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IMPLICATIONS OF AGRICULTURAL LAND SUBDIVISION ON PRODUCTIVITY: A Case Study of Kajiado County, Kenya

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ABSTRACT
Agricultural land in Kenya, including ASALs is being subdivided into small sizes (sometimes below 1ha) despite the enormous importance it has on economic development. This phenomenon has raised concerns among land administrators and managers, policy makers and general public that such transformations may impact negatively on the productivity of the agricultural land. There was need therefore to understand the implications of this phenomenon on agricultural productivity especially in the dry agricultural lands which support extensive livestock production systems. Besides, the relationship between agricultural land sizes and productivity is not universal. Therefore, this paper investigates the impact of agricultural land subdivision on the productivity in the dry agricultural lands of Kajiado County, Kenya. The paper used a mixture of primary and secondary research methods. Primary data was mainly obtained from 203 agricultural landowners in the study area. The correlation and beta coefficients show that there is a weak and negative relationship between agricultural land size and productivity of sheep/goat, cattle and maize in the study area. The paper recommends a mix of policy interventions to manage agricultural land subdivisions: Agricultural landowners should be encouraged to adopt intensive land use practices such as zero grazing, use of more variable inputs, high value crops and irrigation. Mixed crop farming, as opposed to extensive pastoralism systems, and off-farm economic activities should also be encouraged. Agricultural landowners in the dry lands should be sensitized on the alternative and viable modern agricultural practices to discard unsustainable extensive practices such as semi-nomadism and overstocking of livestock. These strategies would avoid negative change in agricultural production (tragedy of spatial anticommons) as the land sizes decrease over the years.

Key Words*: Subdivision of Agricultural Land, Impact, Drylands*

INTRODUCTION

Efficient, optimal and sustainable agricultural production, including extensive pastoralism systems, requires large contiguous land to enable economies of scale and synergy (Robson, 2012). These requirements may be absent when the agricultural land is privately owned in small sizes and fragmented by idle lands or non-agricultural land uses. Therefore, subdivision and fragmentation of agricultural land may lead to increased agricultural production costs and negative change in agricultural productivity resulting to a tragedy of spatial anticommons (Government of Kenya [GoK], 2009; 2016b; Heller, 1998; Henry *et al.*, 2012; Lee, 1999; Robson, 2012; Syagga & Kimuyu, 2016). In Kajiado County, for instance, Syagga & Kimuyu (2016) established that the minimum agricultural land size should be approximately 6.39Ha. This minimum agricultural land size is required for maize (Kenya's staple crop) production to support an average sized household in the County.

Thus, subdivisions of agricultural land in Kajiado County below the above minimum benchmark may transform the agricultural land into unproductive asset. Besides, such agricultural land subdivisions may occur in remote areas without basic services to support alternative land uses such as residential user. Essentially, such agricultural land subdivisions may be untimely and may not benefit either the agricultural landowner or the community at large. The subdivisions of agricultural land into small units, sometimes below economic sizes may eventually occasion conversions of agricultural land use into other users thus reducing agricultural land base (Museleku, 2013).

There may be no consensus on what should be the minimum/economical size of agricultural land but it is globally acknowledged that small agricultural land sizes may have negative impact on agricultural productivity. This is evidenced by attempts by various countries in the world, Kenya included, to regulate on minimum agricultural land sizes (Syagga & Kimuyu, 2016). Generally, however, minimum floor ceiling on agricultural land has been pegged at 1ha or more depending on various factors like whether the agricultural land is irrigated or arable, type of crop planted, scale of operation, among other factors.

The general concern raised by the government and scholars in respect of agricultural land subdivisions into small private units is that such subdivisions may have a negative impact on productivity thus affecting food security and socioeconomic well-being of the rural communities. Such land development issues have been noted to signify a country's lack of effective development control management strategies (Porter, 1997 cited in Pallagst, 2007). There is need therefore to determine the implications of agricultural land subdivision on productivity since previous research has shown that there is no universal relationship between size of agricultural land and productivity Rudra (1978 cited in Chand et al., 2011).

