AJLP & GS
African Journal on Land Policy and Geospatial Sciences

e-ISSN: 2657-2664, Vol.5, Issue.1, January 2022

https://revues.imist.ma/index.php/AJLP-GS/index

https://doi.org/10.48346/IMIST.PRSM/ajlp-gs.v5i1.30458 ***Category of the manuscript: Articles***

Received in: 13 October 2021 **Revised in: 21** October 2021 ***Accepted in:*** 3 November 2021

Large-scale agricultural investments and household vulnerability to food insecurity: Evidence from Kenya, Madagascar and Mozambique

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ABSTRACT

The 2008 food price and fuel price crisis accelerated large-scale agricultural investments in many developing countries. Africa has been the most targeted continent in receiving large-scale land acquisitions. Studies show that investment in land in underdeveloped areas may bring much-needed employment and income opportunities in the agricultural, non-farm and services sectors. Such opportunities could play a role in infrastructure and food distribution that could supply local consumers and stabilise prices.

Goal and Objectives:

This study set out to estimate the role of large-scale agricultural investments on household vulnerability to food insecurity in sample communities in Kenya, Madagascar and Mozambique based on their adoption of coping strategies.

Methodology:

The study used secondary data from the three countries (Kenya, Madagascar and Mozambique). The data were collected by the African Food, Agriculture, Land and Natural Resource Dynamics in the context of the global agro-food-energy system changes (AFGROLAND) project. The study employed coping strategy index (CSI), principal component analysis (PCA) and an ordered probit model to analyse the data.

Results:

The findings of the study revealed that households with members engaged in contract agreements with LSAIs adopted fewer coping strategies and were less food insecure than other households. Contract farming households seemed to cope better during food shortages (based on the marginal effects of the model). In comparison, households with members employed by an LSAI adopted more coping strategies than contract farming households. This might be because households with employed members had smaller numbers of livestock and smaller landholdings. Many LSAIs jobs were seasonal and low-paid, making the household less able to cope with food shortages. The study confirmed that households with more educated heads, smaller households, larger plot sizes and more livestock were less likely to slip into deeper levels of food insecurity should they face adversity. Most employed household heads had migrated from nearby districts. The job opportunities helped migrant workers mediate food insecurity. These results suggest that governments hosting LSAIs can promote plantation and contract farming that protect the land ownership of smallholder farmers, transfer good agricultural practices to improve agricultural production, household incomes and food security of smallholder farmers.

Keywords

Large-scale agricultural investment, food insecurity, coping strategy, vulnerability, ordered probit model.

1. INTRODUCTION

Food insecurity remains high in Africa despite the commitment of African governments to reduce hunger, malnutrition and food insecurity and their prioritisation of agriculture and food security programmes (Yengoh *et al.*, 2016). The G7 Heads of States recently committed to lifting 500 million people out of hunger and malnutrition by 2030 to tackle this challenge (ZEF and FAO, 2020). However, von Braun et al. (2020) have estimated that addressing the challenge by 2030 will require donors and developing countries to double their current spending on these efforts.

Some developing countries consider foreign direct investment (FDI) in the agriculture sector as essential to acquire agricultural inputs, increase productivity and achieve sustainable growth and poverty reduction to achieve food security for their populations (Mahmoodi and Mahmoodi, 2016; Persson, 2016). Africa has the highest number of large-scale land acquisitions in the global South due to the continent's agro-ecological suitability and the relatively low cost of land and labour (Andrews and Cochrane, 2021; Nolte *et al.*, 2016). In these countries, FDIs produce food and fibre crops, biofuels and flowers for export (Glover and Jones, 2019; Mechiche-Alami *et al.*, 2021; Songwe and Deininger, 2009).

African Union member states and other stakeholders have developed guidelines for large-scale agricultural investments in Africa (AUC-ECA-AfDB Consortium, 2014). The guidelines are based on human rights and gender equality. They promote six fundamental principles that include:

i. respecting the human rights of communities
ii. respecting the land rights of women
iii. conducting holistic assessments of investments
iv. recognizing the important role of smallholder farmers (inclusiveness) in achieving food security and poverty reduction
v. promoting collaboration among member states and
vi. enhancing accountability and transparency to improve governance (AUC-ECA-AfDB Consortium, 2014).

