Assessment of Household Land Size and use for Sustainable Food and Livelihood Security in a Dairy Farming System of Gatimu Sub-location, Nyandarua County

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Abstract: *The problem of Land transformation on food and livelihood security has been experienced not only in Kenya and Africa but all over the world thereby necessitating adequate research that is the problem of land size verses food security. Various studies that have been undertaken on general impacts of land sizes and use on livelihood security especially in Ghana and Rwanda have shown that fragmentation has adverse effects on the agricultural productivity. This has not been done in Nyandarua, specifically in Gatimu sub-location thereby resulting in a knowledge gap. This study therefore sought to bridge the gap by assessing household land size and use for sustainable food and livelihood security in an agricultural area with emphasis in dairy farming that is Gatimu sub-location in Nyandarua County. A total of 140 farmers were sampled and both descriptive and inferential analysis were used. The results revealed that the households in Gatimu sub-location who practiced dairy farming owned at least two pieces of land each and both measured approximately 0.99 acres. The findings also revealed that majority of the landowners supported land subdivision among their heirs due to the high population increase and high living standards in the country. The land in Gatimu sub-location however was found to be used for settlement and crop farming besides dairy farming in the area.A bivariate correlation analysis was done on the effects of household size on food and livelihood security and revealed that household land size had an effect on food and livelihood security while the main use of land was not associated with food security.Again the findings revealed that land ownership, total owned family land size, age of household head and the household size were significant factors affecting household land Size and use. Therefore, the study recommended that land subdivision be highly controlled by setting minimum and maximum plot sizes in agricultural areas by the relevant authorities like the Government agencies involved in land administration so as to provide sufficient land size for agricultural activities.A model of settlement similar to Howard's garden city approach pioneeredhas been proposed for this sub location.*
Keywords: *Land transformation, Dairy farming, Land Fragmentation, Consolidation, Transfers*

I. Introduction

Land holds a key position in growth, human existence and development. Since creation, the humans have used land and natural resources in meeting the needs of the humans and their needs may be material, social, cultural, and also personal spiritual. They have not fully utilized land for the purposes of livelihood in terms of production of goods and services, shelter and also food for recreation, leisure and trans-communication (Gikenye, 2016).

Consistently man has fragmented modified and transformed land and continues to do so in various magnitudes and ways. The natural indigenous forests as well as other ecosystems are converted into agricultural areas both for livestock and farming production. The Wetlands have also not been spared and further converted into various uses thereby degrading the environment. However, many other forms of land uses occur whereby agricultural areas are slowly turned into commercial entities and also there are areas where income neighborhoods turn into slums.

According to Agricultural Sector Development Strategy, agriculture dominates the Kenya economy with farming being one of the most important sector. The agricultural sector that comprises six subsectors including industrial crops, horticulture, food crops, livestock, fisheries, and forestry contributes to 26% of the gross domestic product with the livestock-dairy subsector contributing 14 % of agricultural GDP and 3.5 percent of total GDP (Government of Kenya, 2008). The economic outlook of the year 2016 indicates the contribution of agriculture indirectly to the overall production was 27% (Mwavali, 2009). This was done mainly through linkages manufacturing, distribution as well as other service sectors. In addition, the sector contributes about 0.75 of all the raw materials used in the production as well as 0.45 of the total government monetary location in terms of revenue.

Kenya has had a population increase on daily basis. According to KNBS (2010), the population in Kenya stood at 36.8 million with 596,268 being from Nyandarua County. Population growth has contributed to increasing demands for land which is used for housing, farming and recreation among others (Smith et al. 2010). The study focuses on Gatimu sublocation which is in Nyandarua County and the issue of population growth and land fragmentation is not an exception.

The agricultural sector comprises six subsectors including industrial crops, horticulture, food crops, livestock, fisheries, and forestry. Livestock-dairy industry is the single largest agricultural sub-sector in Kenya (Muriuki et al. 2004). It is believed that the Dairy subsector is even larger than tea. Therefore this industry plays a very key role in nutrition. This industry has grown tremendously over time. According to The Food Agricultural Organization (FAO) it is estimated that there are 5.5 million milking animals in Kenya (Kenya TechnoServe, 2008) and Kenya is the only country in Africa after South Africa that produces milk for both export and domestic consumption. Again in a study conducted by Kaitibie et.al (2010). Kenyans are amongst the highest milk consumers in the developing world, consuming an estimated 145 litres per person per year, more than five times milk consumption in other East African countries combined.