THEORY

As Lee (1999) noted, drawing of lines on a map (subdivision process) does not in itself lead to impacts per se. It is what happens after the subdivision process that causes impacts (Shaw, 1995; Upton, 1995 in Lee, 1999). After the subdivision process, for instance, the new agricultural landowners may fence off their small subplots thus physically and legally excluding other users (community) from utilizing the land. The impact of fencing off small agricultural subplots may be important in a community which depends on livestock pastoralism as this may hinder movement of livestock and limit access to pasture lands. The effect of fencing off small agricultural subplots is expected to be the same ecologically, as wild animals may be affected in the same way.

Therefore, the rural communities are denied physical access to utilize the agricultural land when the small agricultural subplots are fenced off. Besides, the agricultural subplots may be situated in a remote area without basic infrastructure services to support alternative land uses. Thus, when the small private agricultural land parcels are fenced off and are not utilized by the various many landowners such an agricultural land may be fragmented and the size may be too small to warranty efficient agricultural production thus such a land may be underutilized and may lead to the tragedy of the spatial anticommons (Heller, 1998). The land may not benefit the many exclusive owners nor does it benefit the community as whole. In addition, the land may produce less and less and transaction costs may be higher.

The impacts of subdivision of agricultural land into small units may become more pronounced when the resultant agricultural subplots are eventually developed with urban housing. The impacts, Henry *et al*. (2012) noted, arise due to clash of rural and urban lifestyles. Rural lifestyles are mainly agriculture based with main agricultural activities being crop, livestock and forestry production. These activities may be a nuisance to the urban dwellers who buy land and develop housing in the rural areas seeking tranquillity away from bustle and hustle of urban areas (Lee, 1999). The nuisance is usually in form of noise, bad odour, dirt, dust and traffic caused by livestock while crossing or grazing along the roads. Consequently, to a new rural dweller that came as a result of the subdivision of agricultural land may perceive that he/she is negatively impacted by the subdivision process. Momsen (1984 in Lee, 1999) has observed that such experiences may lead to social conflicts.

The focus of this study, however, is not on the urban dwellers in rural areas rather it is on the rural communities. It is assumed that the urban dweller that chooses to live in the surrounding rural areas he/she is satisfied with the impacts of the subdivision process. In any case, such a person has benefited from the process.

In view of the above discussion, the perception on whether impacts are positive or negative, Chazan & Cotter (2001) observed will vary from one stakeholder to another. The potential impacts of agricultural land subdivision are usually broadly categorised as environmental, economic and societal. However, the scope of this study is mainly limited to the economic impacts since the study has taken a land economics perspective. Besides, the main national and global concern of agricultural land subdivisions is in regard to their impact on the agricultural productivity, which is an economic function.

Implications of Agricultural Land Subdivision on Productivity

Loss of agricultural land and farmlands through subdivision of agricultural land into small units may affect the farmers by reducing agricultural production thus affecting their income from agricultural activities (Henry *et al*., 2012; Kelleher, *et al*., 1998). Studies have shown, however, this is not always the case. Previous research has shown that subdivision of agricultural land may not necessarily lead to reduced agricultural production.

Indeed, several studies in New Zealand have shown that subdivision of agricultural land may lead to increased agricultural production through intensification of agricultural production and alternative high value agricultural land uses such as horticulture (Lawn *et al*., 1979; Peacocke, 1997; Mears, 1974; Meister &Knighton, 1984, cited in Lee, 1999; Kelleher, *et al.*, 1998; Mearns, 1999). The production has been noted to increase due to agricultural land subdivision if the resultant agricultural subplots are considered together. When the subplots are, however, considered individually the agricultural production has been observed to reduce significantly and the agricultural land being used less productively (O'Connel, 1986; Veltman, 1994 in Lee, 1999).

Several studies have been carried out in India, from 1960s up to date, on the relationship between farm size and agricultural productivity. Interestingly, many previous studies have found an inverse relationship between the size of agricultural land and agricultural productivity, whereby as the size of farms decrease, the agricultural productivity increases (Sen, 1962; 1964; Mazumdar, 1965; Khusro, 1968; Hanumantha, 1966; Saini, 1971; Bardhan, 1973; Berry, 1972 in Chand *et al*., 2011). Similarly, Sial *et al*. (2012), using econometric analysis, determined that farm size and agricultural productivity are inversely related. Other studies, however, have found a positive correlation between farm size and agricultural productivity in India (Bhalla & Roy, 1988; Chadha, 1978; Ghose, 1979 in Chand *et al*., 2011). Chand *et al*. (2011) established that indeed inverse relationship between farm size and agricultural productivity exists in India but found out that per capita output is lower compared to large farms due to lower per capita availability of land. Low per capita agricultural productivity may translate to lower per capita income which cannot sustain livelihoods. The findings have differed depending on the variables used in the regression analysis.

