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RESEARCH ARTICLE

A COMPARATIVE ANALYSIS OF RURAL HOUSEHOLD FOOD SECURITY IN THE HIGH RAINFALL ZONE OF MURANG'A, SEMI – ARID LANDS OF KITUI AND ARID LANDS OF ISIOLO IN KENYA

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ABSTRACT

Food security is a major global concern. It has insidious effects on the health and development of young children and consequently, adults. The paper assesses the food security status and its key determinants for the rural households of the high rainfall zone (HRZ) of Murang'a, semi–arid lands (SALs) of Kitui and arid lands (ALs) of Isiolo in Kenya. A three stage sampling technique was used for respondents (384) selection. Data collected were: demographics, livelihood strategies, food security and livelihood assets. Descriptive and Inferential Statistical methods and descriptive Content Analysis were used. Inferential statistics analytical methods were: ANOVA, PMC, T-test and regression. Overall food insecurity was 48%, but this varied across the agro–ecological zones, with the most affected being the SALs of Kitui at 81% to ALs of Isiolo at 75%. The most food secure was the HRZ of Murang'a at 77%. Food security was significantly different [F (2, 381) = 41.01, P<0.05] across the agro–ecological zones. Livelihood assets accounted for 37.2% (R^2=0.372) of the variability in household food security in the study areas. Specifically, livelihood assets accounted for 28.9%, 37.6% and 42.5% of the variation in household food security in the ALs of Isiolo, SALs of Kitui and HRZ of Murang'a respectively. The overall main determinants for household food security were: natural [t(384)= 9.364, p=.000], physical [t(384)=3.523, P=.000] and financial [t(384)=3.120, P<0.05] capitals. The main determinants for the specific agro–ecological zones were: HRZ of Murang'a; natural [t(228)=8.412, p=.012], physical [(228) =3.778, P=.000] and financial [t(228) =2.784, P=0.002] capitals, SALs of Kitui; financial [t(100) =7.67, P=.000], natural [t(100) = 10.294, P<0.05], social [t(100)=3.42, P<.05] capitals and ALs–Isiolo; natural [t(56)=3.626, P=.000], financial [t(56) = 2.798, P<0.05] and human [t(56) =3.181, P<0.05] capitals. Contextualization of interventions on the determinants found to have significant on food security is necessary in addressing the perennial food insecurity in the study areas. Policies that facilitate food to be within reach and affordable at all times are worth promoting for improved security.

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INTRODUCTION

Food security is a major global concern. The Food and Agriculture Organization (FAO) and the Government of Kenya (GOK) define food security as a state when all people, at all time, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and preferences for an active and healthy life (FAO, 2001; GOK, 2012). While emphasizing the importance of food security, the Millennium declaration of the General Assembly of the United Nations (UN) identified the eradication of extreme poverty and hunger as a goal for all UN member states; of which significant strides have been made towards reduction of extreme poverty (World Development Report, 2012). The UN (2011) Millennium Development Goals (MDG) reported 16% stability in hunger in the developing world in 2005-2007, despite significant reductions in extreme poverty. According to FAO (2010), 1 billion people suffered starvation and malnutrition; hence, attaining MDG number 1 (to halve extreme poverty and hunger by 2015) by the world is still far.

Kenya is one of the countries in Eastern Africa threatened by food insecurity. The Famine Early Warning Systems Network

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(FEWS NET, 2012) reported over 10 million people to suffer from chronic food insecurity and poor nutrition in 2012 which is about one third of the 39 million people in Kenya reported to suffer from chronic food and nutrition insecurity (FEWS NET, 2013). This was demonstrated in the 2012 military recruitment exercise which experienced a shortage of recruits due to the negative impact of the endemic food shortages on the growth of youths in some of the arid and semi-arid lands (ASALs) in Kenya (Daily Nation Newspaper, 20th August, 2012). While this could be attributed to many factors; the most affected areas were those that suffer frequent food shortages and depend on food aid due to drought. Therefore, adverse climatic conditions inhibit food availability (World Food Programme, 2009). Adewuyi (2002) identified climate change leading to adverse and erratic weather patterns to inhibit food security in Nigeria. Similarly, inadequate and excessive rainfall, pests and diseases are the main causes of household food insecurity in Uganda (Morse *et al.*, 2009). Sseguya (2009) attributed decreased production per unit area of land in Uganda to erratic and adverse weather conditions. Therefore, living in a region characterized by average annual rainfall, humidity, cloud cover and high day temperature in rural Nigeria increases the likelihood of being food secures (Oni and Fashogbon, 2012). Whereas rural Central, a high rainfall zone in Kenya has consistently reported the least food insecurity (31.4%), the most food insecure has been the North Eastern Kenya at 66% to Lower Eastern Kenya at 45.2% (GOK, 2006). Therefore, food security varies by agro–climatic conditions.

Assets have also been identified as other factors that affect food security. Household income and size, educational status of household head and quantity of food obtained from own production are key factors that affect food security in a farming household in Nigeria (Babatunde *et al.*, 2007). Similarly, sex of the household head, educational level, age and income had a positive influence; whereas household size had a negative influence on household food security in Nigeria (Oluwatayo, 2008). In Zimbabwe, fertilizer application, cattle ownership and access to irrigation have positive effect on food security, whereas, farm size and household size had a negative effect (Sikwela, 2008). Arguably, achieving food security is a necessary first step towards the more general development objectives of improved human well–being, poverty alleviation, and sustainable economic growth (FAO, 2010). However, the field of food security is still rife with many challenges ranging from conceptualization of food security issues at the household level, the development of effective and generally accepted indicators and the design of operational instruments with which to address these concerns (FAO, 2002). With adequate food intake today, one would still be considered to be food insecure if he/she has inadequate access to food on a periodic basis, risking deterioration in nutritional status (FAO, 2006). This emanates from food availability, accessibility, utilization and stability dimensions of food security theory. Whereas food availability refers to the physical existence of food from own production and markets, food accessibility is the capacity of households to acquire sufficient food to satisfy their nutritional needs (GOK, 2012; FAO, 2007). Households have stability of access when they have continuous access to the food source with minimal risks (FAO, 2006).