Therefore, dairy and non-dairy farming is one of the most important industries for sustainable food and livelihood security. Dairy farming is mostly practiced in the highlands of Kenya with central Kenya being one of them. Therefore land size is an important factor that could greatly affect dairy farming. The study focuses on land sizes and their effect on food and livelihood security in Nyandarua County, Gatimu sub-location.

1.1 Statement of the problem

All over the globe, land size has been a major challenge especially to food and livelihood security of its population. Nyandarua County has been experiencing a high population growth rate at a 2.2% per annum (KNBS, 2010) leading to reduced land size for agricultural practices. Decrease of farmland size due to subdivision has resulted in non-economic farm sizes and holdings which hampers agricultural development leading to unsustainable livelihoods. Various studies have been undertaken on general impacts of land sizes and use on livelihood security especially in Ghana and Rwanda and have shown that fragmentation has adverse effects on the agricultural productivity. However, this has not been done in Nyandarua County, specifically in Gatimu sub-location considering the high population growth thereby resulting in a knowledge gap. This study therefore sought to bridge the gap by assessing household land size and use for sustainable food and livelihood security in an agricultural area with emphasis in dairy farming that is Gatimu sub-location in Nyandarua County.

1.2 Aims and Objectives

The aim of this study is to assess household land size and use for sustainable food and livelihood security in a dairy farming system of Gatimu sub-location, Nyandarua County

The objectives were:
  i. To examine the current household land size and its implication on food and livelihood security in Gatimu sub-location
  ii. To establish the current land uses and their impact on food and livelihood security in Gatimu sub-location
  iii. Analyze the factors that influence the size and use of household land in Gatimu sub-location

II. Literature Review
This section reviews both theoretical and empirical literature.

2.1 Theory of Production

The Theory of production explains the principles by which a business firm decides how much of each commodity that it sells (its "outputs" or "products") it will produce. And how much of each kind of labor, raw material, fixed capital good, etc., that it employs (its "inputs" or "factors of production") it will use. Economics, models, and theories are not dynamic; they are fixed to a period. So, economists base their models on the short run, medium run or long run (Benin, Pender and Ehui, 2003). The difference in these time frames is the ability to change the factors of production. For example, in the short run, its impossible set up a new factory, but it's more plausible to hire a new worker. It shows that in a period, current output can change only so much. While in the long run, you can make many more changes.

A place that is affected by land fragmentation and subdivision there is less input for production because there is less land for farming. Other characteristics like the plot characteristics and its size therefore impact the input and this directly would affect the output on the farm.

2.2 Empirical Review

While studying the land fragmentation problem in Albania, Pavel et.al (2018) concluded that two major issues that could result from land fragmentation. These are: (i) the consolidation policies that relocate and enlarge plots would have a significant impact on reducing agricultural production diversification; and (ii) land fragmentation contributes to the nutritional security improvement by increasing the variety of foodstuffs produced by subsistence farm households (Pavel, 2018).

Pavel (2018) continues to state that when land is subdivided, it affects both land and people living in those lands. The repercussions of land fragmentation are not only economic but also social. These socio-economic effects may lead to costly results on the owners of the land. Fragmentation limits the farmers desire to mechanize or modernize his or her farm. It inhibits the introduction of machinery and large scale irrigation. It may also be a hindrance to expansion of the farm.

Mwavali (2009) in a study on land fragmentation in Vihiga County suggested that there was a general reduction in production and average sale of food crops caused by land fragmentation. The socio-economic effects of land fragmentation included insecurity, reduced income, and increased disputes with neighbors.

