 2021). To address this, integrated approaches are essential, considering the social, economic and environmental dimensions of land use and tenure.

In the global south, agricultural activities predominantly rely on individual households rather than large-scale commercial farming (Chen *et al.*, 2015). This reliance shows the importance of household-level farming for both subsistence and commercial purposes. However, land fragmentation poses a severe threat to development in Sub-

Saharan Africa by limiting the scale, diversity, and intensity of agricultural activities (Food and Agriculture Organization [FAO], 2015). The socio-cultural and policy factors significantly influence land fragmentation in this region. Land tenure systems and inheritance patterns contribute to the continuous subdivision of land. Additionally, urbanisation and inadequate land use planning exacerbate the problem. To counter this, legislative actions are required to prevent land fragmentation and promote more effective agricultural practices (Bentley, 1990; Johnson, 1970). In Kenya, the 2008 Law of Succession Act, which mandates granting land to both sons and daughters, has potentially increased land fragmentation (Wachira, 2008). Previously, land was primarily granted to sons, while daughters were often given only usufructuary rights. This change in legislation has significant implications for land ownership and agricultural productivity.

Vihiga County relies heavily on agriculture as its main economic venture. In Vihiga County, cash crops cover 8,000 hectares, while food crops span nearly 40,000 hectares, together representing 98% of the total cultivated land. Assuming a national population of about 35 million people, the subsector constitutes 7% of the country's land (County Integrated Development Plan [CIDP] Vihiga, 2018). Crop production remain the backbone of this county revenue since it contributes to more than 64% of overall revenue and 85% of its population depends on agriculture. But, Vihiga County has a high population density, 1047 per square kilometre (Kenya National Bureau of Statistics [KNBS], 2019), which also contributes to the land fragmentation. This land fragmentation has been continuous since 1990s and resulting in the decline of agricultural activities by 28% in 2010 (Mutoko *et al.*, 2014). Land fragmentation in Kenya is contributed to by an increased population density. Besides, inheritance sub division and rising urbanization lead to further subdivisions. Solving these problems needs optimal approaches that have bearing on social, economic and environmental implications of land use and tenure with a view to attain sustainable production in agriculture and improvement of human existence.

1.1 Statement of the Problem

Land fragmentation in Vihiga County, Kenya is a major factor which affects the productivity in agricultural and the socio-economic growth of the county (Kihima, 2017). Due to increase in population of the world and concentration on land at large, Vihiga County is experiencing problems relating to sub divided land that hinders the size and productivity of the farming (Lusui, 2023). This fragmentation is made worse by socio-cultural factors such as the conventional systems of land holding and inheritance which results to further sub-division of the land holding among the extended families (Nyonje & Shitote, 2020). In addition, many of the problems exacerbate due to urbanization and lack of proper land use planning. The implication of such a trend of land fragmentation has egalitarian effects. They include declining yield in agriculture, decline in farm income, and problem in management of natural resource. Nonetheless, small fragmented land holding makes farms at household level to be important for both food and commercial production, but challenges of fragmented holdings limit intensive and diverse agriculture practices. The current trends to land tenure such as the 2008 Law of Succession Act that sought to address gender imbalance and allow sons and daughters equal rights to the land have compounded the problem of land fragmentation by splintering the land into even smaller pieces (Harrington & Chpra, 2010). It is therefore important to tackle this challenge in effort to increase agricultural productivity, improve standards of living in the rural areas and as a way of practicing proper land usage in Vihiga County.

1.2 Research Objective

To assess the effect of land fragmentation on agriculture productivity and rural development in Vihiga County of Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Review

This study used the Agricultural Production Function Models which was crucial and informative instruments in measuring the impact of the fragmentation of production lands on agricultural yield returns and rural development in Vihiga County Kenya. This model examined the connection between agriculture inputs which included land fragmentation such as size of the plot of land, the number of parcels owned and dispersion of the plots. When used the fragmentation measures allowed the model to evaluate the effects of alterations in land organization on farm efficiency, as defined by crop yields and farm income. This approach enabled one to distinguished different shades regarding how fragmentation affects efficiency and productivity (Abdel-Aziz *et al.*, 2019).

