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Food Insecurity Coping Strategies and Determinants of Households' Choice of Specific Coping Strategies in Kitui County, Kenya

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Abstract A study was carried out to examine farmers' coping strategies and the determinants of their choice of specific coping strategies to food insecurity in selected agro-ecological zones in Kitui County. A total of 341 households were selected from four different agro-ecological zones: semi-humid, transitional semi-humid to semi- arid, semi-arid and arid zones. The results indicated that use of off-farm income, selling livestock to buy food, reducing number of meals per day, selling family assets and seeking off-farm employment in urban areas were the most common coping strategies adopted by farmers in the study area. Further, there was a statistically significant difference ($p<0.01$) in the farmers' use of off-income to buy food, food assistance for assets programs, relying on relief food, selling livestock to buy food, selling forest products, reducing the number of meals per day and moving herds from one place to another across the four agro-ecological zones. Multivariate probit regression model analysis showed that different socio-economic characteristics had a varying influence on the farmers' choice of specific coping strategies. The study therefore recommends that interventions by state and non-state actors aimed at enhancing households' ability to cope with climate variability and extreme events related food shortages should be informed by household's specific socio-economic characteristics that influence the coping strategy in question in specific agro-ecological zones.

Keywords: *agro-ecological zones, climate variability, food assistance for assets, households, multivariate probit model*

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1. Introduction

The current food system which feeds the great majority of world population and supports the livelihoods of over one billion people has been under pressure from several stressors ranging from climate change to non-climate stressors such as population and income growth as well as demand for animal-sourced products [1]. According to [2], agriculture is one of the most sensitive sectors to climate variability and extreme events since any degree of climate variability is associated with severe negative impacts on agricultural production and related processes. Changes in the frequency and severity of extreme climate events, such as droughts and heavy precipitation are likely to have serious negative impacts on agricultural production with projections showing up to 50% yield reduction and a decline of up to 90% in crop revenue by 2100 [3]. Reports have projected a decline in agricultural productivity due to increasing temperatures, changing precipitation patterns and greater frequency of some extreme events which is a threat to food security in drylands especially in Africa [1]. According to the IPCC Fourth Assessment Report (AR4), predictions have shown that the area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease with yields from rain-fed agriculture, which is important for the poor farmers, reducing by up to 50 percent by 2020 in some countries [4].

The effects of changing temperature and rainfall patterns are more pronounced in developing countries owing to their geographic exposure, low income, greater reliance on rain-fed agriculture and other climate sensitive sectors coupled with its weak capacity to adapt to the changing climate [5,6,7]. The IPCC (2007) report estimated that Africa will be the most vulnerable continent to the progressive changes in climate globally, due to its low adaptive capacity resulting from the multiple stresses of poor infrastructure, poverty and governance [3]. For

sub-Saharan Africa, variations in temperature and precipitation are predicted to see an increase in crop pests and diseases in addition to altered soil fertility [8].

Further, increased temperatures, shifts in rainfall distribution, increased frequency of extreme weather events and consequently increased heat stress and reduced water availability are expected to adversely affect livestock production and productivity around the world which is an important source of food and livelihoods for households in semi-arid lands [9]. According to [10], the adverse impacts of climate variability and change on livestock production are expected to be most severe in arid and semi-arid grazing systems at low latitudes, where higher temperatures and lower rainfall are expected to reduce yields on rangelands and increase land degradation.

The effects of climate variability will affect all the four dimensions of food security: food availability, food accessibility, food utilization and food systems stability thereby impacting on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows [11]. Coupled with declining incomes and rising unemployment, the adverse effects of climate variability and extreme events on the agricultural sector are therefore expected to increase the vulnerability of farmers to food insecurity thereby worsening the state of human health in the region [12].

Like many other countries in Sub-Saharan Africa, studies have shown that Kenya is one of the most vulnerable countries to climate variability and extreme events due to its low adaptive capacity and dependence on climate-sensitive sectors such as agriculture and fisheries as the key drivers of its economy [13,14,15]. In order to respond to the immediate effects of climate variability and extreme events on agricultural productivity, farmers have been reported to use different coping strategies as response mechanisms to climate induced food insecurity [16,17,18]. According to [19], coping mechanisms are short-term actual responses to crisis on livelihood systems in the face of a disaster. Coping involves use of available skills, resources, and opportunities to address, manage, and overcome adverse conditions to enable households achieve basic functioning in the short to medium term [20].