In Kenya, food security is understandably synonymous with the availability of maize (GOK, 2012). A nutrition country profile shows the prevalence of underweight and stunting in the under 5 years old children not to have changed significantly between 1998 and 2003 in the Central and Eastern Kenya (FAO, 2005). While cumulative data are generally available at the national level, the nature and extent of rural household food security dynamics is not well documented and the contributing factors to the observed situation is not well understood. By determining how food securities of particular households vary with the changes in livelihood assets and agro–ecological zones, informed decisions can be made on best interventional measures. The paper assesses food security situation and its key determinants for the rural households of Central and arid and semi–arid lands (ASALs) of Eastern Kenya. The objectives were:

1) To determine households food security levels in the HRZ of Murang'a, SALs of Kitui and ALs of Isiolo (ALs–Isiolo) in Kenya.
2) To establish the main determinants for household food security in the HRZ of Murang;a, SALs of Kitui and ALs of Isiolo in Kenya.

MATERIALS AND METHODS

Study Area

The study was conducted in three agro–ecological zones:

1) High Rainfall Zone (HRZ) of Murang'a

The high rainfall zone of Murang'a (HRZ–Muranga) is in central Kenya, with an annual rainfall of 750–2450mm. It has a total population of 942,581, with a population density of 524 persons per km^2 and 238,208 households in an area of 2,558.9 kms^2 (GOK, 2009). The area is inhabited by one tribe. It lies between latitudes 0^o 34' and 107' south and longitudes 36^o and 37^o 27' east and is characterized with a growing season exceeding 270 days, typical of a humid zone. It is divided into six livelihood zones: forestry, tea and tourism zone, coffee and dairy farming and irrigated agriculture. National Agriculture and Livestock Extension Programme (NALEP) facilitated the establishment of 880 community groups with 34,530 members at different levels of growth.

2) Semi–Arid Lands (SALs) of Kitui

The semi–arid lands of Kitui (SALs–Kitui) are in lower eastern Kenya, with a growing period for crops of 75 and 180 days. The annual rainfall ranges between 400–1000 mm. It has a total population of 1,012,709, with a population density of 33 persons per km^2 and 205,491 households in an area of 30,496.5 kms^2 (GOK, 2009). The population is Kamba tribe. Kitui is located between latitudes 0°10' and 3°0' south and longitudes 37°50' and 39°0' east. The livelihood zones are: Sorghum and cotton, sheep, goats and zebu cattle, coffee and dairy farming and irrigated horticulture. NALEP facilitated the establishment of 230 community groups with 15,144 members at different levels of growth.

3) Arid Lands (ALs) of Isiolo

The arid lands of Isiolo are in upper eastern Kenya, with an average annual rainfall of 580 mm. The average temperature is 26.60 C and a growing period for crops is less than 75 days. It is located between longitudes 36^o 50' and 39^o 50' east and latitude 0^o 05' south and 20' north. It has a total population of 143,294, a population density of 4 persons per km^2 and 22,583 households in an area of 25,700 Km^2 (GOK, 2009). While the population is predominantly Cushite (Oromo, Boran and Sakuye), there are Turkana, Samburu, Meru and Somali communities as well. The main livelihood zones are: agro–pastoralism, pastoralism, firewood and charcoal burning, formal employment and casual labour. NALEP facilitated the establishment of 168 community groups with 8,481 members at different levels of growth.

Research Techniques and Sampling Methods

A three stage sampling technique was used to arrive at the respondent households. Stage one involved simple random selection of the agro–ecological zones (AEZs) and regions, consequently, the HRZ and arid and semi–arid lands (ASALs); and central and eastern Kenya were selected respectively. In stage two, each AEZ was divided into counties from, which Murang'a, Kitui and Isiolo were randomly picked. An Extreme Sampling Technique (EST) was used to identify six (6) community group categories based on their level of participation and success of food security initiative supported by NALEP. EST refers to the process of selecting highly unusual cases of the phenomenon of interest in order to develop a richer, more in-depth understanding and to lend credibility to research account. In stage three, 12 common interest group sub-clusters were selected with enterprise orientation using Maximum Variation Sampling Technique (MVST). This seeks representation by including a wide range of extremes of the target population instead of equal probability. The desired sample size (384) for the study areas was derived from Fisher's model at 95% confidence interval as follows:

$$n = \frac{z^2 pq}{d^2}$$

Where:
n = Desired sample size if the target population is greater than 10,000.
z = Standard normal deviate at the required confidence level (1.96).
p = Proportion in the target population estimated to have characteristics being investigated (50%).
q = 1 – p
d = Level of statistical significance set (5%).

The respective region's common interest group membership strength relative to other regions determined its sample share. Thus, regions share (r_n) was derived as follows:

$$r_n = \left(\frac{r}{N}\right) n$$

Where:
R=Region total group membership [HRZ–Murang'a (34,530), SALs–Kitui (15,144), ALs–Isiolo (8,481)].
n = Sample size for three AEZs of the study (384).
N =Total group membership population for the regions or AEZs (58,155).

The respondent households (384) were randomly picked from the common interest groups based on county sample share [HRZ–Murang'a (228), SALs–Kitui (100), ALs–Isiolo (56)] and willingness to participate in the study.