Its application to Vihiga County, it enabled drawing of conclusions on whether fragmentation of land resulted to negative returns, resource waste or high costs in farming activities. By using qualitative research, this paper was able to offer policy makers an understanding of some of the key informants that affect the performance of agriculture and the challenges of fractional land ownership. Through the provision of knowledge on the economic characteristics of

disaggregate farming systems, these instruments help promote pro-farmer and pro-land policies for the better use of available resources to underpin more efficient and sound rural development.

2.2 Empirical Review

Fragmentation of land leads to the raise of the cost of production, hence, a decline in agricultural output. There has been an association between farm size on one hand and productivity on the other. Sheng et al. (2017) noted that fragmented land into smaller size leads to lower productivity associated with high operation costs and low scale of economy. Fragmentation also an indicator of high labour and transportation costs, which has an effect on efficiency of the farms. Rahman and Rahman (2018) pointed out that a fragmentation of land in Bangladesh led to the reduction of labour productivity as farmers spent more time and energy to cultivate numerous small fragmentations. This is supported by Shuhao (2020) who stated that sub-optimal land use leads to a longer distance between multiple fields, a consideration which inflates the transport cost of input and output.

In the same way, Ali and Deininger (2020) noted that such fragmentation of land in Uganda hindered efficiency in the production of food crops hence low output. Analyses like Okezie et al., (2012) in Nigeria, in addition to Ayalew and Deininger, (2013) Rwanda among others have pointed out to the effect of small and fragmented parcel sizes on income in farming. Corbeels et al. (2019) analyzed that in Tigray land fragmentation enhanced the challenge of soil fertility management through increasing labour intensity and hence poor output. The above findings are in line with Ntihinyurwa and de Vries (2021) arguing that small plots of land are disadvantageous to sustainable agribusiness as they require more land for instance for fencing and access roads, therefore exhausting the available land.

According to Monchuk et al. (2018), small land sizes imply longer time and efforts in management, supervision and security hence magnifying the effects of land fragmentation. These led to poor quality implements which slow down the mechanization of farming activities thereby reducing productivity even more. The nature of compartmentalization in fragmented land holdings necessitates very many boundary lines invariably leading to excessive wastage of land. Demetriou (2018) discussed that boundaries such as stonewalls, ditches and pathways decrease the area that can be cultivated and defines the expenses for fencing and marking the Border. This issue is worst in small parcels in which use of modern machineries is not possible, labour is required and high value crops cannot be grown (Ali & Deininger, 2020). These restrictions on utilization of land do not only reduce total output but also cause likely conflicts with neighbours as concluded by Karouzis (2017) and Burton (2019). Furthermore, many lending institutions in the country do not allow farmers to use small and dispersed land parcels as security when seeking credit facilities hence discouraging loan facilities to support investment and productivity on agricultural land (World Bank, 2021). However, the measurement of the individual effects of land fragmentation on farm productivity in Vihiga County has not been well studied and this forms the research gap of this study.

III. METHODOLOGY

This study took place in Vihiga County situated in the western part of Kenyan in the Lake Victoria basin. The county spans five sub-counties: Hamisi, Emuhaya, Luanda, Sabatia and Vihiga sub counties which cover an area of 563 Km² and has a population of 590,013 according to KNBS (2019). Vihiga county is a tropical region and it has high fertility rate. The county has a population of 87 people per square kilometre; 2% are involved in agriculture and because of high human population density and prevalence of small holder farming, the study area will allow evaluation of the effect on farm productivity. In view of this the quantitative research used a descriptive cross-sectional survey design to compare between land fragmentation and farm productivity. This design which measures the variables and how they are related is suitable for establishing relations without rationale of cause.

The Land use change of subdivided farms targeted the population of land owners who subdivided their farms between 2008 and the year 2019. The study sample comprised peasant farmers in the sub-counties, sub-county lands officers, agricultural officers, area chiefs and community elders, for purposes of gaining qualitative data on the fragmentation of land. Then, using Fisher's formula, the necessary sample size was estimated and it was found to be 384 peasant farmers. To cater for the non-respondents a total of 400 questionnaires were administered. Three different samples were adopted including purposive cluster sample, proportionate quota sample and strata quota sample for households occupying subdivided land. Targeted purposive sampling was used on key informants since they possessed adequate knowledge as well as was capable of being informative.