In their study, [21,22] and [6] noted that adoption of different coping strategies vary among different geographical locations and between social settings, as well as between livelihood cores (e.g. between agro-pastoral communities depending on livestock raising compared to sedentary farming communities depending primarily on crop production. Further, [23] noted that a household's ability and decision to adopt a particular strategy is determined by several institutional and socio-economic factors. The present study therefore sought to examine strategies adopted by farmers to cope with food insecurity at the household level as well as the determinants of the farmers' choice of specific coping strategies in four agro-ecological zones in Kitui County.

2. Materials and Methods

2.1. Profile of the Study Area

The study was carried out in four agro- ecological zones; semi-humid, transitional semi-humid to semi- arid, semi-arid and arid zones in Kitui County. The study sites are shown in Figure 1.

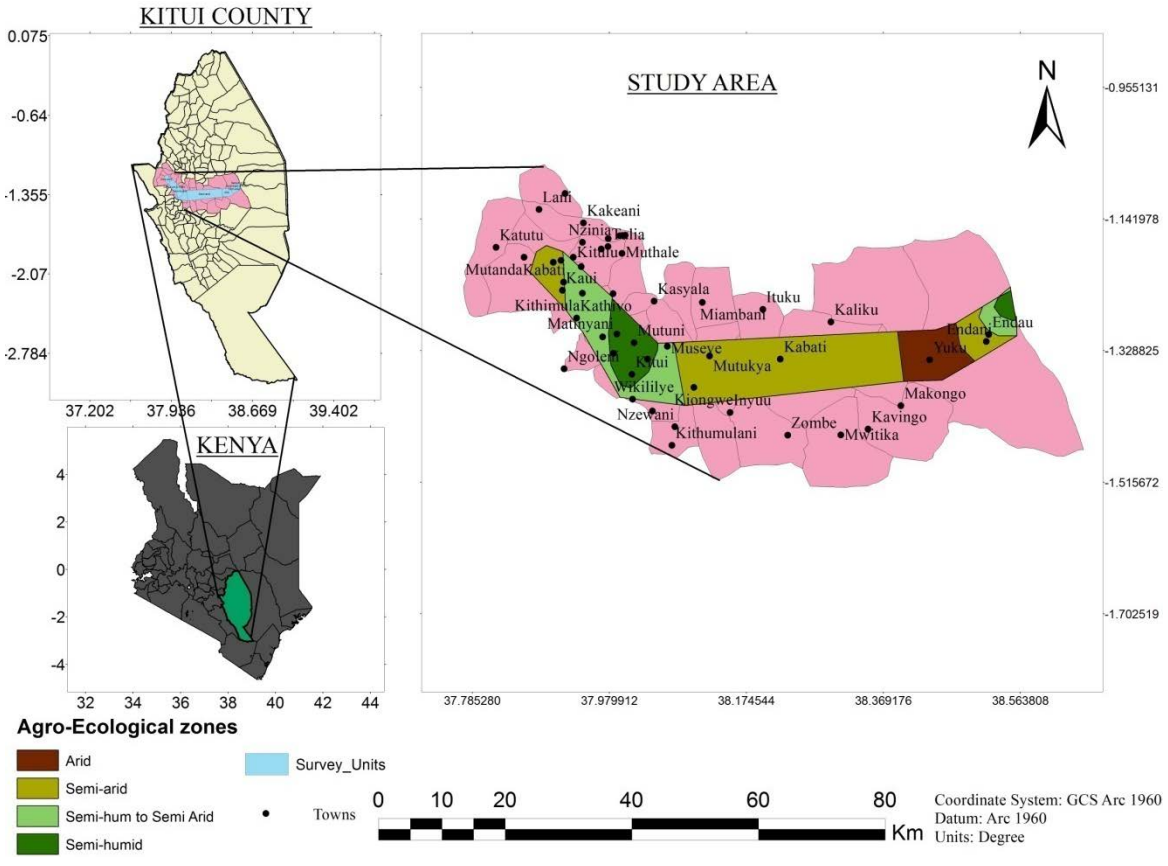

Figure 1. Map of Kitui County showing the study area in four agro-ecological zones (Source: ILRIS GIS Database)

Kitui County lies between 400m to 1,830m above sea level and generally slopes from the west to east with the highest regions being Kitui Central and Mutitu Hills [24]. The climate of the area is semi-arid with very erratic and unreliable rainfall. The area is hot and dry throughout the year with temperatures ranging from a minimum of 14-22° centigrade to a maximum of 26-34° centigrade. The months of February and September are the hottest months in the year [24].

Rainfall is distributed within two seasons annually, long rains which are experienced between March and May and short rains between October and December. The total rainfall in the County varies from 500-1050mm with about 40% reliability. The short rains are considered more reliable than the long rains since it is during the short rains that farmers get their main food production opportunity [25].