Data Collection

Data were collected through literature review, structured questionnaire and an in-depth interview. A study questionnaire was distributed to 384 (HRZ–Muranga = 228, SAL–Kitui = 100, ALs–Isiolo = 56) households followed by in–depth focused group interviews. The data collected were: household head highest education level, household size, age of household head, sex of household head, land ownership, land size, households monthly income, number and types of household social networks, types of access roads, kilometers travelled to markets, watering points and health facilities. Information on availability, accessibility and stability of access to food was collected using a numerical food security scale and a related variety of specific conditions, experiences, and behaviors that serve as indicators of the varying degrees of severity of the condition for the households during the preceding 12 months. Besides, on a Likert Scale [where: SD = Strongly Disagree, D = Disagree, A = Agree, SA = Strongly Agree], 384 households were questioned to find out their perception concerning mobilization of livelihood assets for food security activities and outcomes. The in-depth focused group interview was conducted with 12 groups to determine the factors that influence participation of household members in food security initiatives.

Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics. For qualitative data, Content Analysis was used. Household demographic data were analysed in terms of: household head sex, educational level, age bracket and occupation; and household size and monthly income. Descriptive and Inferential Statistics; and Content Analysis were used to analyze household food security. Coping strategies for rural household food insecurity was analysed using descriptive statistics and Content Analysis. A multiple linear regression was used to analyze the effects of the main determinants (livelihood assets) on household food security.

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon.$$

Where:
β_o = Constant
β = Regression coefficient for livelihood assets
Y= Dependent variable (Rural household food security)
X_1= Natural capital
X_2= Financial capital
X_3= Human capital

X_4=Social capital
X_5= Physical capital

All tests of significance were computed at $\alpha = 0.05$ and $\alpha = 0.01$. The Statistical Package for Social Sciences (SPSS) version 22 was used to analyze the data.

RESULTS AND DISCUSSION

Demographic Characterization of the Rural Households

About 81% (311) household heads were males with 48% (184) in their youthful (<35 years) and middle (35–55 years) age brackets where people are capable of actively engaging in food security activities and outcome. However, about 64% (246) household heads were either illiterate or semi–illiterate having attained primary or no formal education. Less than 50% household heads in all the cases had secondary education and above. Therefore, majority of the household heads did not have adequate capacity to engage in food security issues that require formal education meant to improve household livelihood security and outcomes. The household sizes varied by AEZ with an overall variability index of 2 persons for the HRZ–Murang'a and ALs–Isiolo; and 3 for the SALs–Kitui with an overall mean of 5 persons per household. This is higher than the mean household size in Kenyan (4.2 persons) as presented in the 2008/2009 Kenya Demographic and Health Survey (KDHS) report (GOK, 2010b). Therefore, households from the SALs–Kitui required more food in order to effectively feed their large household members than either the ALs–Isiolo or HRZ–Murang'a. Olaniyan and Okemakinde (2008) argue that formal education which is an investment in the human capital is highly instrumental and even necessary to improve the production capacity of a population. A worldwide survey on education and small farm production reveals a positive correlation between education attainment and farm efficiency in 31 out of 37 cases (Onphanhdala, 2009).

Rural Households Food Security in the High Rainfall Zone of Murang'a, Semi–arid Lands of Kitui and Arid Lands of Isiolo in Kenya

The overall food insecurity for the study areas was 48%, but this varied across the AEZs, with the most affected being: the SALs–Kitui at 81%, to ALs–Isiolo at 75%, and the most food secure HRZ–Murang'a at 77%. The 2005/06 Kenya Integrated Household and Budget Survey (KIHBS) report food security to have been fluctuating at between 41% and 66% since1994 in all the regions except the Central Kenya (GOK, 2006) represented by the HRZ–Murang'a in this study. Further analysis presents food security as significantly different across the study areas [$F(2, 380) = 41.01$, $P<0.05$] with a food security mean score for the HRZ–Murang'a being (M=3.01, SD=0.62), the SALs–Kitui at (M=2.58, SD=0.20) and the ALs–Isiolo at (M=2.42, SD=0.50). Whereas the ALs–Isiolo was presented as the least food secure in terms of the food security mean score (M=2.42, SD=0.50) contrary to the descriptive perception of the rural households, there was no great difference in food security means scores for SALs–Kitui (M=2.58, SD=0.20) and ALs–Isiolo (M=2.42, SD=0.50) in eastern Kenya. This implies that annual rainfall received in a given AEZ has an effect in household food security. Similarly Oni and Fashogbon (2012) argue that living in a region characterized by average annual rainfall, humidity, cloud cover and high day temperature increases the likelihood of households being food secure. Morse et al. (2009) identify inadequate rainfall, pests and diseases, and excessive rain as the main causes of household food insecurity in Uganda. The Kenya food security brief by FEWS NET (2013) identifies acute and chronic food insecurity as highest among households in the ASALs which have low resilience to shocks due to repeated exposure to drought and depletion of assets. Whereas 27% stunting and 8.7% severe stunting has been reported in Central, Eastern Kenya demonstrated 32.5% stunting and 12.9% severe stunting. A report by the Central Bureau of Statistics (CBS), Ministry of Health (MOH) and Opinion Research Company (ORC) Macro (2004) record 14.6% underweight and 2.2% severe underweight cases in Central relative to 21.4% underweight and 4.2 severe underweight in the Eastern Kenya. The 2000 Kenya Multiple Indicator Cluster Survey (MICS) conducted by the CBS and Ministry of Planning (MFP) report 27.4% stunting and 9.6% severe stunting; and 15.4% underweight and 3.3% severe underweight in the Central Kenya (CBS and MFP, 2002). Likewise, the 1998 KDHS reports a 27.5% stunting and 9.8% severe stunting in Central compared to 36.8% stunting and 13.2% severe stunting in the Eastern Kenya (Republic of Kenya, 1998). The CBC, National Council for Population and Development (NCDP) and Macro International Inc (1999) report 14.3% and 2.0% cases of underweight and severely underweight respectively in the Central relative to 25.7% underweight and 6.6% severe underweight in the Eastern Kenya. Table 1 shows four categories of food accessibility as: 24.2 % (1) households from the HRZ– Murang'a had access to the preferred food relative to 6% from SALs–Kitui and 2% from the ALs–Isiolo. Although households may have had adequate food intake, they would still be considered to be food insecure with inadequate access on a periodic basis or within the foreseeable future. Whereas 38% households from the HRZ–Murang'a had a continuous access to food, 96% households from the ALs–Isiolo and 83% from the SALs–Kitui were at risk of hunger in the last twelve months before the study. Overall, the most vulnerable households susceptible to a future loss of capacity to maintain livelihood and food security over time were 40%.