Ndirangu (2017) in a study on land fragmentation stated that one major implication of Land fragmentation is food security. This is because most of the original large-scale farms have been subdivided beyond economically sustainable production capacity. The government is already exploring measures to mitigate against this issue. Institutional and policy measures are being established to tackle the question of food security with regards to land fragmentation

Land division also causes some portion of land to remain futile. This is due to the absence of well-organized road structures that render certain land fragments inaccessible. Therefore, making them unproductive because they remain uncultivated or get deprived of various necessities. Often, small fields have inaccessible roads. Likewise, lack of a road linkage to access the small fields precludes the institution of other useful agricultural infrastructure such as drainage systems and irrigation. Furthermore, this problem leads to disagreements and conflicts amongst neighboring landowners (Kenya Land Alliance, 2014).

2.3 Literature on Policy and Legislative provisions

These include policy and legal framework that guide land fragmentation. The constitution of Kenya is major guiding framework. The bill of rights guarantees every human being has the right to a uncontaminated and health environment that is sustainable (Seto & Reenberg, 2014). It also gives the right to social and economic rights which include acceptable standards of health, access to adequate and affordable housing and to reasonable standards of sanitation. The constitution also gives the provision of access to adequate food of acceptable quality in conjunction with portable water.

2.3.1 The 1963 and 2010 Constitutions of Kenya

The 1963 constitution granted a lot of power on maters land to the president and the former county councils. The president in consultation with the county councils could allocate land to even individuals if he deemed fit. (Section 118). This lead to a lot of Government land resting in the hands of private individuals in what was seen as land grabbing.

This is different with the 2010 constitution that has structure for the management of land and land related resources. The chapter of the constitution on Land and Environment provides for the use and management of the land in a manner that is equitable, efficient, productive, and sustainable. The principles include the power of the state to regulate the use of any land policy principles. The principles include the power of state to regulate the use of any land or any interest in or right over any land in the public interest as well as the management and protection of the environment for sustainable exploitation, management, utilization and conservation of the environment and natural resources.

2.3.2 National Land Commission Act

The act provides for the administration and management of land. It guides the country towards efficient, sustainable and equitable land use. It seeks to promote positive land reforms for the improvement of the livelihoods of the people (Ezra, 2010). For effectiveness, it provides roles to the Government to review planning and development control legislation in harmonizing the governance structures, decision making processes and planning standards and regulations together with developing effective administrative and legal mechanisms for the regulation and development in freehold land in gazette and planned urban areas.

2.3.3 National Spatial Plan 2015-2045

The National Spatial Plan marks a significant milestone in Kenya's development agenda. The plan has the national spatial vision that will guide the long term spatial development of the country for a period of 30

years. It covers the entire territory of Kenya and defines the general trend and direction of spatial development for the country.

It aims at achieving an organized, integrated, balanced and sustainable development in the country and hence it will inform the future use and distribution of activities by providing a framework for better national organization and linkages between different activities within the national space (Ezra, 2010). Additionally, the plan gives a framework for the efficient, productive, and sustainable use of land as advocated for both in the Constitution and the National Land Policy. Further, it provides strategies in facilitating sustainable exploitation of the country's huge potential in agriculture, tourism, energy, water, forestry and fishing. It is expected to reduce regional inequalities that have existed by ensuring that these regions are no longer perceived as low potential but as differently endowed.

III. Methodology

3.1 Research Design

A research design constitutes the blueprint for the collection, measurement and analysis of data (Kothari, 2011). The study adopted a descriptive research design. This is because a descriptive research design provides a detailed examination of a single subject group or phenomena to understand the study area and make conclusions.