The County's population is approximately 1,136,187 according to the population and housing census report of 2019 [26]. Livestock production and crop farming are the back bone of the people's economy in the area contributing to nearly three quarters of the household earnings [24,27]. The main livestock types kept in the County are cattle (beef and dairy), goats (meat and dairy), sheep and poultry (indigenous and exotic) [24].

Various crops such as maize, beans, sorghum, pigeon peas, millet and cassava are cultivated mainly for subsistence while green grams, sweet potatoes, vegetables such as tomatoes, kales, spinach, pawpaw, onions and fruits (mangoes, bananas, water melons) are grown for sale and household consumption [24,25,27]. The study area comprises selected sub-locations from four different agro-ecological zones in Kitui County.

2.2. Study Design and Sampling Techniques

The study employed the descriptive survey design. Agro-pastoral farmers in the study area were the target population. The household was the unit of study while the head of the households were the respondents. Stratified sampling method was used to classify the study sites with reference to four different agro-ecological zones in Kitui County. One sub-location in each agro-ecological zone was randomly selected along a transect line (in a buffer zone of 5km radius on both sides of the line). Simple random sampling method was used to identify respondents in the selected sub-location.

The study sample size was determined by calculating 10% of the number of households in each of the four sub-locations since according to [28], a sample size of 10% provides an adequate representation of the target population in descriptive research. The total sample size for the study was 341 households with 39, 160, 38 and 104 households being selected from arid, semi-arid, transitional semi-arid to semi-humid and humid zones, respectively.

2.3. Data Collection and Analysis

Primary data was collected through administration of structured questionnaires and key informant interviews. Chi square test of independence was used to test for difference in the adoption of different food insecurity coping strategies across the agro-ecological zones.

Multivariate Probit (MVP) regression model was run in Stata version 12 to assess the determinants of households' choice of different food insecurity coping strategies in the study area.

The MVP decision model is guided by the random utility theoretical model which describes a choice decision in which an individual has a set of alternative coping strategies to choose from [29]. The utility model assumes that each option has distinct attributes that influence a farmer's choice over another alternative and is based on the assumption that the utility is derived by choosing several alternatives.

The utility random model is described below as applied by [30]. Assuming that U_j is the expected utility that a farmer will gain from adopting coping strategy j whereas U_k is the expected utility for not choosing coping strategy j but rather k.

The linear random utility model of coping with food insecurity by choosing j_{th} coping strategy (U_j) can be expressed as a function of explanatory variables X_i as shown below;

$$U_{ij} = x_i\beta_j + \mu_j \quad (1)$$

The linear random utility model for i_{th} farmer who does not use j_{th} coping strategy but rather k_{th} coping strategy is given by:

$$U_{ik} = x_i\beta_k + \mu_k \quad (2)$$

Where x_i is a vector of explanatory variables β_j and β_k are vectors of parameters for choosing j_{th} and k_{th} coping strategy, respectively, μ_j and μ_k are error terms for choosing j_{th} and k_{th} coping strategy, respectively. According to [31], to the error terms in the above equations are assumed to be normally independently and identically distributed.

If a farmer chooses to adopt j_{th} coping strategy, then the expected utility that the farmer gets is greater than the expected utility for not using that strategy and according to [32], a farmer chooses coping strategy j over strategy k if and only if the expected utility from coping strategy j is greater than that of k as expressed in equation 3.

$$U_{ij} = x_i\beta_j + \mu_j > U_{ik} = x_i\beta_k + \mu_k \quad (3)$$

Following [33] and [34], the MVP model assumes that each subject has J distinct binary responses. Let i=1,...n be the independent observations, j=1,...J be the available options of binary responses, and X_i be a matrix of covariates composed of any discrete or continuous variables.

Let $Y_{ij} = Y_{i1}\ldots Y_{ij}$ denote the J-dimensional vector of observed binary responses taking values {0;1} on the i^{th} household and; $Z_{ij} = Z_{i1}\ldots Z_{ij}$ denote a J-variate normal vector of latent variables such that:

$$Z_{ij} = X_{i\beta} + \varepsilon_i 1 = 1\ldots n \quad (4)$$

where $\beta = \beta_1\ldots\beta_j$ is a matrix of unknown regression coefficient, ε_i is a vector of residual error distributed as multivariate normal distribution with zero means and

unitary variance; $\varepsilon_i \sim N\left(0, \sum\right)$, where Σ is the variance-covariance matrix.