Determinants for Households Food Security in the High Rainfall Zone of Murang'a, Semi–arid Lands of Kitui and Arid Lands of Isiolo in Kenya

Livelihood assets accounted for 37.2% of the variability in household food security. The overall significance of the regression model for food security was ($F=10.2$, $P<0.05$). The main determinants for household food security were: natural [$t(384)=9.364$, $P=.000$], physical [$t(384)= 3.523$, $P=.000$], financial [$t(384)= 3.120$, $P<0.05$] and social [$t(384)= 1.944$, $P=.000$] capitals. An increase in natural, physical, financial and social capitals by one standard deviation increases household food security by 0.486, 0.188, 0.182 and 0.097 standard deviations respectively. The optimal level for household food security for the study was: $Y= 1.044 + 0.655X_1 + 0.220X_2 + 0.022X_3 + 0.071X_4 + 0.200X_5 + \varepsilon$, (Y= food security, X_1= natural capital, X_2=financial capital, X_3= human capital,

Table 1. Percent (%) Access to Food by the Rural Households (N=384)

% Access to Food	HRZ- Murang'a (n=228)	SALS-Kitui (n=100)	ALs Isiolo (n=56)	Overall (N=384)
Often did not have enough to eat	1	15	21	8
Sometimes did not have enough to eat	22	66	54	40
Enough but not always the kinds of food we wanted to eat	53	13	23	36
Enough of the kinds of food we wanted to eat	24.2	6	2	16
% Stability of Access to Food	HRZ-Murang'a (n=228)	SALS-Kitui (n=100)	ALs Isiolo (n=56)	Overall (N=384)
Often worried that their food would run out	3	35	40	19
Sometimes worried that their food would run out	59	48	56	54
Never worried that their food would run out	38	17	4	27

Table 2. Household Food Security Model Coefficients the Agro–ecological Zones (N=384)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	SE	β		
HRZ– Murang'a	(Constant)	2.011	.		6.(	.000
	Natural Capital	.865	.	.624	8.4	.012
	Financial Capital	.250	.	.256	2.7	.002
SALs – Kitui	Human Capital	.052	.	.142	.1	.634
	Social Capital	.079	.	.098	1.3	.040
	Physical Capital	.189	.	.210	3.7	.000
	(Constant)	1.757	.		10.	.000
	Natural Capital	.405	.	.387	7.4	.002
	Financial Capital	.530	.	.451	7.(	.000
ALs - Isiolo	Human Capital	.001	.	.001	.(	.989
	Social Capital	.282	.	226	3.4	.001
	Physical Capital	.207	.	.189	3.2	.001
	(Constant)	.053	.		.1	.868
	Natural Capital	.501	.	.370	3.(	.000
	Financial Capital	.324	.	.323	2.7	.006
	Human Capital	.288	.	.313	3.	.002
	Social Capital	-.033	.	.037	.4	.676
	Physical Capital	.125	.	.108	1.4	.164

Table 3. Correlation Analysis Results for Natural Capital and Household Food Security by Agro–ecological Zone

AEZ			Natural Capital	Household Food Security
	NC	Pearson Correlation	1	.726**
		Sig. (2-tailed)		.000
		N	228	228
HRZ–Murang'a	HFS	Pearson Correlation	.726**	1
		Sig. (2-tailed)	.000	
		N	228	228
	NC	Pearson Correlation	1	.937**
		Sig. (2-tailed)		.000
		N	100	100
SALs–Kitui	HFS	Pearson Correlation	.937**	1
		Sig. (2-tailed)	.105	
		N	100	100
	NC	Pearson Correlation	1	.847**
		Sig. (2-tailed)		.000
		N	56	56
ALs–Isiolo	HFS	Pearson Correlation	.847**	1
		Sig. (2-tailed)	.000	
		N	56	56

**.Correlation is significant at the 0.05 level (2-tailed); NC = Natural Capital, HFS = Household Food Security

Table 4. Household Food Security Model Coefficients (N=384)

AEZ	Predictor Variable	B	Wald	Df	Sig.	Exp. (β)
HRZ	Land Ownership	1.255	20.586	1	.053	3.508
	Land Size	.326	6.634	1	.010	1.386
	Constant	2.279	4.867	1	.027	9.766
SALs	Land Ownership	1.124	19.586	1	.003	3.808
	Land Size	-1.160	7.346	1	.000	.313
	Constant	2.079	4.117	1	.017	7.996
ALs	Land Ownership	-.866	4.164	1	.041	.421
	Land Size	-.963	3.861	1	.053	.381
	Constant	1.279	3.867	1	.031	3.599