While these guidelines seek to ensure sustainable benefits for communities, investors and governments, LSAIs might not follow these guidelines, increasing the vulnerability of households in areas where such investments are located to food insecurity. In addition, the establishment of LSAI may affect livelihoods and household well-being through reduced access to land, natural resources such as water and pasture lands and tenure insecurity (Eriksen *et al.*, 2005; Verma, 2014).

Some scholars argue that FDI in large-scale agricultural investments may provide opportunities for smallholder farmers to create employment, transfer technology, foster economic growth and provide training, inputs and credit for smallholders (Persson, 2016; Zepeda, 2001). Studies have shown that LSAI may increase household income and improve production, reducing household vulnerability to food insecurity by smoothing consumption and improving the ability to cope during food shortages (Bekele *et al.*, 2021; Clemence *et al.*, 2017; Fitawek *et al.*, 2020; Fitawek and Hendriks, 2021).

Other scholars argue that large-scale agricultural investments (LSAIs) might negatively affect smallholder farmers by reducing access to land and natural resources (Johansson et al., 2016); they cause displacement and conflict (Oberlack *et al*., 2017; Soeters *et al*., 2017) and increase environmental degradation (Lisk, 2013; Zaehringe *et al*., 2018). These factors may increase the vulnerability of households to food insecurity (Baumgartner *et al*., 2015; Lazarte, 2017). Other studies have shown that migrant workers often occupy the jobs generated by large-scale farms, leaving local households vulnerable to food insecurity (Baumgartner *et al*., 2015; Lazarte ,2017).

2. THE CONCEPT OF VULNERABILITY TO FOOD INSECURITY

The term food insecurity describes the current and past condition of households, while vulnerability describes the risk of future food insecurity or worsened food insecurity (Hendriks, 2015). The term food security is defined as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (HLPE, 2020). Vulnerability is defined as the range of factors that place people at risk of becoming food insecure, including factors that affect their ability to cope (Proag, 2014; Sileshi *et al*., 2019; West and Haug, 2017). The degree of vulnerability is determined by exposure to the risk and the ability of individuals and households to cope with or withstand stressful situations (Conte, 2005; Thomas *et al*., 2018; Sileshi *et al*., 2019). These risk factors may be natural or human-induced, such as climate change, droughts, flooding, frost, land degradation, pests, rainfall patterns or risks related to population densities and price shocks (Dercon and Christiaensen, 2011; Gelaw and Sileshi 2013; Sileshi *et al*., 2019). Household food security is not static. It can change over time, existing on a continuum of experiences on which households move between more and less severe levels of food insecurity depending on their specific context (Hendriks, 2015).

Food-insecure households are vulnerable to shocks (Babatunde *et al*., 2008; Limon *et al*., 2017; Sileshi *et al*., 2019) and adopt food consumption coping strategies to mitigate food shortages (Shariff and Khor, 2008). Vulnerability also arises from the complex interactions between socio-economic, institutional and environmental systems (Eriksen *et al*., 2005; Krishnamurthy *et al*., 2014; Lazarte, 2017; Wineman 2016). New investments, technologies and safety net programs could offer opportunities to improve or secure new livelihoods for households (Ncube, 2012; West and Haug, 2017). The establishment of large-scale agricultural investments (LSAIs) might affect smallholder vulnerability to food insecurity (Behrman *et al*., 2012). Behrman *et al*. (2012) have suggested that if LSAIs are adequately implemented and follow an inclusive business model, they can distribute local resources more evenly and provide employment opportunities. Some studies have shown that contract farming business models may be more inclusive and beneficial for smallholder farmers' livelihoods and food security than plantation systems (Hall *et al*., 2017; Paglietti and Sabrie, 2013).

Many food security studies have used the Coping Strategies Index (CSI) to evaluate food insecurity (Bekele and Abdissa, 2019; Dunga and Duga, 2017; Ibrahim *et al*., 2016). The CSI has also been widely applied by World Food Program/Vulnerability Analysis Mapping Unit (WFP/VAM) and FAO (Bindraban *et al*., 2003; WFP, 2009; WFP, 2018). The CSI measures food security indirectly by asking households questions related to food consumption behaviour (Maxwell and Caldwell, 2008). It measures the severity of behaviours that households adopt to mitigate food shortages amidst or anticipation.