The off-diagonal elements in the correlation matrix, $\rho_{kj} = \rho_{jk}$ represent the unobserved correlation between the stochastic components of k^{th} and J^{th} options [35].

The relationship between Z_{ij} and Y_{ij} is:

$$Y_{ij} = \begin{cases} 1 & if > 0; \\ 0 & otherwise \end{cases} \} i = 1 \ldots n \text{ and } j = 1 \ldots J \qquad (5)$$

The likelihood of the observed discrete data is then obtained by integrating over the latent variables

$$Z : P(Y_{ij} = {}^{1}\!\!\diagup\!\!_{X_i \beta \sum}) \int A_{i1} \Phi_T (Z_{ij} = {}^{1}\!\!\diagup\!\!_{X_i \beta \sum}) dZ_{ij} \qquad (6)$$

Where, A_{i1} is the interval (0, ∞) if Y_{ij}=1 and the interval (-∞, 0) otherwise and $A_{i1}\Phi_T (Z_{ij} = {}^{1}\!\!\diagup\!\!_{X_i \beta \sum}) dZ_{ij}$ is the probability density function of the standard normal distribution.

Since the coefficient estimates from MVP regression show the direction of influence rather than the magnitude [36] to interpret the effects of explanatory variables on the probabilities, marginal effects were derived as follows:

$$\partial ij = \frac{\partial Pij}{\partial x_i} Pij \left[\beta j - \sum_{k=0}^{j} P_{kj} \beta_k \right] = P_{ij} \left[\beta j - \beta \right] \qquad (7)$$

Where, δij-denotes the marginal effect of the explanatory variable on the probability that alternative j is chosen. According to [37], the marginal effects measure the expected change in probability of a particular choice with respect to a unit change in an explanatory variable. The multivariate probit (MVP) regression model was suitable for this study since it simultaneously models the influence of the set of explanatory variables on each of the coping strategies, while allowing the unobserved factors (error terms) to be freely correlated [38,39].

Selected food insecurity coping strategies adopted by farmers were used as the dependent variables while farmers' socio-economic characteristics were used as the explanatory variables for the model as described in Table 1 and Table 2, respectively.

Table 1. Description and summary statistics of dependent variables used in the Multivariate Probit model

Dependent variables (Coping Strategies)	Description of Variables	Mean	SD
Reduce food consumption	Dummy=1 if household adopts reduce food consumption 0=otherwise	0.41	0.49
Sell livestock to buy food	Dummy=1 if household adopts sell of livestock to buy food 0=otherwise	0.62	0.47
Use off-farm income to buy food	Dummy=1if household adopts use of off-farm income 0=otherwise	0.64	0.48
Sell family assets	Dummy=1if household adopts sell of family assets 0=otherwise	0.35	0.48
Sell forest products	Dummy=1if household adopts sell of forest products, 0= otherwise	0.11	0.31

Table 2. Description and summary statistics of explanatory variables used in the Multivariate Probit Model

Variable	Description	Mean	SD	Expected sign
X_1	Gender of household head (1= male; 0= female)	1.29	0.46	+/-
X_2	Age of the household head (number of years of the household head)	55.86	15.11	+/-
X_3	Household size (number of family members in the household)	5.88	2.64	+/-
X_4	Education level of the household head (years of schooling of the household head)	12.43	4.41	+
X_5	Access to credit (1= yes; 0= otherwise)	0.35	0.48	+
X_6	Distance from the market (how far the household is from the market in Km)	2.79	3.24	+
X_7	Land size (number of acres owned by the household)	5.82	8.07	+/-

3. Results

3.1. Farmers' Coping Strategies to Food Insecurity in the Study Area

Results from the study showed that farmers in the study area had adopted several strategies to cope with food shortages resulting from climate variability and extreme events as shown in Table 3. Chi-square test results showed that there was a statistically significant difference ($p<0.01$) in farmers' use of off-income to buy food, food for work programs, receiving relief food, selling livestock to buy food, selling forest products and reducing number of meals per day across the four agro-ecological zones.

From the results, it was noted that most farmers from the arid (85%) and semi-arid (66%) zones used off-farm income to buy food as compared to those in the transitional semi-humid to semi-arid (58%) and semi-humid (53%) zones. The results also indicated that most farmers in the arid (90%) and semi-arid zones (68%) sold livestock to buy food compared to those in the transitional semi-humid to semi-arid and semi-humid zones (43% and 66%, respectively).

Further, the results showed that a larger percentage of farmers in the arid and semi-arid zones (67% and 47%, respectively) reduced the number of meals per day to cope with food shortages from drought as compared to their counterparts in the semi-humid (37%) and transitional semi-humid to semi-arid zones (32%) zones.