X_4 = social capital, X_5= physical capital). Natural capital had the greatest effect (B=0.655) on household food security, while, human capital made the least contribution (B=0.022) when the other predictor capitals were controlled for. However, the rest of the variation was attributed to both the insignificant and unstudied predictor variables. Specifically, livelihood assets contribution to household food security varied from 42.5% (R = 0.652, R^2 = 0.425) in the HRZ–Murang'a to 37.6% % (R=0.613, R^2=0.376) in the SALs–Kitui and 28.9% (R=0.537, R^2=0.289) in the ALs–Isiolo. Whereas the three main determinants for household food security in the HRZ–Murang'a were natural [t(228) =8.412, P=0.012], physical [(228) =3.778, P=.000] and financial [t(228) =2.784, P=0.002] capitals, the SALs–Kitui reported financial [t(100) =7.67, P=.000], natural [t(100) = 10.294, P<0.05] and social [t(100)=3.42, P<0.05] capitals. The main determinants for household food security for the ALs–Isiolo were: natural [t(56) =3.626, P=.000], financial [t(56) = 2.798, P<0.05] and human [t(56) =3.181, P<0.05] capitals. Table 2 presents household food security in the HR–Murang'a as increasing by 0.624, 0.256, 0.210 and 0.098 standard deviations as natural, financial, physical and social capitals increase by one standard deviation respectively and vice versa. Similarly, food security in SALs–Kitui increases by 0.451, 0.387, 0.226 and 0.189 standard deviations as financial, natural, social and physical capitals increase by one standard deviation respectively. An increase in natural, financial and human capitals by one standard deviation increases household food security by 0.370, 0.323 and 0.313 standard deviations respectively in the ALs–Isiolo. This implies that as social capital for the rural households' in the ALs–Isiolo increases, predicting household food security correctly decreases and vice versa.

Table 3 presents natural capital as significantly and strongly positively correlated with household food security in all the study areas, with the SALs–Kitui at (r =0.937, P<0.05, n=100), ALs–Isiolo at (r =0.847, P <0.05, n= 56) and the HRZ–Murang'a at (r =0.726, P<0.05, n= 228). This implies that natural capital which includes the natural environment, land, water resources and the variations in the climate had a strong effect on household food security. These results are in line with the perspective of O'Connor (2000) that natural capital is the stock that yields the flow of natural resource, thus, the foundation of all human activities, including food security. Brody (2001) and Venema (2004) hold the view that both shifting and settled cultivators manipulate and control the natural systems for their sustenance. However, the observed variation by AEZ can be attributed to the effects of other capitals on household food security.

Table 4 shows land ownership (proxy indicator for natural capital) as a significant predictor for household food security in the SALs–Kitui and ALs–Isiolo except the HRZ–Murang'a. As land ownership increases by one standard deviation, food security in the SALs–Kitui increases by 3.808 standard deviations. On the contrary, as land ownership increases by one standard deviation, food security in the ALs–Isiolo decreases by 0.421 standard deviations. Similarly, size of land accessed by a household was not a significant predictor (P=0.053) for household food security in the ALs–Isiolo with the probability of a household selected at random being food secure not statistically significant, [χ^2 (4, n = 56) = 128.640, P= 0.061)]. However, size of land owned and cultivated by a household was a significant predictor for household food security in the SALs–Kitui (n=100, P=.000) with the probability that a household selected at random would be food secure significant at [χ^2 (8, n = 100) = 131.334, P<0.05], and the HRZ–Murang'a (n=228, P=0.01), χ^2 (10, n = 228) = 120.680, P<0.05). As size of land under cultivation increases by one standard deviation, food security for the HRZ–Murang'a increases by 1.386 standard deviations and vice versa. However, a study by Faridi and Wadood (2010) demonstrates that total land owned by a household has a strong impact on food security of that particular household. The observed results for the ALs–Isiolo and SALs–Kitui can be explained by the land tenure system where about 67% (67) and 1% (1) households from the SALs–Kitui held family and communal land respectively; and 54% (30) and 10% (6) households from the ALs–Isiolo, a pastoral area, held family and communal land respectively. Consequently, the decision on land use is vested in the wider family and community, thus, affecting food security negatively. Additionally, communities in the ALs–Isiolo by their very nature are pastoralists that migrate from place to place in search of pasture for their livestock. These results are somewhat consistent with Njuguna and Baya (2001) review report that while the concept of individual land ownership and the land tenure systems is beneficial for economic development in Kenya, it may not be suitable in certain parts of the country for example, the pastoralist areas, due to ecological and socio-cultural factors.

Household monthly income was a significant predictor for food security with significantly different food security levels for the five monthly income brackets cross the study area [F (4, 379) = 3.2, P=0.04]; with HRZ–Murang'a at [F (4, 223) = 4.19, P= 0.009)] to [(4, 51) = 3.266, P=0.015] for the ALs–Isiolo and [F (4, 95) = 3.266, P=0.038] for the SALs–Kitui. Table 5 shows the HRZ–Murang'a leading in high food security mean scores (M) given the household monthly income, with the households with more monthly income more likely to be food secured. A study conducted by Bashir *et al.* (2012) in India demonstrates that an increase in household's income by rupees (Rs) 1000 increases the chances for rural households' food security by 5%. Likewise, households in the Rs 5001–10000 monthly income bracket had 15 times more chances of achieving food security compared to the households in the Rs 0–5000 income bracket. Besides, Gundersen and Gruber (2001) in their study on household food security identify low average income, initial assets, and negative income shocks, lack of savings, and liquidity constraints as reasons for household food insecurity. A five city case studies [Rosario (Argentina), Bogota (Colombia), Accra (Ghana), Kitwe (Zambia) and Colombo (Sri Lanka)] on the effects of global financial crisis on food security of low and middle income populations present income as crucial for food security for people living in cities as purchasing was the main source of food for 95% of households studied (Prain, 2010). Further analysis presented financial capital as significantly and positively correlated with household food security in all the study areas, with the SALs–Kitui at (r =0.684, P = 0.012, n= 100) to ALs–Isiolo at (r =0.454, P<0.05, n=56) and HRZ–Murang'a (r =0.354, P=0.032, n= 228).