These previous findings suggest that subdivision of agricultural land into small sizes may actually lead to a tragedy of the anticommons (reduced agricultural productivity) on one hand. On the other hand, this relationship is not universal hence anticommons properties are not necessarily tragic, depending on the measures adopted by the private exclusive landowners to avert tragedy (Heller, 1998). Use of technology/mechanization, use of fertilizer, irrigation, high-yielding varieties and other agricultural inputs are likely to increase agricultural output in smallholdings thus increasing productivity per hectare. As Rudra (1978 in Chand *et al*., 2011) postulated, there is no a universal relationship between farm size and agricultural productivity. The previous studies, however, have focused more on the prime crop lands and not on the dry agricultural lands, the focus of this study.

Concerns about subdivision of agricultural land into small units in Kenya and world over have been about effects of such subdivisions on the agricultural productivity (GoK, 2016; 2010; 2012; 2009; Chand *et. al*., 2011). It is generally assumed that subdivisions of agricultural land into small sizes automatically leads to reduced agricultural productivity and thus may impact negatively on food security. Previous studies, however, have shown that this general assumption may not always hold. In other words, anticommons property are not necessarily tragic, as Heller (1998) suggested.

To ensure agricultural economies of scale, agricultural land needs to be used as one large contiguous unit (Robison, 2012). This is likely to reduce agricultural production costs and encourage higher production. Besides, in an area where crop production is practiced, large agricultural land will make mechanization possible and this may lead to increased productivity and commercialization of agriculture. Similarly, extensive livestock production systems like pastoralism require even bigger agricultural land for pasture purposes. The impact of agricultural land subdivision (ALS) on extensive livestock production systems may be more severe if the resultant small private agricultural subplots are fenced off and the farmers rely on natural vegetation for pasture.

According to FAO (2006), dry agricultural lands in Kenya should produce approximately 6.7 bags of 90kg/ha or 603kg/ha in Agro Climatic Zone (ACZ) V and 2.2 bags of 90kg/ha or 198kg/ha in ACZs VI-VII. On livestock production, average carrying capacity in Kenyan dry agricultural lands ranges between 0.5-1 cow/ha (Syagga, 1994; Syagga & Kimuyu, 2016). Thus, if subdivisions of agricultural dry lands are found to have reduced agricultural productivity below these benchmarks, then evidence of a tragedy of the spatial anticommons could be present.

Randall *et al*. (2005) studied the impacts of subdivision of group ranches in Kajiado District on quantity of wild animals and livestock, from an ecological perspective. Their study found out that the quantity of livestock was declining due to subdivision of group ranches in the district. The subdivision of agricultural land, however, did not stop with subdivision of group ranches' land in Kajiado County. Individual private landowners have continued to subdivide their agricultural land, sometimes below 0.05ha subplots. Indeed, it is on the private land where most of the subdivisions are now taking place, yet extensive livestock production systems (mainly pastoralism) which require large contiguous agricultural land to sustain is still practiced. There is need therefore to determine the implications of such subdivisions, which reduce agricultural land sizes, on productivity.

After subdivision into small sizes, agricultural land, perhaps the most important factor in agricultural production may become more expensive and inaccessible by the farmers due to competition from urban land uses. Elsewhere, the price of agricultural land has been noted to rise beyond the reach of the rural farmers after subdivision process (Blackie, 1996; Edwards, 1992; Meister & Stewart, 1980 in Lee, 1999). Thus, farmers who may want to increase their agricultural production by acquiring more agricultural land may find it difficult and almost impossible to do so due to high prices charged on the resultant small agricultural subplots. This may become one of the frustrations that farmers face and eventually decide to exit the agricultural production, through subdivision and/or disposal of the agricultural land to property developers.

RESEARCH METHODOLOGY

Research Design

Cross-sectional survey and case study designs were utilized in this study. Babbie (1994) postulates that survey design is probably the best method available for studying social phenomena because it allows researchers to collect original data for describing a population too large to observe directly. Subdivision of agricultural land into small sizes is a social phenomenon and a survey approach is appropriate. The choice of the study designs is influenced by the nature of the data and the essence of meeting the study objectives in a cost efficient manner.