Additionally, it was noted from the results that a larger proportion of farmers in the arid (49%) and semi-arid (34%) zones benefited from food assistance for assets programs compared to their counterparts in the transitional semi-arid to semi-humid (32%) and semi-humid (20%) zones. The results further indicated that a greater percentage of households in the arid zone (28%) were selling forest products such as charcoal, timber and firewood to cope with drought as compared to the other zones.

Table 3. Farmers coping strategies to food insecurity in the study area

Coping Strategy	Percentage adoption in different agro-ecological zones				X^2	P-Value
	Arid zone (Yuku Sub-location)	Semi-arid (Kauwi Sub-location)	Transitional Semi-arid to Semi-humid (Kauwi Sub-location)	Semi-humid (Kauwi Sub-location)		
Use off-income to buy food	85	66	53	58	11.29	0.01***
Taking loans to buy food	10	9	18	11	2.59	0.46
Food Assistance for Asset programs	49	34	32	20	11.96	0.01***
Relying on relief food	46	68	66	22	55.85	0.00***
Selling livestock to buy food	90	68	65	43	30.12	0.00***
Seek off-farm employment	41	29	21	26	4.39	0.22
Sell forest products	28	6	8	4	16.39	0.00***
Sell sand	5	3	0	1	3.40	0.34
Reduce number of meals	62	44	37	32	11.4	0.00***
Sell family assets	54	40	21	27	13.96	0.00***

Note * significant at 99% confidence level.

3.2. Determinants of Farmers' Choice of Specific Coping Strategies to Food Insecurity in the Study Area

Multivariate Probit regression model was run in Stata version 12. The coefficients estimates of the model are presented in Table 4. The null hypothesis for test of independence in the model was rejected since the likelihood ratio test (*Log likelihood = -889.28*; Prob > $\chi 2$ = 0.00) of independence of error terms was significant implying that there is mutual interdependence among the coping strategies thereby justifying the use of multivariate probit regression model in assessing the determinants of farmers' choice of different coping strategies as it captures wider effects as opposed to the univariate probit model. The pairwise correlation coefficients (Rho) indicated in Table 4 also indicate a positive correlation between the pairs most of which are highly significant implying that the sets of coping strategies are complimentary. Variance inflation factor (VIF) values for all the explanatory variables were between 1 and 3 and thus multicollinearity was not a concern since according to [47], multicollinearity concerns arise when the VIF value is greater than 10.

Table 4. Coefficient estimates of Multivariate Probit regression results on determinants of farmers' adoption of specific coping strategies in the study area

Explanatory Variables	Dependent Variables				
	Reduced food consumption	Sell livestock to buy food	Seek off-farm jobs	Sell family assets	Sell forest products
Age	-0.01 (0.01)	-0.01 (0.01)	-0.02 (0.01)**	0.02 (0.01)**	-0.01 (0.01)
Gender	0.49 (0.16)***	0.10 (0.16)	-0.39 (0.17)**	0.35 (0.16)**	0.02 (0.02)
Household size	0.07 (0.03)**	0.10 (0.03)***	0.01 (0.03)	0.07 (0.03)***	0.11 (0.04)***
Education level	0.01 (0.02)	-0.03 (0.02)*	0.01 (0.02)	-0.03 (0.02)*	0.03 (0.02)
Access to credit	0.13 (0.15)	0.06 (0.14)*	0.08 (0.16)	0.01 (0.15)	0.01 (0.20)
Distance to market	-0.06 (0.03)*	-0.03 (0.03)	0.03 (0.03)	-0.01 (0.02)	0.01 (0.02)*
Land size	0.03 (0.01)***	0.03 (0.01)**	-0.00 (0.01)	0.01 (0.01)	0.01 (0.01)
Constant	-1.22 (0.40)***	-0.20 (0.40)	0.84 (0.43)**	-0.53 (0.40)***	-2.34 (0.56)***
	Rho 1	**Rho 2**	**Rho 3**	**Rho 4**	**Rho 5**
Rho 2	0.12				
Rho 3	0.44***	0.03			
Rho 4	0.33***	0.04	0.29***		
Rho 5	0.38***	0.26***	0.48***	0.19**	

Number of obs = 341; Wald chi2(35) = 108.19 Log likelihood = -883.83 Prob > chi2 = 0.00
Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0: chi2 (10) = 94.6
*Prob > chi2 = 0.00; Figures in parentheses are standard errors; ***, **, * significant at 99%, 95% and 90% confidence levels, respectively.*

Marginal effects were used to quantify the influence of explanatory variables on the dependent variables as shown in Table 5.