Table 5. Analysis of Household Food Security by Income Level

	Monthly Income Level (KES)	N	Mean	SD	SE	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
HRZ-Murang'a	<5000	80	2.856	.62134	.0695	2.717	2.995
	5000 –10000	91	2.914	.58904	.0617	2.791	3.037
	10000 –20000	34	2.956	.60124	.1031	2.750	3.162
	20000–30000	11	3.302	.58860	.1775	2.947	3.657
	>30000	12	3.325	0.6102	.1761	2.973	3.677
	Total	228	3.0110	.62491	.0413	2.9304	3.0937
SALs–Kitui	<5000	67	2.3254	.51250	.0626	2.3006	2.5462
	5000 – 10000	22	2.4340	.50214	.0222	2.5340	2.6223
	10000 – 20000	6	3.0034	.48023		2.9304	3.0917
	20000 – 3000 >30000	2.0	3.0126	.54268	.0303	2.7543	2.8738
	Total	100	2.5782	.42045	.0222	2.5340	2.6223
ALs–Isiolo	<5000	38	2.1024	.40733	.0661	1.9702	2.2346
	5000 – 10 000	13	2.2982	.20107	.0558	2.1866	2.4097
	10000 – 20000	3	2.4011	.42490	.2453	1.9105	2.8917
	20000 – 30000	1	2.5140	.31320	.3320	2.2008	2.8272
	>30000	1	2.6420	.21220	.2122	2.4298	2.8542
	Total	56	2.4234	.40733	.0544	2.3146	2.5322

Table 6. Food Security by Education Level of the Household Head (n=328)

AEZ	Level of Education	N	Mean	SD	SE	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
HRZ–Murang'a	No Formal Educ.	16	2.330	.50727	.0510	2.3089	2.5526
	Primary	103	2.438	.20107	.0224	2.3840	2.6221
	Secondary	71	3.170	.62491	.0411	2.9304	3.3017
	Tertiary	38	3.404	.65321	.0518	3.0123	3.5012
	Total	228	2.836	.60395	.0403	2.7547	2.8739
SALs–Kitui	No Formal Educ.	30	2.112	.30123	.0416	2.0022	2.4890
	Primary	58	2.189	.13423	.0327	1.9976	2.4568
	Secondary	9	2.764	.42600	.0344	2.5678	2.9876
	Tertiary	2	3.067	.35321	.0418	2.9034	3.3067
	Total	99	2.533	.50455	.0319	2.3432	2.7898

Table 7. Correlation Analysis Results for Social Capital and Household Food Security by Agro–ecological Zone

AEZ			Social Capital (SC)	Household Food Security (HFS)
	SC	Pearson Correlation	1	.291**
		Sig. (2-tailed)		.000
		N	228	228
HRZ–Murang'a	HFS	Pearson Correlation	.291**	1
		Sig. (2-tailed)	.000	
		N	228	228
	SC	Pearson Correlation	1	.016
		Sig. (2-tailed)		.885
		N	100	100
SALs–Kitui	HFS	Pearson Correlation	.016	1
		Sig. (2-tailed)	.885	
		N	100	100
	SC	Pearson Correlation	1	.078
		Sig. (2-tailed)		.522
		N	56	56
ALs–Isiolo	HFS	Pearson Correlation	.078	1
		Sig. (2-tailed)	.522	
		N	56	56

**Correlation is significant at the 0.05 level (2-tailed); SC=Social Capital, HFS=Household Food Security

Table 8. Correlation Analysis Results for Physical Capital and Household Food Security by Agro–ecological Zone

AEZ			Physical Capital	Household Food Security
	PC	Pearson Correlation	1	.428**
		Sig. (2-tailed)		.000
		N	228	228
HRZ–Murang'a	HFS	Pearson Correlation	.428**	1
		Sig. (2-tailed)	.000	
		N	228	228
	PC	Pearson Correlation	1	.043
		Sig. (2-tailed)		.703
		N	100	100
SALs–Kitui	HFS	Pearson Correlation	.043	1
		Sig. (2-tailed)	.703	
		N	100	100
	PC	Pearson Correlation	1	.139
		Sig. (2-tailed)		.254
		N	56	56
ALs–Isiolo	HFS	Pearson Correlation	.139	1
		Sig. (2-tailed)	.254	
		N	56	56

** Correlation is significant at the 0.05 level (2-tailed), PC= Physical Capital, HFS= Household Food Security

Table 9. Mean Distance Travelled to Access Infrastructural Facilities (KMS)

AEZ	Infrastructure	Sex	N	Mean	SD
HRZ–Murang'a	Market Outlets	Female	29 (13%)	2.8	11.9
		Male	199 (87%)	3.1	22.2
	Watering Point	Female	29 (13%)	.2	.5
		Male	199 (87%)	.4	.9
	Health Facility	Female	29 (13%)	3.6	2.5
		Male	199 (87%)	3.9	4.2
SALs–Kitui	Market Outlets	Female	26(26%)	2.2	1.9
		Male	74(74%)	4.9	5.4
	Watering Point	Female	26(26%)	3.0	2.3
		Male	74(74%)	3.7	2.5
	Health Facility	Female	26(26%)	4.2	3.5
		Male	74(74%)	5.3	3.3
ALs–Isiolo	Market Outlets	Female	18(32%)	2.9	9.1
		Male	38(68%)	4.1	18.4
	Watering Point	Female	18(32%)	1.4	2.0
		Male	38(68%)	1.3	2.1
	Health Facility	Female	18(32%)	9.4	10.5
		Male	38(68%)	8.9	8.2