Target population, sample size and sampling techniques

The total target population in this study included all agricultural land parcels and their respective owners in the study area who were accessible at the period of the study. Other respondents included Kajiado County land administration and management officials (County physical planners and surveyors; District physical planners and surveyors; County Land Management Board and Land Control Board).

To estimate the population of the agricultural land parcels and their owners in the study area, the study used the number of households in the study area according to the latest Kenya's national housing and population census statistics of 2009. The total number of agricultural land parcels and their owners is estimated to be approximately 5,000, which is less than 10,000 cases. According to Mugenda & Mugenda (1999) when the population is more than 10,000 a sample size of 384 is adequate. When the population is less than 10,000 cases, however, the following formula should be used to estimate sample size.

Box 1: Sample size for agricultural landowners and land parcels

nf = n/1+n/N Where:

nf = desired sample size when the population is less than 10,000

n = desired sample size when the population is more than 10,000

N = estimate of the population size.

Using the above formula sample size is calculated as follows:

Nf = 384/1+384/5,000 = 356.6 = 357 Agricultural land parcels & owners

Source: Adapted from Mugenda & Mugenda, 1999

The study used simple random sampling technique to access the targeted agricultural land parcels and landowners living in their land in the study area at the time of the field survey. This sampling technique was used to survey a total of 39 villages in the study area. Out of the 357 targeted agricultural land parcels and owners, 203 were accessible, resulting to a response rate of approximately 57 per cent which was adequate for analysis purposes (Mugenda & Mugenda, 1999).

Data collection tools

In this study, collection of data was done using both qualitative and quantitative methods to collect information on agricultural land subdivision. The data sought was mainly primary and secondary data. Primary data was sourced from the survey respondents while secondary data was sourced from libraries, internet and public/government offices, mainly from Kajiado County government and local land control board. The tools that were used for data collection are as follows.

Structured observation method

Non-participant direct observation of documents and the land parcels in the study area was done in a structured manner and data recorded in the process of observations using photography and note book. The unit of observation was the existing agricultural land sizes and their proximity to services, among other physical factors that may influence demand for agricultural land or the rate of subdivisions. Structured observation method is advisable since it eliminates bias and relates to current information which is not complicated by past events or future aspirations. Besides, they are not dependent with respondent's willingness to participate in a study, unlike in questionnaire method (Kothari, 2004). Consequently, structured observation was used to gather data relevant to the study objectives.

Semi-structured personal interviews

Interview method involves presentation of oral questions and responses given in the same way by the respondents. Structured interviews are more economical, easier to analyze for generalization purposes and ensures high response rate. In addition, they allow the interviewee to clarify questions hence the researcher is able to gather more data than is possible using observation method (Alreck & Settle, 1995; Babbie, 1994; Kumar 2005; Kothari, 2004; Nachmias & Nachmias, 200). Thus structured interviews were conducted with the key study informants who include the county and district land officials (planners and surveyors), chairman of land control board and county land management board.

Semi-structured self-administered questionnaires/Schedules

Questionnaire is a proforma with a set of well sequenced questions relevant to the study objectives. Schedules/self-administered questionnaires are more appropriate where the respondents are not well educated than use of questionnaires (Kothari, 2004). Schedules are faster and ensure that data collected is complete without omissions/unanswered questions. They also enable high response rates and enables combination of different methods and personal contact possible (Babbie, 1994; Kumar, 2005). This study used schedules due to the above reasons to collect data from the agricultural landowners.

Data Analysis and Presentation

The implication of land subdivisions on agricultural production was mainly carried out by use of correlation analysis and multiple regression analysis. Correlation is used to determine the direction (positive or negative) and the strength (none, weak, moderate and strong) of linear association/relationship between variables (Kingoriah, 2004). Correlation and regression analysis were performed using Statistical Package for Social Sciences (SPSS) software. Specifically, Pearson correlation (2-tailed) was performed to show how the agricultural productivity (dependent variable) is related to the factors influencing it (independent variables). This was necessary to demonstrate how the dependent and independent variables explain each other.