Both primary and secondary data were gathered for this study through the use of semi structured questionnaires, key informant interview guides; focus group discussion guides and direct observation checklists. Both an explorative and a quantitative approach was used. Cross sectional study was conducted in Hamisi Sub County where pilot study was conducted to ascertain credibility and reliability of the data collection instruments. It entailed 38 farmers participants and was effective in reformulation of the instruments based on the feedback. Data were again checked for completeness

and entered in SPSS for purpose of descriptive and inferential statistical analysis. Differences found in mean scores, social demographic categories, and gender were thematically classified, aligned with other collected qualitative data and represented as a summary table. An ethical analysis of the study was conducted in accordance with the following principles: permission, anonymity, voluntary participation and informed consent. Researchers ensured that the study was in compliance with the principle of autonomy, justice, confidentiality, beneficence and non-maleficence.

IV. FINDINGS & DISCUSSION

4.1 Size of Land and Farm Productivity

The study sought to establish the size of land for the participating households. Figure 1 summarize the findings. The findings in Figure I show that there were 223 (58%) households owning at least a quarter-acre to a half-acre of land. There were (18%) some households that lived on less than a quarter acre of land. Furthermore, the size of the land was largely between one-quarter acre and one-half acre 58%, followed by a size of less than one-quarter acre 18%. Only 16% of the farmers were on land that was more than one acre in size. Figure I illustrate the findings.

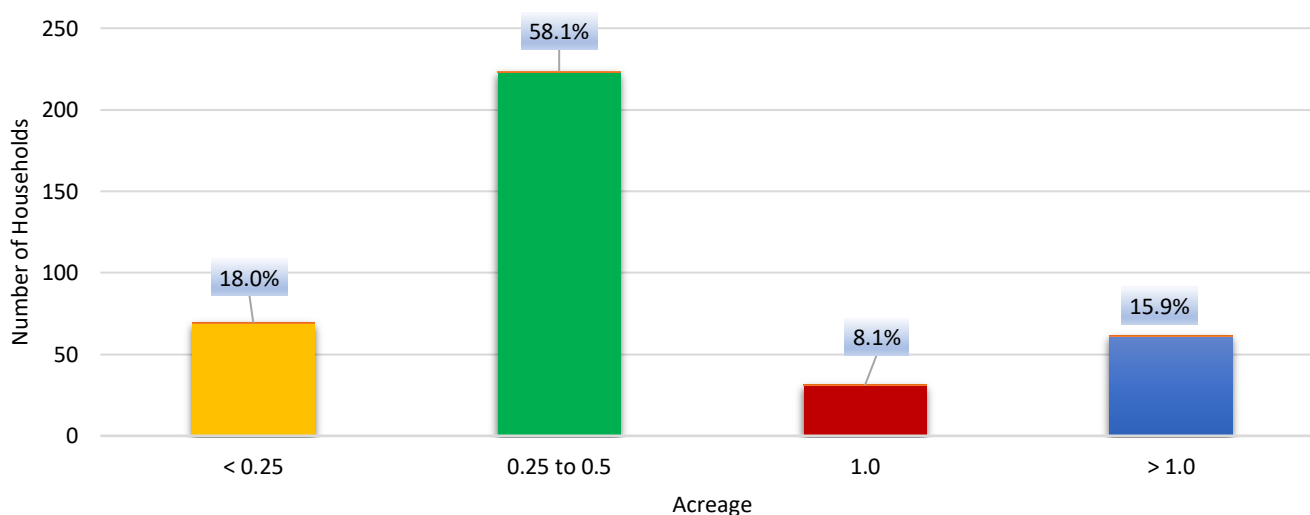


Figure 1
Size of Land

Ren *et al.*, (2019) assert that farm size is a key factor in the sustainability of agriculture. The study further found that increasing farm size has a positive impact on farmer’s net profit, as well as economic, technical and labour efficiency. Previous study revealed a perfect positive relationship between land size and land fragmentation. Huang *et al.*, (2019) suggests that when the size of land parcels gets smaller its fragmentation probability increases. This is because the inheritance laws that promote aspects such as sub-divide among the family members and economic challenges on the smaller land parcel make them prone to sub-divide and fragmentation (Carter *et al.*, 2014). In addition, as land becomes more fragmented, landholdings shrink and produce less, which can exacerbate the economic pressures that cause further fragmentation (Wu *et al.*, 2018). As a result, there may be a vicious cycle whereby land fragmentation results in smaller and less productive landholdings, which then fuels more fragmentation.