KMS= Kilometres

However, the SALs–Kitui had the strongest correlation (r=0.684) between financial capital and household food security, whereas the HRZ–Murang'a had the least coefficient (r = 0.354), demonstrating that the effect of financial capital on household food security was lowest in the HRZ–Murang'a relative to the ALs–Isiolo and SALs–Kitui. The higher food security correlation coefficients for the SALs–Kitui and ALs–Isiolo could be explained by low agricultural productivity due to frequent drought and low rainfall regimes, consequently, low food production for own consumption. Hence, market outlays were the main source of food available to households for purchase. Sseguya (2009) argues that food accessibility is achieved through purchasing power, financial outlays or access to the necessary resources. Similarly, Krantz (2001) argues that financial capital plays a critical role in food accessibility by households and therefore, is essential for the pursuit of any livelihood strategy. Therefore, Norton *et al.* (2001) proposes that state intervention to support the prices of the goods produced by the poor or commodities they require for subsistence can smooth income and consumption respectively. Age of the household head was not a significant predictor for household food security in the SALs–Kitui [F (2, 225) = 9.477, P=0.062] and ALs–Isiolo [F (2, 53) = 16.017, P=0.102] except in the HRZ–Murang'a [F (2, 225) =7.428, P=0.048] where households headed by individuals who were 55 years old and above were much more food secured compared with the under 35 and 35–55 years age brackets. However, Aidoo *et al*. (2013) study in Ghana demonstrates the coefficient of age as not significant in explaining household food security status. The effect of education status of the household head on food security varied with the HRZ–Murang'a at [F (12, 216) = 167.75, P=0.005)] and a food security mean scores of 3.170 and 3.404 for secondary and tertiary educated household heads respectively, to [F (12, 88) = 53.855, P = 0.022] and a food security mean scores of 2.764 and 3.067 for households heads with secondary and tertiary education respectively for the SALs–Kitui (Table 6). However, there was no significant difference in food security mean score given the educational level of the household head [F (12, 44) = 24.42, P=0.072] from the ALs–Isiolo. Faridi and Wadood (2010) study reveals a clear linkage between education and food security issues. Besides, Bashir, *et al.* (2012) study present household food security as increasing by 99.9% and 177.1% with 8 and 12 years of schooling respectively by the household head in India. Heflin *et al.* (2007) study reveals those with less than a high school grade to be more likely to report food insufficiency than a diploma grade and household heads with more than a high school grade were less likely to report food insufficiency. Hence secondary education is a necessary condition to assure food security for particular households as household heads with more human capital are prone to suffer less from food insecurity. Besides, a higher level of education provides a wider range of employment opportunities and as a result alternative sources of income, hence, determining the quality and quantity of food a household feeds on. Burchi and De Muro (2007) argue that education improves rural people's capacity to diversify assets and activities, increase productivity and income, foster resilience and competitiveness, access information on health and sanitation, strengthen social cohesion and participation which are essential elements to ensuring food security in the long run.

Similarly, household size had a significant relationship with household food security with the HRZ–Murang'a at [F (3, 224) = 2.05, P=.014], to [F (3, 96) = 7.136, P=0.00) for the SALs–Kitui and [F (3, 52) = 12.99, P=0.007] for the ALs–Isiolo. There was a significant difference in household food security mean score for household size [1 versus 6–10 (P =0.022)]. Whereas no significant difference in household food security mean score was demonstrated between households with one and 2–5 (P = 0.073)]; 2–5 and 6–10, (P= 0.052) in the HRZ–Murang'a, a significant difference in food security mean score was reported in households with one versus 6–10 member(s) at (P = 0.007) and 2–5 versus 6–10 member(s) at (P=0.045) in the ALs–Isiolo. Households with 6–10 members had higher food security mean scores relative to those with one or 2–5 member(s) in the ALs–Isiolo. However, the HRZ–Murang'a was much more secured with 2–5 than 6–10 household members given that an increase in household size mean more mouths to feed, thus, indirectly reducing income per head and increasing expenditure per head and per capita food consumption. A study by Sindhu *et al.* (2008) in India reveals

an increase in household food insecurity (49%) with an increase of one family member. Similarly, Aidoo *et al*. (2013) demonstrate household size to be significantly (P<0.01) and negatively related with food security, hence, the probability of household food security decreases with an increase in household size. However, the agriculture sector in Kenya provides more than 60% of informal employment in the rural areas (GOK, 2009) whose labour force is family based. Therefore, households with 6–10 members stand a better chance when it comes to provision of labour into the family food security initiative relative to those with few. Sex of the household head had a significant effect on household food security in the ALs–Isiolo [t (54) = - 1.809, P= 048] and the HRZ–Murang'a [t (226) = - 2.509, P=0.018], except the SALs–Kitui [t (98) =-2.311, P=0.058]. Male headed households food security mean score was significantly higher than female headed households [Male (M = 2.236, SE=0.027), Female (M=2.080, SE=0.021)] for the ALs–Isiolo and [Male (M=2.877, SE=.05233), Female (M = 2.544, SE=.0458)] for the HRZ–Murang'a. Helflin *et al.* (2007) study demonstrates married or cohabitating women to be less likely to report food insufficiency than their unmarried counterparts. Table 7 shows no significant relationship between social capital and household food security in the SALs–Kitui (r =0.016, P=0.885, n=100) and ALs–Isiolo (r =0.078, P=0.522, n = 56), except the HRZ–Murang'a (r =0.291, P=.000, n=228). The effect of social capital on food security was small in the HRZ–Murang'a but negligible in the SALs–Kitui and ALs–Isiolo. However, the effects of social network, a type of social capital on household food security was stronger in the HRZ–Murang'a [r=0.411, P=0.003] compared to the SALs–Kitui [r =0.296, P=0.045] and AL–Isiolo [r=0.378, P= 0.022]. These results are in line with the views from focussed group discussion where the HRZ–Murang'a demonstrated a strong collective action towards livelihood security initiatives and outcomes through the cooperative movement that enhanced their access to credit from equity bank. However, the SALs–Kitui with the highest social networks compared to the HRZ–Murng'a and ALs–Isiolo seemed to lack resources to drive their agenda, thus waiting on local development agencies for support. Further, a weak collective action towards food security initiatives and outcomes was evident in the ALs–Isiolo which could be attributed to cultural differences that promoted division among the local tribes. Therefore, social capital requires a favourable social environment that promotes active participation, inclusion and frequent interaction to nurture shared principles, norms and purpose (Killerby, 2001). For this reason, people need to be assisted to make connections and sustain relationships where there are cultural differences and obstacles that promote division (Gilchrist, 2004). Additionally, Van Bastelaer (2000) proposes that the implementation of formal credit programmes geared towards poverty eradication in rural areas should not only consider the existing social capital but also the social structure of the rural community. A report by UN–Habitat (2003) from Colombo in Sri Lanka demonstrates social capital as a resource that can be exploited to help the poor access credit. Likewise, a study by Grootaert (2001) on whether social capital helps the poor presents households with higher social capital in Indonesia as better able to obtain credit. A similar study by Narayan and Prittchet (1997) in Tanzania demonstrate households in villages with higher social capital to be able to access credit for agricultural improvements and members of financial associations to be more likely to obtain lager credit than non-members.