Table 5. Marginal effects of explanatory variables on the dependent variables in the model

Explanatory Variables	Dependent Variables				
	Reduced food consumption	**Sell livestock to buy food**	**Seek off-farm jobs to buy food**	**Sell family assets**	**Sell forest products**
Age	-0.00 (0.00)	-0.00 (0.00)	-0.01 (0.01)***	0.01 (0.01)*	-0.00 (0.00)
Gender	0.18 (0.06)***	0.03 (0.06)	-0.12 (0.05)	0.12 (0.05)**	-0.00 (0.04)***
Household size	0.02 (0.01)**	0.03 (0.01)***	-0.00 (0.01)	0.02 (0.01)**	-0.02 (0.01)***
Education level	0.00 (0.17)	-0.01 (0.01)*	0.01 (0.01)	-0.01 (0.01)*	0.01 (0.01)
Access to credit	0.05 (0.05)	0.03 (0.16)*	0.04 (0.01)	0.01 (0.05)	-0.01 (0.03)
Distance to market	-0.02 (0.01)**	0.02 (0.01)**	-0.01 (0.01)	-0.01 (0.01)	0.01 (0.01)
Land size	0.01 (0.00)***	0.02 (0.01)***	-0.04 (0.00)	0.01 (0.01)	-0.01 (0.01)**

The multivariate probit regression results indicated that age of the household head had a negative influence on the adoption of all the coping strategies except on the adoption of selling family assets. Further, the age of the household head had a significant positive and negative significant influence on the adoption of seeking off-farm jobs and selling family assets, respectively. The marginal effects showed that a unit increase in age of the household head increased the probability of selling family assets while reducing that of seeking off-farm jobs by 1%.

Gender of the household head had a positive influence on reducing food consumption, selling livestock, selling family assets and selling forest products to buy food. The influence of gender of the household head was however negative on the adoption of seeking off-farm jobs. Further, results indicated that influence of the gender of the household was significant on the adoption of selling family assets, reducing food consumption and seeking off-farm jobs with marginal effects of 0.12, 0.18, and 0.12, respectively. This implies that male-headed households were more likely to adopt selling of family assets and reduction of food consumption by 12% and 18% respectively, compared to female-headed households which were 12% more likely to seek off-farm income to feed their households in times of food shortage.

As expected, household size had a significant positive influence on the adoption of reduction of food consumption and selling of livestock, family assets and forest products to buy food. From the marginal effects results, a unit increase in household size increased the probability of adopting reduction of food consumption, selling of family assets and forest products by 2% and that of adopting sale of livestock by 3%.

In regards to education level of the household head, the results showed a significant negative influence on the adoption of selling of livestock and family assets to buy food with marginal effects of 0.01 on both coping strategies. The results imply that a unit increase in the number of schooling years of the household head reduced the probability of selling livestock and family assets to buy food by 1%.

The results further indicated that access to credit facilities had a significant positive influence on the adoption of sale of livestock to buy food with a marginal effect of 0.03. The results imply that households with access to credit were 0.03 times more likely to adopt selling of livestock as a coping strategy than households without access to credit facilities.

In addition, distance to the market had a significant negative and positive influence on the adoption of reduction of food consumption and selling of forest products, respectively. It had a marginal effect of 0.02 on the adoption of reducing food consumption while that of forest products was 0.01 implying that a unit increase in distance to market reduced the adoption of reduction of food consumption as a food insecurity coping strategy by 2%. Similarly, it increased the adoption of selling forest products by 1%.

Lastly, the results indicated that land size had a significant positive influence on the adoption of selling of livestock to buy food and reduction of food consumption and with marginal effects of 0.02 and 0.01, respectively.

4. Discussion

4.1. Farmers' Coping Strategies to Food Insecurity in the Study Area

The results of this study showed that there was a significant variation in the adoption of the several coping strategies in the four agro-ecological zones. This could be because the different agro-ecological zones have varying exposure levels to climatic extremes as well as different adaptive capacity due to different climatic and socio-economic settings. Households in the semi-humid zone for example, are less likely to experience extreme food shortages which might force them to reduce their daily meal consumption since they have relatively favorable climatic conditions for crop farming compared to those in the arid zone. Further, households in the arid zones are often exposed to subsequent droughts and food shortages and have therefore invested most of their efforts on off-farm income generating activities in order to meet their food needs as opposed to those in the semi-humid areas.