3.3 Target Population and study area

The target population in this study consisted of all the households of Gatimu sub-location in Nyandarua County. These included those with relatively large farms and the ones with small farms.
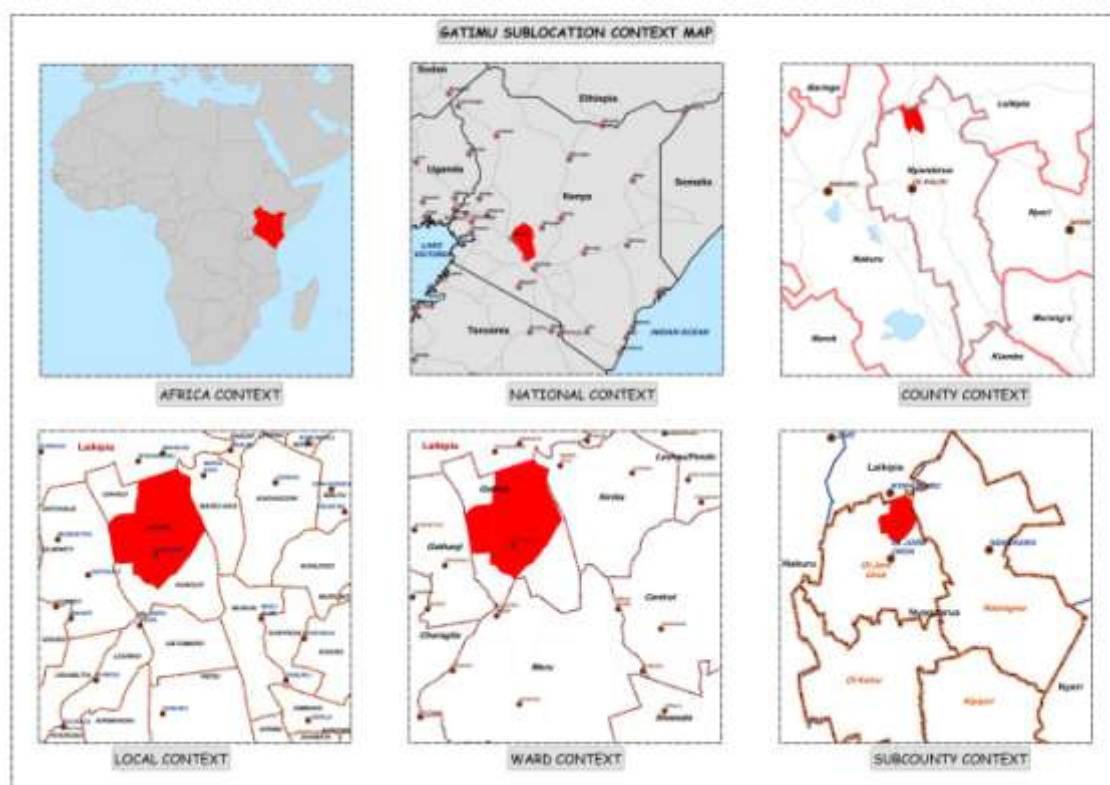
Map 1: Location of Gatimu Sub Location, Nyandarua County, Kenya.

3.4 Sample Size Determination

In determining the sample size, population for the whole sub location was put into account. Gatimu sub location had 13600 people (KNPHS, 2009) and therefore, the formulae by Mugenda et al (2003) for sample size calculation where the population is above 10,000, was used. The sample size was determined at 95% confidence level with a margin error of 5%.

Sample size (n) was calculated based on Mugenda et al (2003 Where:-

$$n = \frac{z^2 \, p \, q}{d^2}$$

Where, n= Desired sample size, Z= standard normal deviate. Usually 1.96 for 95% confidence interval, p = Proportion of target population estimated to have particular characteristics assumed to be 0.9 (90%), q = is

the population without characteristics under investigation, q = 1-p, d = is the margin of error. (5% is used for this case)

Hence, n was found to be 140 households

The households were divided to the villages as shown in Table1.

Table 1: Sample size determination

VILLAGE	NUMBER OF HOUSEHOLDS	NUMBER SAMPLED
Gatimu (Jamuhuri)	361	36
Gatimu (Baraka A)	120	12
Gatimu (Baraka B)	170	17
Gatimu (Kisima)	280	28
Gatimu (Muhindi)	220	22
Gatimu (Turbo)	200	20
Gatimu (Nyairobi)	50	5
TOTAL	1401	140

Stratified sampling and simple random sampling was used in selecting the households to be surveyed.

3.5 Data Analysis Methods and presentation

The study used primary data collection methods which included interviews, questionnaires and observations. Data Analysis is the method of processing data to make meaningful information from it (Sounders, Lewis &Thorn bill, 2009).

In this study, the data was coded and analyzed using SPSS version 24 statistical software. The data was then analyzed using descriptive statistics and inferential statistics. Descriptive statistics included mean, standard deviation, range, frequencies and percentages while inferential statistics include Pearson's bivariate correlation and a t- test which was run to examine the linear relationship among the independent and the dependent variables in the study. The analysed data after analysis was presented in the form of tables and charts. The analysis was done per the research objectives.