Multiple regression analysis (MRA) was performed, by use of ENTER method of SPSS, on the data to measure the marginal and relative contribution of the independent variables to the agricultural productivity and land size. This was necessary to check the marginal and relative contribution of land size on the agricultural productivity of sheep/goat, cattle and maize and thus determine the implication of agricultural land subdivision on productivity.

RESULTS

In general economics, the main factors of production include; land, labour, capital and management/entrepreneurship. The factors that are likely to influence agricultural productivity in the study area are thus considered to be; land (agricultural land size, land fertility, price/value of land & amount of rainfall), labour and management/entrepreneurship (number of adult family members, level of education and age of the landowner) and capital (off-farm income and farm income of the landowner). Amount of natural rainfall influencing the agricultural production and productivity is a time series data thus is constant for all the output levels, which is cross-sectional data. Consequently, the amount of rainfall factor was dropped in the subsequent data analysis. Subdivision, which is measured by sizes of agricultural land, is therefore one of the factors influencing agricultural productivity. There was therefore need to perform correlation analysis between the remaining factors and the agricultural productivity of sheep/goat, cattle and maize (the main agricultural activities in the study area) to determine the relationship among these variables. The key objective of this exercise was to determine the relationship of subdivision (measured by sizes of agricultural land) and productivity.

Descriptive statistics was performed on the data to summarize the variables influencing agricultural productivity to enhance understanding and further analysis. Murphy (as cited in Kieti, 2015) suggests that descriptive statistics should be performed on data before correlation and regression analysis to check for completeness of data sets and whether data obeys normal distribution curve. Data sets that obeys normal distribution curve should have small value of standard deviation, value of mean and median should be equal or almost equal, value of skewness should be <1 or 0 and value of kurtosis should be ≤ 3 or 0 (Kingoriah, 2004; Murphy, as cited in Kieti, 2015).

Table 1: Summary of descriptive statistics on dependent and independent variables

Variable	**Mean**	**Median**	**Standard deviation**	**Skewness**	**Kurtosis**
Sheep/Goat productivity	3.654	2.965	1.362	.907	-.065
Cattle productivity	2.113	1.656	.735	1.258	1.227
Maize productivity	12.315	12.355	3.186	-.046	-1.657
Land size	34.255	20.235	42.970	2.761	9.635
Land fertility	1.840	2.000	.371	-1.827	1.350
Price/value of land	11.076	11.120	2.226	.433	-.486
Farm income	7.770	9.000	3.546	-.664	-.950
Off-farm income	5.61	5.000	3.719	.220	-1.345
Level of education	4.250	4.000	1.622	-.524	-.933
No. of adult family members	4.520	5.000	1.841	.234	.031
Age of landowner	2.700	3.000	1.115	.207	-.826

Source: Field Survey, 2016/2017

Thus, descriptive statistics performed on the data for this purposes included mean, median, standard deviation, skewness and kurtosis. Mean and median are averages whereby to obtain the mean one needs to add up all the values and divide the result with the number of the values while median is the middle number when the values are arranged from the smallest to the largest. Standard deviation, skewness and kurtosis all measure the amount of variation or dispersion from the mean value of a data sets thus they should be small to indicate that the data is normally distributed (close to the mean) and that there are no outliers (Kingoriah, 2004). The descriptive statistics was performed using SPSS software.

The results of descriptive statistics are shown in table 1 above which indicates that the data sets were normally distributed save for the land size variable whose mean (34.255ha) and median (20.235ha) are rather distant and has a big standard deviation of 42.970 and a kurtosis value of 9.635. This variation could be explained by the fact that land ownership in Kenya is usually skewed with a few individuals/families owning large tracts of land while others own small sizes or nothing at all. Land size variable, however, is not a dependent variable in agricultural productivity models.

At 95% confidence level (α = 0.05 significance level), correlation between two variables whose p-value is less than or equal to α (0.05) would be statistically significantly correlated to each other, and vice versa.