4.2 Ownership of Land

The research sought to establish the land ownership by the participating household i.e., owned by the respondent in the family or the land is still under the ownership of the parent. Figure 2 presents the findings.

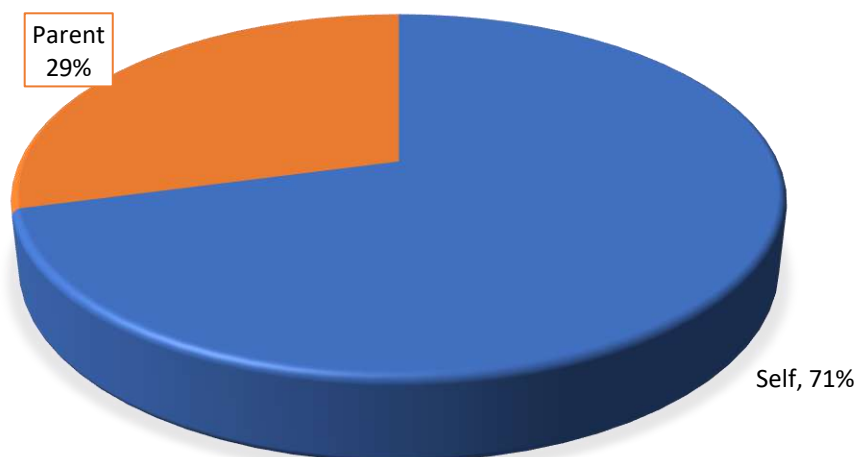


Figure 2
Ownership of the Land

The study found that 272 (71.3%) of the farmers owned the land they were on, while the remaining 112 (28.7%) were owned by the parent (Figure II). Ownership of land has implications regarding the extent it can be used, and the type of farming activity that can be carried out on it. According to Alemu *et al.*, (2017), land is the primary source of livelihood for all rural households. The size of the land reflects ownership of an important farm asset. The larger farm size implies more resources and greater capacity to invest in farms and increased production.

It was found that 71.3% of farmers owned their land, which revealed that ownership was vital in the distinction of the amount of land use and the kind of farming activities to be carried out. The study also found out that farmers who own their farms have a better chance to fully exploit their potential, practice innovations and thereby enhance both their income and yield (Alemu *et al.*, 2017). Nyonje and Shitote (2020) further assert that environmental, cultural, historical, sociopolitical and economic considerations all contribute to the understanding of the importance of land in society. The most typical way of thinking about the importance of land is from an economic perspective. In this context, land is the primary source of wealth, power, and social standing (Nyonje & Shitote, 2020).

Hakizimana *et al.*, (2017) also found that there is increasing land fragmentation which is caused by the inheritance system as land is divided across generations. The majority of the households in the study area acquired land through inheritance (Hakizimana *et al.*, 2017). In another study conducted by Kihima (2017) on the impact of land subdivision and fragmentation on rural development: a case study of Vihiga County found that the majority of the respondents acquired land through inheritance. In addition, a study by Obonyo *et al.* (2016) that examined land fragmentation and food security found that farmers acquired land using a variety of methods. Of the farmers surveyed, 68.3% said they inherited their land, 26.3% said they bought it, 2.7% said they leased it, and only 1.5% said they received it as a gift from friends and family.

4.3 Fragmentation of land

Respondents were asked whether the land had ever been fragmented. The responses are summarized in Figure 3.