The results are in agreement with findings from a similar study by [21] which established that there was a

significant variation (P <0.01) in coping strategies used by households such as borrowing food and money as well as reducing meal frequency and amount across different climatic zones in Dabat District, Northwest Ethiopia. Similarly, [40] noted that households in three different agro-ecological zones in Lay Gayint District, Ethiopia had adopted different coping strategies to food shortage with reduction of the numbers and types of meals and selling land to purchase food being more adopted in the most vulnerable agro-ecological zone, Kolla, lowland.

The results indicated that most farmers from the arid and semi-arid zones used off-farm income to buy food compared to those in the transitional semi-humid to semi-arid and semi-humid zones. This could be explained by the fact that the arid and semi-arid zones receive erratic and little rainfall resulting to subsequent crop failures and food shortage and thus farmers have to rely more on off-farm income to buy food as compared to those in the transitional and semi- humid zones which receive relatively adequate rainfall for crop production in most seasons. The results are in consonance with findings from similar studies which noted that households used off-farm income to buy food in times of food shortage [17,25,41].

As indicated in the results, most farmers in the arid and semi-arid zones sold livestock to buy food compared to those in the transitional semi-humid to semi-arid and semi-humid zones. This could be attributed to the fact that the arid and semi-arid zones are mostly suitable for livestock production than crop production as compared to the transitional semi-humid to semi-arid and semi-humid zones which receive relatively adequate rainfall for crop production and have smaller pieces of land which can hardly support large herds of livestock. The results concur with findings from [42] who noted that selling of livestock to buy food was an important coping strategy to food shortage in Turkana County, a dryland in Kenya. Additionally, [43] also noted that selling of livestock to buy food was a common coping strategy to food deficit in Dailekh District, in Nepal.

Additionally, the results showed that a larger percentage of farmers in the arid and semi-arid zones reduced the number of meals per day to cope with food shortages from drought as compared to their counterparts in the semi-humid and transitional semi-humid to semi-arid zones. This implies that farmers in the drier agro-ecological zones are at a higher risk of experiencing food shortages due to climate variability and extreme events compared to their counterparts in relatively wetter agro-ecological zones. The results are in agreement with findings from similar studies by [44], [21] and [40] who noted that reduction in number of meals per day was a common coping strategy to food shortage. Further, the current trend of results corroborates findings of similar work by [41].

A larger proportion of households in the arid and semi-arid zones benefited from the food assistance for assets programs compared to their counterparts in the transitional semi-arid to semi-humid and semi-humid zones. This could be because most of the intervention programs by World Food Program in partnership with other development partners such Caritas-Kitui and NDMA target the dry land regions of Kitui County due to their higher vulnerability to droughts. The food assistance for assets programs provide immediate food needs for the most vulnerable farmers while increasing their long-term food security and resilience to climate variability and extreme events by increasing the farmers' capacity to adopt different adaptation measures such soil conservation and farm water harvesting structures for supplementary irrigation [46,47]. Key informant interviews with stakeholders however revealed that the programs had been suspended for more than 5 years thereby leaving the households to fend for themselves in times of food shortages.

In regards to selling forest products, the results further indicated that a greater percentage of households in the arid zone were selling forest products such as charcoal, timber and firewood to cope with drought as compared to the other zones. This is probably because the arid zones experience more frequent and severe droughts compared to the other agro-ecological zones in the study area thus households have incorporated exploitation of forestry products such as charcoal and wood fuel as a means of income diversification in times of droughts. Further, households in the arid zones have relatively large pieces of land with indigenous tree species which provide an opportunity for charcoal production compared to the other zones. Unsustainable exploitation of forestry products however could contribute to deforestation and further desertification thereby increasing the households' vulnerability to climate related disasters. The results are in consonance with findings from a similar study by [42] who noted that production and selling of charcoal was a major source of income for coping with food shortages during drought among households in Turkana County in North Eastern Kenya. Additionally, [41] also noted that 54.2% of the respondents in Kwale County used income from charcoal production to cope with food insecurity.

4.2. Determinants of Farmers' Choice of Specific Coping Strategies to Food Insecurity in the Study Area

According to [23], the ability and decision to adopt a particular coping strategy is determined by several socio-economic factors. Results from this study indicated that different socio-economic characteristics of farmers had varying influence on the farmers' choice of specific coping strategies to food insecurity. The results implied that households with older household heads were more likely to sell family assets to buy food in times of food shortage compared to those with younger household heads while households with younger household heads were more likely to seek off-farm jobs compared to older household heads. The reason for this could be as age increases household heads become less productive and may therefore not be able to engage in off-farm income generating activities thereby resorting to sell their family assets to buy food in the face of food insecurity. Similar studies indicated that households with older household heads were more vulnerable to food insecurity since as the household head grows old, opportunities to engage in meaningful income-generating activities are minimized [44,48].