Table 2: Results of correlation analysis

Independent variables	**Agricultural productivity (dependent variable)**					
	Sheep/Goat		**Cattle**		**Maize**	
	(r)	**(p)**	**(r)**	**(p)**	**(r)**	**(p)**
Land size	**-.216**	**.002****	**-.195**	**.005****	**-.028**	**.002****
Land fertility	-.038	.596	.040	.574	.008	.909
Value of land	-.066	.349	**.156**	**.027***	-.120	.091
No. of adult family members	**.465**	**.008****	**.591**	**.000***	**.232**	**.001****
Level of education of landowner	.031	.661	.046	.518	.085	.230
Age of landowner	-.075	.288	-.130	.066	.026	.713
Off-farm income	-.030	.673	.055	.435	.030	.669
Farm income	.116	.100	.087	.218	**.231**	**.001****

Source: Field Survey, 2016/2017

****** *Means that the correlation is significant* ***[P ≤ 0.05 or alpha*** *(α)****]***

The results of the correlation coefficients are shown in table 2 above which indicates that only agricultural land size and number of adult family members are significantly correlated with the agricultural productivity of sheep/goat, cattle and maize. Agricultural land size has a significant weak negative correlation with sheep/goat productivity (r = - .216, p = .002), cattle productivity (r = - .195, p = .005) and maize productivity (r = - .028, p = .002). This means that as agricultural land size decreases, the agricultural productivity of sheep/goat, cattle and maize increases but marginally, and vice versa. Correlation analysis has also revealed the magnitude of the relationship to be weak.

The number of adult family members, however, has a moderate positive correlation with sheep/goat productivity (r = .465, p = .008) and cattle productivity (r = .591, p = .000). In addition, there is a weak positive correlation between the number of adult family members and maize productivity (r = .232, p = .001). Therefore, the more the number of adult family members, the more the agricultural productivity of sheep/goat and cattle. The association between these variables is moderate and positive while the relationship between agricultural land size and maize productivity is positive and weak.

The relationship between the value of land and cattle productivity is positive and very weak (r = .156, p = .027) while the correlation between farm income and maize productivity is positive and weak (r = .231, p = .001). These variables are, however, significantly correlated to each other as indicated by their p-values, which are less than our significance level or α of 0.05 at 95% confidence level. The other remaining independent variables are insignificantly correlated to agricultural productivity as shown in table 1 above since their p-values are greater than α at 0.05.

Subdivision of agricultural land, which results to decrease in agricultural land size, is thus generally weakly and negatively correlated to agricultural productivity in the study area and does not affect negatively agricultural productivity of sheep/goat, cattle and maize in the study area.

Table 3: Multicollinearity diagnosis on independent variables using correlation coefficients

Independent Variables	**Correlation coefficients between variables (r)**							
	Land size	Land fertility	Value of land	No. of adult members	Level of education landowner	Age of landowner	Off-farm income	Farm income
Land size	.000	.076	.307*	.049	.287*	.249*	-.032	.221*
Land fertility	.076	.000	.036	-.080	.011	-.109	-.148*	-.002
Value of land	.307*	.036	.000	.059	-.259*	.039	.298*	.040
No. of adult family members	.049	-.080	.059	.000	.073	-.001	.001	.259*
Level of education of landowner	.287*	.011	-.259*	.073	.000	.303*	.377*	.088
Age of landowner	.249*	-.109	.039	-.001	.303*	.000	.377*	.191*
Off-farm income	-.032	-.148*	.298*	.001	.377*	.377*	.000	-.053
Farm income	.221*	-.002	.040	.259*	.088	.191*	-.053	.000

** Indicates that the correlation is significant between the variables (p ≤ 0.05).*

Source: Field Survey, 2016/2017

Table 3 above shows that the data sets is no affected by multicollinearity thus the MRA results are reliable. The results of MRA are shown in tables 4 to 12, below.

<u>Model 1: Sheep/Goats productivity (Dependent Variable)</u>

Table 4: Sheep/Goat productivity MRA results (Model Summary)

					Change Statistics				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**R Square Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
1	.705	.497	.476	.985834	.497	23.745	8	192	.000

Source: Field survey, 2016/2017

Table 5: Sheep/Goat productivity: Analysis of Variance (ANOVA)

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	184.614	8	23.077	23.745	.000
	Residual	186.599	192	.972		
	Total	371.213	200			

Source: Field survey, 2016/2017

Table 6: Sheep/Goat productivity MRA results (Model Coefficients)