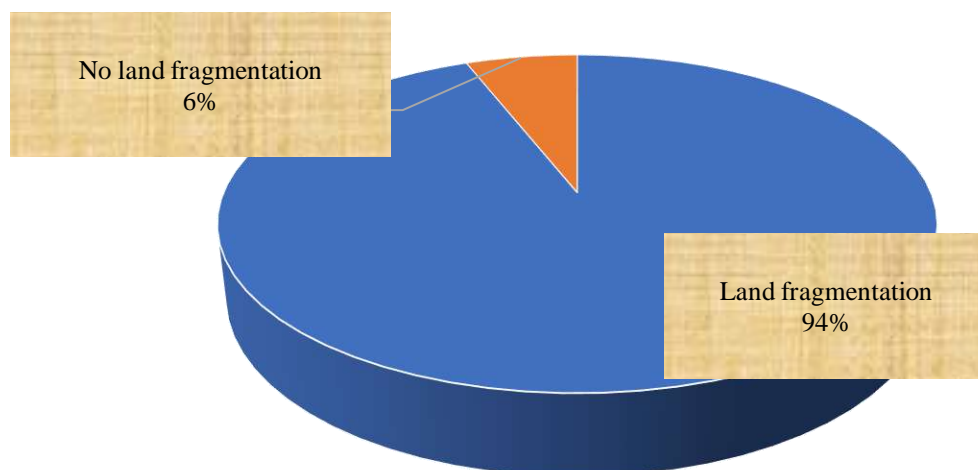


Figure 3
Land Fragmentation

The findings showed results that overall, 361 out of 384 respondents understood the fact of land fragmentation in their area (94%). This indicated that land fragmentation is an endemic problem in Vihiga County. On the other hand, 6 percent or 23 respondents were of the opinion that land fragmentation was not a big issue in their county. These findings highlight a consensus on the presence of land fragmentation, underscoring its relevance and impact on the community's agricultural practices and land use. The sustainability of agriculture depends on the availability and accessibility of arable land. According to Obayelu et al. (2019), land is one of the most vital, natural resources that are not renewable this and is pivotal to human existence and stewardship of ecosystems. Small holding or fragmentation of land is a worldwide problem which greatly affects less developed agricultural systems (Alemu et al., 2017). Using the methodology of a cross-sectional survey, Adhiambo et al. (2018) ascertained that land fragmentation in Vihiga County resulted to small land holding sizes and thus exerted a dampening impact on income generation as well as productivity in agricultural activity. A study carried on the farms established that they were relatively small in size with an average farm size being 0.8 hectares, and some of them as small as 0.1 hectares subsequent resulting into loss of soil fertility and thus low productivity.

Kiemo et al. (2019) noted that the current small land sizes in Vihiga County made food security a recurrent factor as fragmented land inhibited large scale diverse crop commercial agriculture production impacting productivity and income. Mwavali (2009) further observed that cultural practices in inheritance and in as much as population pressure kept fragmentation afloat, the outcome was food insecurity and inevitably lower income. According to the study, there is a need to rethink the tradition concerning inheritance as well as advocate for the use of land by different people in the community. The study done by Songoro (2020) in Kisii County revealed that even though land fragmentation impacted the sizes of the parcels of land, it did not necessarily affect food and livelihood insecurity. Although incomes have subsequently been allowed to reduce and fragmentation of land has been accepted by many of the respondents, they have been involved in non-farming activities income generating ventures. According to Obonyo et al. (2016) fragmentation made land in Western Kenya to have low productivity due to long distances to travel within small fields, high rates of labour and the challenges associated with mechanization. Kihima (2017) revealed that reduced farm sizes hindered modern agricultural practices and economies of scale, limiting investment in high-yield crops and advanced techniques. These studies collectively underscore the negative impact of land fragmentation on farm productivity and rural livelihoods, suggesting the need for policies promoting land consolidation, improved land management practices and modern agricultural techniques to enhance productivity and ensure sustainable rural livelihoods in Kenya.

4.4 Frequency of Fragmentation

When asked the number of times the land had been fragmented, respondents revealed that it had been once (Figure 4)

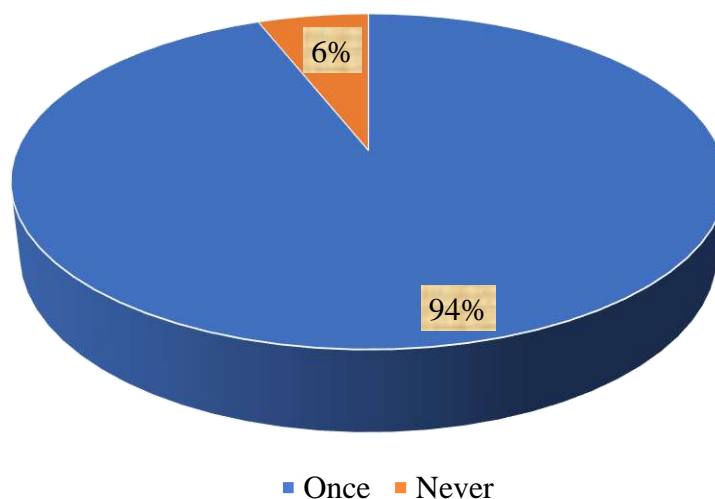


Figure 4
Frequency of Fragmentation of the Land

Findings show that 361 (94%) of the respondents had subdivided land only once. Only 23 (6%) respondents had never subdivided the land. Land in Vihiga has been successively subdivided into small parcels. The reason behind the fragmentation was given as being competing interests among the beneficiaries, implying that once the land is subdivided, there is a likelihood that farming will be adversely affected as the land use changes. It was reported that:

“...Beneficiaries cannot co-own land because of their different interests, after the principal owner dies his children carry out succession.”