Table 8 presents physical capital as significantly, but weakly correlated with household food security in the HRZ–Murang'a; (r =0.428, P<0.05, n=228) except for the SALs–Kitui (r =0.043, P=0.703, n=100) and the ALs–Isiolo (r=0.139, P=0.254, n=56). This implies that physical capital which includes productive assets, marketing and transportation systems, watering and health facilities had a strong effect on household food security in the HRZ–Murang'a relative to the ALs–Isiolo and SALs–Kitui.

Table 9 shows households travelling longer distances to market outlets, watering points and health facilities in the ALs–Isiolo and SALs–Kitui relative to the HRZ–Murang'a. Besides, about 74% (41) households from the ALs–Isiolo had access to dry weather roads to enhance livelihood activities for food security. Therefore, poor road network and isolation of ALs–Isiolo and SALs–Kitui affected movement of food and water from source to the households. These results affirm the likert scale findings where households from the HRZ–Murang'a had access to more physical assets for food security activities and outcomes compared to the SALs–Kitui and ALs–Isiolo. Whereas 65% (149) households from the HRZ–Murang'a had adequate access to road networks to enhance livelihood activities for food security, only 43% (24) and 33% (33) households from the ALs–Isiolo and SALs–Kitui respectively had access to similar infrastructure. Besides, focused group discussion findings presents rampant insecurities and theft of physical assets (irrigation kits, water tanks, bee hives and livestock) as an impediment to food security in the ALs–Isiolo. According to Tembo and Simtowe (2009), the presence of infrastructure often determines if a village receives higher or lower prices. Markets in the arid and semi–arid lands tend to be isolated with poor infrastructure links to other markets, thus, affecting the ability of households to purchase food (FEWS NET, 2013). Similarly, FAO (1997) highlights marketing and transportation systems to inhibit the cost–effective movement of food from source to need. Simmonds (2006) identifies location isolation as a key contributor to food insecurity in Malawi.

Conclusion

There is persistence of food insecurity (48%) across the study areas, with the most affected households being in the arid and semi–arid lands of Isiolo and Kitui. Agriculture was the mainstay for 79% rural households. Livelihood assets accounted for 37.2% of the variability in household food security in the three AEZs. Overall, the main determinants for household food security were natural, physical and financial capitals in that order. Particularly, the main determinants for household food security varied from natural, physical and financial capitals in the HRZ–Muranga, to financial, natural and social capitals in the SALs–Kitui and natural, financial and human capitals in the ALs–Isiolo with intra–ecological differences on the contribution of livelihood assets to rural household food security. In the ALs–Isiolo, livelihood assets accounted for 28.9% of the variation in household food security. An increase in natural, financial and human capitals

by one standard deviation resulted in an increase in household food security by 0.370, 0.323 and 0.313 standard deviations respectively. Land ownership had a significantly negative effect on household food security, with a decrease in food security by 0.421 standard deviations as land ownership increases by one standard deviation. An increase in household monthly income increases household food security means score. Household size and sex of the household head were significant predictors for household food security. Livelihood assets accounted for 37.6% of the variability in food security in the SALs–Kitui. As financial, natural and social capitals increase by one standard deviation, household food security increases by 0.451, 0.387 and 0.226 standard deviations respectively. An increase in household monthly income increases household food security means score. Similarly, land ownership was a significant predictor of household food security. Livelihood assets accounted for 42.5% of the variability in household food security in the HRZ–Murang'a. Food security increases by 0.624, 0.256 and 0.210 standard deviations as natural, financial and physical capitals increase by one standard deviation respectively. Food security increases by 0.139 standard deviations when land under production increases by one standard deviation. Age of the household head was a significant predictor for household food security.

Recommendations

Achieving food security is a necessary first step towards the more general development objectives of improved human well–being in all the study areas and probably, Kenya as a whole. This requires the adoption of mixed strategies and policies along those capitals found to have a significant effect on food security within the AEZs of the study. Contextualization of food security interventions is necessary to address the perennial food insecurity. Policies that encourage investment in natural and physical capital are worth promoting in all the study area as both capitals hold the key to rural households' food security. For example, appropriate economic policies that facilitate nutritious food to be within reach and affordable to all, at all times should be developed by the national and county governments. Further studies should be carried out to establish the factors that contribute to the observed un-accounted for variations (62.8%) in the food security model to give a holistic understanding and approach to household food security. In the ALs–Isiolo, an understanding of the ecological and social cultural factors is necessary in determining viable food security interventions. Policies encouraging investments in human capital are worth promoting as educated people are likely to make better choices and informed decisions on household size, types of foods to consume and land use systems. Tailored food security interventions targeting the female headed households should be pursued by the national and county governments to unlock the food insecurity bottle necks in those rural households. In the SALs–Kitui, efforts to improving household monthly income through the promotion of determinants shown to have significant effect on food security should be pursued by both national and county governments. Reforms that facilitate individualization of tenure should be put in place as land is beneficial for economic development, including food security. Food insecure households should be assisted to make connections with development agencies and community members to secure leverage support for food security initiatives. Food security interventions targeting the HRZ–Murang'a should be geared towards enhancing agricultural production and productivity through natural capital development, particularly, increasing the area under production. Efforts to improving household monthly income particularly, for the under 55 years old household heads through the promotion of determinants shown to have significant effect on food security should be pursued.

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