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	-.398	.532		-.748	.455
	Land size	-.003	.001	-.272	-4.684	.000
	Land fertility	-.030	.193	-.008	-.154	.878
	Land value	-2.349E-8	.000	-.038	-.665	.507
	No. of adult family members	.493	.040	.666	12.404	.000
	Level of education	.046	.051	.054	.890	.374
	Age of landowner	-.028	.069	-.023	-.403	.687
	Off farm income	-.003	.021	-.008	-.139	.889
	Farm income	.000	.021	.001	.022	.982

Source: Field survey, 2016/2017

In the sheep/goat productivity model (see tables 4 to 6 above), agricultural land size is negatively associated with the productivity of sheep/goat (B = - .003). This means that a unit change in size of agricultural land (by one hectare) would lead to 0.3% negative change in sheep/goat productivity. In addition, the t-value associated with land size is t = - 4.684. Therefore, it can be concluded that subdivision of agricultural land (agricultural land size) does not affect productivity of sheep/goat in a negative manner in the study area, the two are negatively associated.

Model 2: Cattle productivity (Dependent Variable)

Table 7: Cattle productivity MRA results (Model Summary)

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**				
					R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**
2	.649	.421	.396	.571107	.421	17.422	8	192	.000

Source: Field survey, 2016/2017

Table 8: Cattle productivity: Analysis of Variance (ANOVA)

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
2	Regression	45.459	8	5.682	17.422	.000
	Residual	62.623	192	.326		
	Total	108.082	200			

Source: Field survey, 2016/2017

Table 9: Cattle productivity MRA results (Model Coefficients)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	-.137	.308		-.446	.656
	Land size	-.001	.000	-.165	-2.656	.009
	Land fertility	.101	.112	.051	.907	.366
	Land value	2.959E-8	.000	.090	1.446	.150
	No. of adult family members	.242	.023	.605	10.492	.000
	Level of education	-.014	.030	-.031	-.479	.633
	Age of landowner	-.048	.040	-.073	-1.189	.236
	Off farm income	-.018	.012	-.092	-1.476	.142
	Farm income	-.004	.012	-.018	-.301	.764

Source: Field survey, 2016/2017

In the cattle productivity model (see tables 7 to 9 above), agricultural land size is negatively associated with the productivity of cattle (B = - .001). This means that a unit change in size of agricultural land (by one hectare) would lead to 0.1% negative change in cattle productivity. In addition, the t-value associated with land size is t = - 2.656. Therefore, it can be concluded that subdivision of agricultural land (agricultural land size) does not affect productivity of cattle in a negative manner in the study area since the two are negatively related.

Model 3: Maize productivity

Table 10: Maize productivity MRA results (Model Summary)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
3	.503	.253	.222	3.692871	.253	8.121	8	192	.000

Source: Field survey, 2016/2017

Table 11: Maize productivity: Analysis of Variance (ANOVA)

Model		Sum of Squares	df	Mean Square	F	Sig.
3	Regression	886.009	8	110.751	8.121	.000
	Residual	2618.360	192	13.637		
	Total	3504.369	200			

Source: Field survey, 2016/2017

Table 12: Maize productivity MRA results (Model Coefficients)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
3	(Constant)	.699	2.000		.349	.727
	Land size *	1.247	.204	.403	6.118	.000
	Land fertility	.160	.722	.014	.221	.825
	Land value	3.012E-7	.000	.160	2.354	.020
	No. of adult family members	.418	.149	.184	2.810	.005
	Level of education	-.223	.189	-.086	-1.181	.239

	Age of landowner	-.016	.257	-.004	-.064	.949
	Off farm income	-.109	.080	-.097	-1.355	.177
	Farm income	.115	.080	.097	1.429	.155

***** *The land size used here is land under maize crop which is usually less than the total land owned by an individual entity (usually a portion of the total land).*

Source: Field survey, 2016/2017

In the maize productivity model (see tables 10 to 12 above), agricultural land size is positively associated with the productivity of maize (B = 1.247). This means that a unit change in size of crop land (by one hectare) would lead to 124.7% positive change in maize productivity. In addition, the t-value associated with crop land size is t = 6.118. This association is only applicable only if the land size under crop is considered in the model. If the total agricultural land size is taken into account, however, the association was found to be negative (B = -.001, t = -.414). Therefore, it can be concluded that subdivision of agricultural land (crop land size) does affect productivity of maize in a positive manner in the study area since the two are positively related. Taking the total land size into account, however, leads to an insignificant negative change (- 0.1%) in maize production.