When interviewed about the trends of fragmentation in the sub-county, the Lands officer stated:

“...Land fragmentation in Vihiga County has been on the increase in the last 10 years, this has been occasioned by a surge witnessed in population. The reasons for the increase are to grant children their inheritance”

Furthermore, it was revealed that the trends of fragmenting are intense because of tradition. One of the participants reported that:

“...Traditions have played a main role in land fragmentation where the natives feel they cannot buy land elsewhere and leave their ancestral land.”

The fragmentation process has given rise to a lot of boundary disputes. Several shelves in the County Lands office are dedicated just to the files dealing with land disputes.

During an interview with a key informant, it was reported that:

“...In Vihiga land has been divided to mainly less than a quarter of an acre with some going to as far as less than 0.01 hectare, because of the less land in Vihiga. Boundary conflicts are very common.”

The study found that, although the land was mainly subdivided out of tradition to pacify family members and avoid conflict, this in itself became a source of conflict between siblings. A key finding was the fact that the subdivisions had indeed increased arising from the statutes of the new constitution giving daughters a right to land inheritance. The following was revealed during Focus Group Discussions:

“...The main reason for land fragmentation is tradition; natives consider it a birthright to grant land to their sons who have come of age. Land is fragmented as a way to reduce conflict among siblings....to grant land to daughters, especially those not married. After promulgation of the new constitution, daughters have come back to claim land from their parents which has caused more conflicts between sons and daughters.”

Similarly, the following was revealed from a Key Informant Interview who stated that:

“...Majority of natives don't understand that 2010 constitution changed land dynamics Initially clan members and village elders subdivided land but now must be done within the law. Most of the land is owned by the ancestors and dependents haven't conducted succession. Subdivisions happening now do not give ownership to new landowners. Land parcels are very small, up to less than 0.1 hectare. Some subdivide for disposal in order to buy land elsewhere. Land has been divided to not more than a quarter hectare and very few residents own more than that. People own even a 1/8 or less hectares. The division is also done to avoid conflict among siblings as a result of pressure from children”.

Presently, there is no known minimum land fragmentation size owing to ownership. It is the responsibility of the Cabinet Secretary of Lands through the National Commission of Land to determine the minimum land for fragmentation (Kenya Land Act, 2008).

4.5 Size of Land Used for Farming

The respondents were asked to state the size of the land that is set aside for farming. The results are shown in Figure 5.