IV.   Results And Discussion

4.1 Document analysis on land size

In order understand the trend of land size in Gatimu sub location, registry index maps and an aerial image were analyzed. Majority of the plots were found to be subdivided into smaller portions owing to the increased population among other factors. This is evidenced by the comparison of a similar map at different times as shown:

Map2: An index map of Gatimu Sub-location in 1973

Map3: An index map of Gatimu Sub-location in 2018

Map4: A map showing aerial view of Gatimu sub-location in 2018

Map 2 shows Gatimu sub-location in 1973 where the results show that the land was not greatly subdivided while Map 3 shows Gatimu sub-location map in 2018. Comparing the two, Gatimu sub-location has experienced massive subdivision in the recent past. The aerial view in map 4 again confirms these findings.

4.2 Current household size and its implication on food and livelihood security in Gatimu sub-location
The first objective of the study sought to explain the current household size and its implication on food and livelihood security in Gatimu sub-location

Table 2: Current household size and its implication on food and livelihood security in Gatimu sub-location

Variable	Min	Max	Mean	SD
What is the total owned family land size in acres	0.125	9.500	0.990	1.63
How many pieces of land do you own	0.250	5.00	1.58	1.25
Spatial location and distance (Km)	0.000	2.00	1.08	1.31
For how many months in a year does the current yield from the farm feed your family?	2.000	12.00	8.22	3.18

The results showed total family land size owned, land pieces owned and the spatial location and the distance of the land from the homes of the respondents. The results indicated that 88% of the households owned land where on average the households in Gatimu sub-location who practice dairy farming own an average of

0.990 acres of land and each household owns an average of 2 pieces and the spatial location and distance is 1.08 KM on average and the current yield of the farm feeds the family for 8 months.

4.2.1 Effect of household land size on food and livelihood security in Gatimu sub-location

An independent sample t-test was conducted to examine the effect of household land size on food and livelihood security in Gatimu sub-location by testing whether the household land size had an effect on food and livelihood security. Those who had sufficient food (had food all the 12 months) and those who had scarcity (3 months and below) had their land sizes compared and the results presented in Table 3.

Table 3: Independent t-test

		Levene's Test Equality of Variances		fort-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Size acres	Equal variances inassumed	5.306	.189	2.25	93	.027	.61478	.27328	.07209	1.1574
	Equal variances not assumed			2.07	46.8	.044	.61478	.29713	.01695	1.2126

The results indicated that there was a significant difference in the land sizes of those who were food secure and those who were food insecure, t=2.25, p=0.027. Therefore this validated the findings that household land sizes have an effect in the food and livelihood security.

4.3 Current land uses and their impact on food and livelihood security

The second objective aimed at establishing the current land uses and their impact on food and livelihood security.

Table 4: Current land uses and their impact on food and livelihood security

| Livestock type	Percent	No. of Animals	Average Yield	Units consumed	Units sold	Average income earned (Ksh)
Chicken	31.8%	13.14	115.72 kgs	46.81kgs	72.20kgs	36194.18
Sheep	19.9%	4.15	3.40 sheep	1.80 sheep	2.00 sheep	10000.00
Cows	37.3%	3.76	136.4000	54.76 ltrs	107.59ltrs	8991.67
Rabbit	1.5%	17.67	23.33 rabbits	5.33 rabbits	10.67 rabbits	
Goats	7.5%	3.73	123.00	52.86	-	-
Pigs	2.0%	3.50	1.00	1.00	-	-
Total	100.0%					

The findings indicated that land was used in various ways: dairy farming was one of the key. Cows and goats were kept for milk.Approximately 136.4 and 52.86 litres of cow milk and goat milk respectively were produced. 107.59 litres were sold while the rest were consumed.Other uses of land included poultry farming and cattle keeping.

4.3.1Effect of land uses and their impact on food and livelihood security in Gatimu sub-location

The second objective sought to examine effect of main land uses and their impact on food and livelihood security in Gatimu sub-location. Land in Gatimu sub location was found to be used mainly for farming and human settlement. A cross tabulation and a Chi-square test were used to examine whether food and livelihood security was associated with land use. The results were presented in Table 5.