DISCUSSION

A correlation analysis between agricultural land size and productivity of sheep/goats, cattle and maize using Pearson correlation (2-tailed) resulted to negative and weak significant correlation coefficients of; r = - .216, p = 0.002; r = - .195, p = 0.005 and r = -.028, p = 0.002, respectively. The weak inverse association has further been confirmed by the multiple regression coefficients whereby the relationship between sheep/goat and cattle productivity has been determined to be B = - .003, p = 0.000 and B = - .001, p = .009, respectively. The B coefficients associated with maize productivity, and taking only crop land size into account, was found to be 1.247, p = .000. When the total agricultural land size was considered in the MRA model, however, the B coefficient was found to be - .001, p = .679, signifying a negative and weak correlation between the two variables. The above correlation and beta coefficients prove that there is a weak and negative relationship between agricultural land size and agricultural productivity of sheep/goat, cattle and maize in the study area.

Subdivision of agricultural land, which results to decrease in agricultural land sizes, is thus generally weak and negatively correlated to agricultural productivity in the study area and does not affect negatively agricultural productivity of sheep/goat, cattle and maize in the study area. This observation could be explained by various land use practices that were noted in the study area; intensive agricultural land use, semi-nomadism, off-farm economic activities and informal regulation of agricultural land subdivisions. These land use practices could have enabled the agricultural landowners in the study area to produce more output relative to their agricultural land sizes.

The above finding on the inverse implication of agricultural land subdivision (land size) on the agricultural productivity is similar to several previous studies carried out in New Zealand which have shown that subdivision of agricultural land may lead to a positive change in agricultural productivity. In New Zealand, previous studies have shown that intensification of agricultural production and alternative high value agricultural land uses such as horticulture have led to increased agricultural productivity in arable land (Lawn *et al*., Peacocke, Mears, Meister & Knighton, as cited in Lee, 1999; Kelleher, *et al*., 1998; Mearns, 1999). It appears the same results are replicable even in dry agricultural lands.

Similarly, many previous studies in India have also found an inverse relationship between the size of agricultural land and agricultural productivity, whereby as the size of farms decrease, the agricultural productivity increases (Sen, Mazumdar, Khusro, Hanumantha, Saini, Bardhan, Berry, as cited in Chand *et al*., 2011; Sial *et al*., 2012). The previous studies have however been carried out in arable agricultural land and not in dry agricultural land, which was the focus of this study. The results however appear to be similar.

The findings of this study regarding the impact of agricultural land subdivision on the agricultural productivity nevertheless contradicts other studies that have found a positive correlation between farm size and agricultural productivity in India (Bhalla & Roy, Chadha, Ghose, as cited in Chand *et al.,* 2011).
The findings of this study thus confirm that there is no a universal relationship between agricultural land size and agricultural productivity as Rudra (as cited in Chand *et al*., 2011 postulated. Besides, the statement holds true in both arable and dry agricultural lands. The findings also confirm that anticommons properties are not necessarily tragic in the short run. In the long run however anticommons properties are likely to become tragic hence the need to put in place formal land administration and management policy interventions before tragedy strikes.

CONCLUSIONS AND RECOMMENDATIONS

The above correlation and beta coefficients prove that there is a weak and negative relationship between agricultural land size and agricultural productivity of sheep/goat, cattle and maize in the study area. The findings of this study thus confirm that there is no a universal relationship between agricultural land size and agricultural productivity. Besides, the statement holds true in both arable and dry agricultural lands. The findings also confirm that anticommons properties are not necessarily tragic in the short or even medium term. In the long run however anticommons properties are likely to become tragic hence the need to put in place formal land administration and management policy interventions before tragedy strikes.

Agricultural landowners should be encouraged to adopt intensive land use practices such as zero grazing, use of more variable inputs, high value crops and irrigation. These practices would ensure increased agricultural production and productivity. Mixed crop farming, as opposed to extensive pastoralism systems, and off-farm economic activities should also be encouraged. Agricultural landowners in the dry lands should be sensitized on the alternative and viable modern agricultural practices to discard unsustainable extensive practices such as semi-nomadism and overstocking of livestock. These strategies would avoid negative change in agricultural production (tragedy of spatial anticommons) as the land sizes decrease over the years.

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