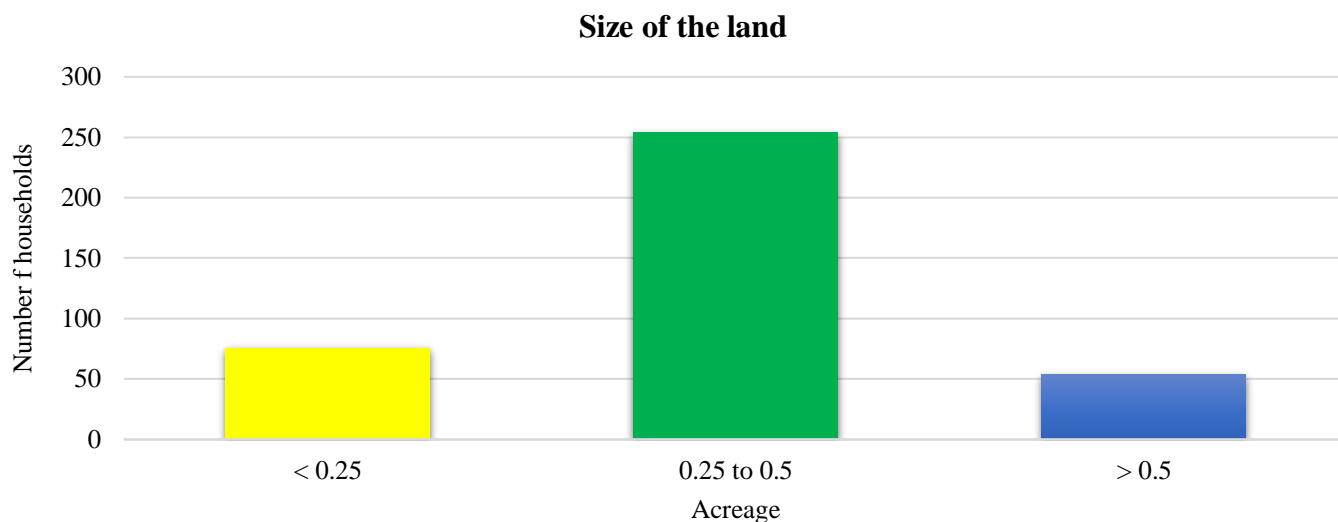


Figure 5
Size of Land Used for Farming

The findings in Figure 5 suggest that 66% of the participants, possessed land parcels ranging from a quarter to half an acre for farming purposes. This aligns with existing previous studies highlighting the prevalence of smallholder farms in many agricultural landscapes, particularly in densely populated or peri-urban areas (Jayne *et al.*, 2018). Additionally, 20% of respondents reported having less than a quarter acre, indicating the prevalence of even smaller land holdings among some farmers. Such findings are consistent with studies documenting the challenges faced by smallholder farmers, including limited access to resources and constraints on agricultural intensification (Lowder *et al.*, 2016). Conversely, 14% of respondents indicated ownership of more than half an acre, which may suggest variations in land endowments and land tenure systems within the study area. This underscores the heterogeneity of land distribution patterns and their implications for agricultural productivity and rural livelihoods (Deininger & Jin, 2018). Overall, these results underscore the importance of understanding landholding patterns and their implications for agricultural development and poverty alleviation efforts in diverse farming contexts.

One of the key informants responded that;

“ ... there no minimum or maximum land sizes to which land may be fragmented in Vihiga County, it’s a willing buyer willing seller basis.”

The study also established the trends in land fragmentation in the study area. The results are summarized in Table 1. The results indicate that 48% of them said that the land had been subdivided into less than one-quarter acre plot sizes. Further, 30% of the respondents indicated that the land had been divided into quarter-acre plot sizes; 12% said half-acre plot sizes and subdivisions into one-acre plot sizes constituted 10% of the total respondents.

Table 1
Trend of Land Subdivision

Land sub-division size	Proportion (%) of total subdivisions
To one-acre plot size	10%
To half-acre plot size	12%
To quarter acre plot size	30%
To less than one quarter acre plot size	48%
Total	100%



From the findings provided in Table I, it examined trends of land fragmentation in Vihiga County. The study found that a majority (48%) of the subdivisions were less than one-quarter of an acre; indeed, these plots constitute 48 percent of the total subdivisions. This concurs with earlier works done on land fragmentation where the works show that the division of land results in the production of small plots of land (Abdel-Aziz et al., 2019; Ntirenganya et al., 2020).

In addition, it was noted from Table I that approximately 30% of subdivisions led to quarter acre plots and therefore a significant portion of the land is subdivided into what are effectively very small lots. This is in line with other research done by other scholars on the effects of land fragmentation on farm productivity stressing on area Southern Africa where the number of holdings is likely to be fragmented into several small parcels (Mashayerkhi & Ghaderzadeh, 2013; Webster & Wilson, 1980).

Altogether, the findings of Table I indicates that 22% of subdivisions result into plot sizes greater than one quarter of an acre with 12% having half an acre size and 10% an acre size. Although these larger plot sizes may be seen as attempt to reduce fragmentation to some extent, the dominance of the smaller ones presents clear evidence of fragmentation in the study area. These observations, therefore, call for knowledge on the impact of fragmentation on farm productivity. Previous studies noted that fragmented land is characterised by small parcel sizes, which are known to compromise factors such as economies of scale, labour opportunities and machinery usage in farming production (Jha & Petrick, 2011; Corbeels et al., 2019). Therefore, the distribution of land subdivisions presented in Table I provides valuable insights into the nature and extent of land fragmentation in the study area, reinforcing the need for targeted interventions to address this issue and improve agricultural productivity.