Table 5: Main use * Food and livelihood Security Cross tabulation

		Food and livelihood Security		Total	Chi-square (p-value)
		Food insecure	Food Secure		
Main use	Dairy Farming	22	30	52	0.752
	Homestead and other farming	23	22	45	(0.386)
Total		45	52	97	
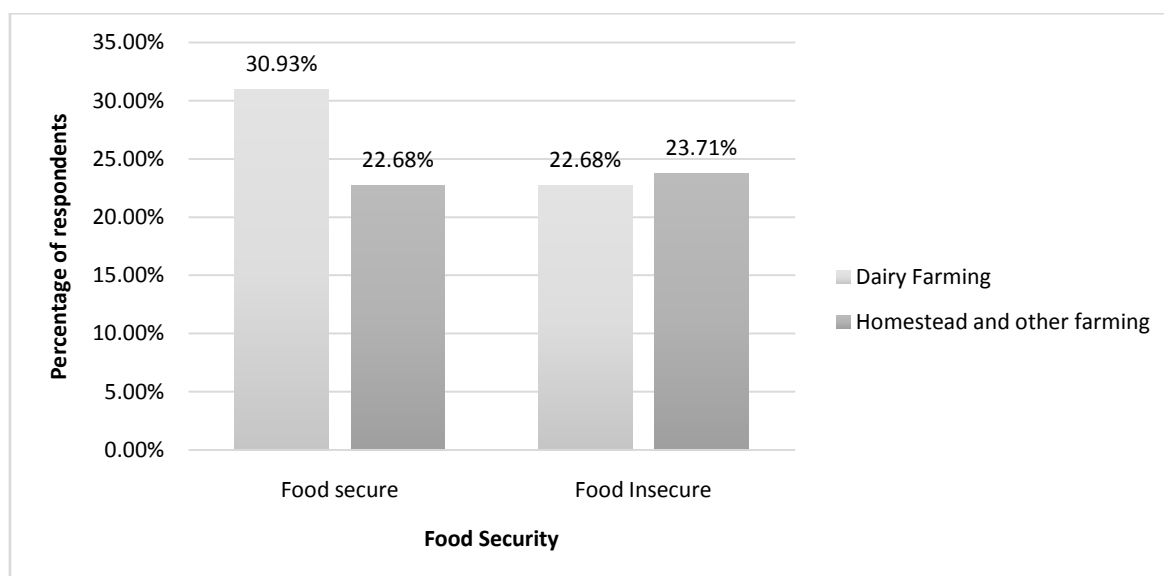
Figure 1: Main Land use and Food security

The findings revealed that those who did dairy farming, majority, 30.93% were food secure unlike those who did other farming and used land for homestead which revealed that majority were food insecure. However, the chi-square results revealed that though there was an effect of the use of land on food security and livelihood security, there was no significant association between main land use and food and livelihood security, chi-square = 0.752, p=0.386.

These residents were found to practice business and other forms of income generating activities other than dairy farming supporting the findings.

4.4 Effect of Demographic factors and land ownership characteristics on the size and use of household land in Gatimu sub-location

The third objective aimed at analyzing factors that influence the size and use of household land. The factors identified were Land Ownership, Total owned family land size, Age of household head and Household size. Pearson's correlation coefficient was applied to investigate the significance, strength and direction of the relationship between Size and use of household land (which is the dependent variable) and Land Ownership, Total owned family land size, Age of household head and Household size, which are the independent variables. Pearson's correlation values range from −1 to 1. -1 indicates a perfect negative relationship, 0 indicates that there is no relationship between the variables while +1 indicates a perfect positive relationship. Again an absolute Pearson's correlation value of 0.5 indicates a strong linear relationship between the variables while a value below 0.5 indicates a weak linear relationship. The sign of the Pearson's correlation coefficient value indicates the direction of the relationship. Finally, the resultant p-value less than 0.05 at 95% confidence level indicates that the linear relationship between variables of interest is statistically significant.