In regards to gender of the household head, the results indicated that male-headed households were more likely

to adopt selling of family assets and reduction of food consumption compared to female-headed households which were on the other hand more likely to seek off-farm income to feed their households in times of food shortage. The could be because women are in charge of their families' welfare and are therefore more likely to use available resources and skills towards improving the household's food needs compared to men. Similar work by [49] indicated that female household heads provide a critical buffer against food consumption shortfalls since they give more priority to improving their household's food security. In addition, [50] reported that women tend to use almost all of their non-agricultural income to satisfy the food needs of the household as opposed to their male counter parts who often use cash income for other purposes.

The significant positive influence of the household size on the adoption of reduction of food consumption and selling of livestock, family assets and forest products to buy food in the present study could be because a larger household size has higher demand for food resources compared to smaller households and therefore larger households might not meet the higher household food demands in times of food shortage and therefore resort to reduction of food consumption and selling of livestock, family assets and forest products such as charcoal to buy food. The results are in agreement with findings from a similar study by [51] that found out that food availability to larger families per head was frequently lower than that of smaller families and that per capita food intake decreases with an increase in family size. Similar work by [44] also indicated that households with larger family size tend to be more food deficient than those with smaller family size.

As expected, the results indicated that education level of the household head reduced the probability of selling livestock and family assets to buy food in the study area by 1% which could be explained by the fact that being an important human capital, education increases a household's opportunities for food access as well as production capacity through access to agricultural inputs and technology in climate smart agricultural practices thereby enhancing household's food security in the face of climatic uncertainties. Similar studies have found that education has a positive influence on a household's food security [52,53,54].

The results indicated that households with access to credit were more likely to adopt selling of livestock as a coping strategy than households without access to credit facilities which could be due to the fact that access to credit provides capital to households for investment in livestock production whose sales in turn provide income for food purchase in times of food shortage. The current trend of the results is in agreement with findings from other studies which indicated that access to credit increases the chances of farming households acquiring productive resources which boost production thus improving the household food security [52,55].

Distance to the market had a significant negative and positive influence on the adoption of reduction of food consumption and selling of forest products, respectively, implying that households near the market were less likely to reduce food consumption compared to those far away from the market who were more likely to sell forest products to buy food. This could be because access to market increases access of food products as well as agricultural inputs, information and technologies for enhanced agricultural production thus improving the households' food security. The results are in agreement with findings by [56] who noted that households that have access to major market centers had a significantly higher likelihood of being food secure compared to those without. Further, [57] also noted that proximity to market increases households' access to food products since trade in markets allows food to flow from areas of surplus to areas of deficit.

Lastly, the results indicated that households with larger land size were more likely to use income from livestock sales to buy food compared to those with smaller sizes of land. This could be explained by the fact that large sizes of land increase a household's capacity to keep larger herds of livestock and hence households with larger land sizes can sell more livestock to buy food in times of food shortages compared to those with smaller pieces of land. A similar study by [58] indicated that households with large herd sizes had better chances of earning more income from livestock production, thus enabling them to purchase food on cash when they are faced by food deficit as well as investing in farm inputs thereby increasing their food security.

Contrary to the expectation, the results implied that increase in land size increased a household's probability of adopting reduction of food consumption as a coping strategy to food shortage. This could be because most households in the study area use smaller proportions of their total land sizes for crop production since large land sizes may require more investments in terms of farm inputs and labour. Further, recurrent crop failures due to droughts may also discourage farmers form cultivating large sizes of land. The results however contradict findings by [59] who found that land size had a positive increase on the value of crop production, net crop income and net household income per adult equivalent in Kenya. Similarly, contradictory findings were reported by [60] who noted that each additional acre of household's land size in Masaka District, Uganda was associated with a 70% higher probability of having more than two meals among the households.

5. Conclusion and Recommendations

The study has indicated that farmers in different agro-ecological zones have autonomously adopted varied coping strategies in attempt to cope with vagaries of climate change, variability and extremes. In addition, the study found out that different socio-economic factors influenced farmers' choice of a specific coping strategy. The study therefore recommends that interventions by state and non-state actors aimed at enhancing households' ability to cope with climate variability and extreme events related food shortages should be informed by household's specific socio-economic characteristics that influence the coping strategy in question in specific agro-ecological zones. Further, studies on analysis of farmers' vulnerability to climate change, variability and extremes are recommended to yield information that can inform polices on planned adaptation and coping to the changing environment.

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Conflict of Interest

The authors declare no conflict of interest in the study.

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