The local leaders had a lot to say regarding the reasons behind the land fragmentation in Vihiga County;

“...Immigration into Vihiga County by non-natives have led to shrinkage in sizes of lands arising from purchasing of small pieces of land just for residential house constructions to get more space elsewhere. In Vihiga, the land is relatively expensive, so the natives sell and buy land in the settlement schemes elsewhere, especially Soi, Bungoma and Kitale. For food security reasons people sell land to buy bigger portions where they are able to grow crops.”

This statement indicates the prices of land parcels in Vihiga based on their sizes, which suggests that land prices in Vihiga are higher for larger parcels, reflecting the demand and scarcity of available land in the region.

4.6 Correlational Test on the Size of Land, Land Ownership, Land Fragmentation, Land used for Farm Productivity and other Land use Fragmentation

The study sought to determine the correlation of the variables under land fragmentation among households in Vihiga County. Table 2 summarises the Pearson correlation test.

Table 2
Correlations on Variables under Land Fragmentation

		Size of land	Land ownership	Land fragmentation	Land size used for farm productivity	Land use fragmentation
Size of land	Pearson Correlation	1				
	Sig. (2-tailed)					
	N	384				
Land ownership	Pearson Correlation	0.799**	1			
	Sig. (2-tailed)	0.000				
	N	384	384			
Land fragmentation	Pearson Correlation	0.799**	1.000**	1		
	Sig. (2-tailed)	0.000	0.000			
	N	384	384	384		
Land size used for farm productivity	Pearson Correlation	0.888**	0.598**	0.598**	1	
	Sig. (2-tailed)	0.000	0.000	0.000		
	N	384	384	384	384	
Land use fragmentation	Pearson Correlation	0.469**	0.378**	0.378**	0.443**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	
	N	384	384	384	384	384

** . Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows the inter-variable relationship of factors related to land fragmentation, land ownership, land size, land use for farm productivity and land use fragmentation. This study also shows that the size of the land is strongly and positively related with the proportional ownership of the land; $r = 0.799$; $p < 0.01$. This is in line with the previous

study done by Abdel-Aziz et al. (2019) where the research found that large size concentration may indicate the land ownership by individual or family.

Also, further Table II, we confirm that the direct correlation between land fragmentation and land ownership = 0.799 $p < 0.01$ this maintains that fragmented parcels of land are owned by individuals or families. Such a relationship is consistent with the effect which land subdivision has on the ownership patterns of the land as highlighted in the studies on land tenure systems and agricultural land use (Ntirenganya et al., 2020). Furthermore, it was also established in Table II that there was positive relationship in between land size used for farm productivity and size the land ($r = 0.888$ **, $p < 0.01$) and fragmentation of the land ($r = 0.598$ **, $p < 0.01$). From these observations, it is clear that size and extent of land details have a positive relationship on the land use for participatory farming productivity. This corresponds to a study by Ciaian et al. (2018) which emphasizes on the functions of land consolidation and proper use of land to improve the productivity of agricultural land.

In addition, the results showed that there was a medium positive correlation between the level of land use fragmentation and size of the land, ownership of the land and fragmentation of the land ($r = 0.469$, $p < 0.01$; $r = 0.378$, $p < 0.01$; $r = 0.443$, $p < 0.01$ respectively). This implied that dispersed land use pattern was more evident in areas with large land size, individual ownership and high level of fragmented land. These correlations are an indication of the compounded interaction between the physiographic attributes of land with its utilization and therefore call for a holistic method in managing and planning our nations land resources (Looga et al., 2018). The correlations depicted in Table II offered a good understanding of the degree of association between different factors which are associated with the fragmentation and the use of land for agriculture purpose. Therefore, the research adds knowledge on factors affecting use of land and productivity in the study region, which can help in designing of possible solutions to the concerns of land fragmentation and development of sustainable farming systems.

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

The majority of the households had average sized plots of land; however, most of the parcels were sized between a quarter of an acre up to half an acre. A good number of these farmers were part-owners hence they were more willing to invest and produce more. The fragmentation of land was a normal occurrence and was widely accepted which in turn results in the development of small and uneconomical portions. Non-fragmented land patterns were associated with larger size of landholding as well as individual ownership. From these findings it was evident that land consolidation and efficient land management was a telling factor in increasing productivity of the agricultural land as was also the need to adopt sustainable measures in development.

5.2 Recommendations

To address the issue of fragmentation, this study advises for the prioritisation of land consolidation and the encouragement of land ownership reforms to accommodate investments in different techniques in support of superior usage of land, thereby increasing agricultural, production and sustainability levels.

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