Therefore, a correlation analysis was performed in this study and the findings were presented in Table 6

Table 6: Correlation analysis

		Size and use of household land	Land Ownership	Total owned family land size	Age of household head	Household size
Size and use of household land	r	1				
	p					
	N	116				
Land Ownership	r	.291**	1			
	p	.002				
	N	116	139			
Total owned family land size	r	.833**	.240*	1		
	p	.000	.010			
	N	107	114	114		
Age of household head	r	.224*	.029	.279**	1	
	p	.018	.739	.003		
	N	111	131	109	132	
Household size	r	.250**	.075	.247**	.399**	1
	p	.007	.381	.008	.000	
	N	115	138	113	131	139

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

*. Correlation is significant at the 0.05 level (2-tailed).
r = Pearson's correlation coefficient
p = p-value

According to the results in Table 4.23, there was a significant linear relationship between Land Ownership and Size and use of household land, r = 0.291; p = 0.002. The findings also revealed that there was a very strong significant linear relationship between Total owned family land size and Size and use of household land, r = 0.833; p = < 0.0001. This was indicated by significant p-values less than 0.05 at 95% confidence level. There was a significant linear relationship between Age of household head and Size and use of household land, r = 0.224; p = 0.018 and finally the results showed that there was a significant linear relationship between Household size and Size and use of household land, r = 0.250; p = 0.007.

V.   Summary And Conclusions

From the findings majority of the households own at least 2 pieces of land approximately 0.99 acres and were found to be located 1.08 Km away from the place of residence. Land size was found to be a significant factor for food security.

The main economic activity of the households in Gatimu sub-location was agriculture (crop and livestock farming). Cows and goats were kept for Dairy farming for both commercial and domestic consumption.Main use of a household land has no association with food security.Land Ownership, Total owned family land size and the age of household head were the significant factors of Household size and Size and use of household land in Gatimu sub-location.

5.1 Recommendations

The study made the following recommendations:

i. Traditional land inheritance ought to be reconsidered or abolished as it has been one of the major contributors to the continued land subdivision. Other forms of inheritance to be considered could be education where parents educate their children relevant skills which would earn them a living in a different manner.

ii. The study also recommends a proper land use planning in an effort to utilize the scarce land resource.

iii. Owing to the above then, a model of settlement similar to Howard's garden city approach pioneeredhas been proposed for this sub location. The area is spatially located near the Municipality of Nyahururu with 58% of the people being in business, an aspect that supplements the agricultural potential of the area. This qualifies the proposed model of planning where people will conduct their affairs together with nature. This approach will have residential areas, green belts, industrial parks combined with agricultural areas that will act as magnets to the proposed design.This will assist in addressing the urban problems witnessed in the agricultural hinterland. It will also curb land subdivision besides being a response to enhanced quality of life thereby safeguarding the environment.

The proposed design is illustrated below.
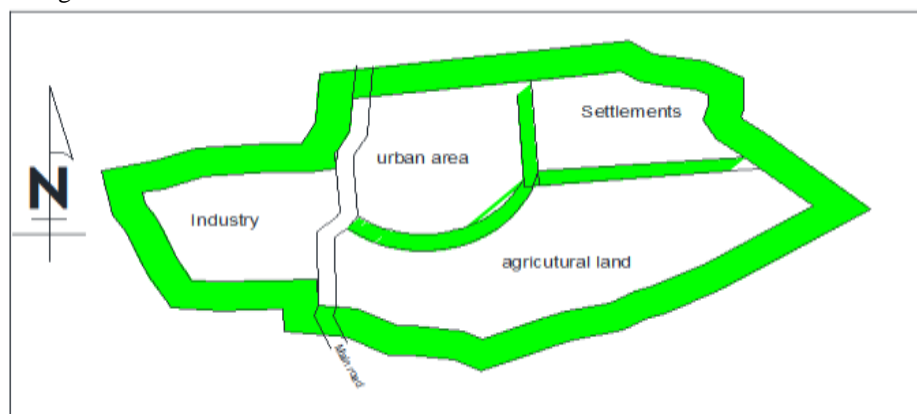
Map 5: Proposed design of Gatimu sub-location

5.2 Areas of further research

The study identified Land Ownership, Total owned family land size, Age of household head and the Household size as significant factors affecting the Size and use of household land, however, this is not exhaustive and therefore a further study is encouraged to identify more factors that affect the use and land sizes as well as more impact and strategies to control the negative impact.

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