Maxwell and Caldwell (2008) categorised the coping strategies into four severity levels. The severity weighted as four (4) indicates the most severe strategies such as sending household members to beg, skipping the entire days without eating and gathering and eating wild fruits or immature crops. The severity level weighted as level three (3) includes practices such as consuming seed stocks held for the next season and restricting the food consumption for adult members. The severity level weighted as level two (2) (less severe strategies) includes borrowing food from relatives or friends, buying food on credit, sending a household member to eat elsewhere, feeding working family members and reducing the number of meals eaten in a day. The least severe strategies (weighted as level one (1)) include eating less preferred and less expensive foods and reducing meal sizes or limiting proportions. The socio-economic characteristics identified by many studies to be associated with vulnerability to food insecurity are summarised in Table 1.

Table 1. Variables, definitions and relation with vulnerability

Variables	Unit of Measurement	Hypothesised relationship with vulnerability to food insecurity
Household categories	Different groups of households (employed, contract and non-engaged	Employed and contract farming groups were less vulnerable to food insecurity (Behrman *et al*., 2012; Ibrahim *et al*., 2016; Loopstra *et al*., 2019)
Sex of the household head	Sex of the household head	Female-headed households were more vulnerable than male-headed (Eriksen *et al*., 2005; Mendy *et al*., 2020; Nkegbe *et al*., 2017)
Marital status of the household head	Marital status of the household head	Married households were less vulnerable than other groups (single, divorced and widowed) (Mthethwa and Wale, 2021; Mustapha *et al.,* 2016; Nkegbe *et al.,* 2017)
Education status of the household head	Education status of the household head	Educated households were less vulnerable than others (Eriksen *et al.,* 2005; Lazarte, 2017; Mendy *et al.,* 2020; Yengoh, 2016)
Household size	Total number of the household	The larger the household size, the more vulnerable the household (Ibrahim *et al.,* 2016; Mendy *et al.,* 2020; Sileshi, 2019)
Migration status of the household head	Migration status of the household	Migrant households were less vulnerable than a non-migrant (Adger *et al.*, 2002; Gartaula *et al.,* 2012, Sam *et al.,* 2019).
Household lost their land right	Household that lost their land right or not	Household that lost their land right were more vulnerable to food insecurity (Shete and Rutten, 2015)
Livestock ownership	Number of the livestock owned by the household head	Households with more livestock were less vulnerable to food insecurity (Eriksen *et al.*, 2005; Ibrahim *et al.,* 2016)
Land size	Total cultivated land sized owned by the household(ha)	The larger the land size, the less vulnerable the household (Ibrahim *et al.,* 2016; Sileshi *et al.,* 2019)

This study investigated the role of LSAIs on household vulnerability to food insecurity in sample communities in Kenya, Madagascar and Mozambique based on their adoption of coping strategies. The analysis employed the CSI and an ordered probit model to identify households who were most vulnerable to deepening levels of food insecurity relative to the nature of their engagement with the LSAI.

3. METHODOLOGY

The study used secondary data from the three countries (Kenya, Madagascar and Mozambique). The data were collected by the African Food, Agriculture, Land and Natural Resource Dynamics in the

context of global agro-food-energy system changes (AFGROLAND) project.

3.1. Data source and sample size

The study areas were purposively selected by the AFGROLAND project based on the location of LSAIs over the past two decades. These three countries promote FDI through large-scale agricultural investments to support agricultural sector growth (Gunasekera and Newth, 2015). Mozambique is among the ten most targeted countries worldwide for agricultural FDI. In Africa, Mozambique is second only to the Democratic Republic of the Congo (DRC) (Land Matrix, 2021) in terms of the amount of land involved in LSAIs, with investments involving 3 409,537 ha in Mozambique in 2020 (Land Matrix, 2021). The Land Matrix (2021) has reported LSAIs covering 356,038 ha in Kenya and 588,322 ha in Madagascar.

The project used a three-stage stratified random sampling procedure. In the first stage, project areas were purposively selected in each country: Nanyuki area in Kenya, Satrokala and Ambatofinadrahana regions of Madagascar and the Nacala Corridor in Mozambique (Monapo and Gurué districts) based on the existence of at least one LSAI. In the second sampling stage, companies were purposively selected based on their level of development (most had been established in the last 10 to 20 years), the area cultivated (greater than 200ha) and the number of households potentially affected by the LSAI through contracts and jobs. In the third stage, a total of 1651 representative households were randomly selected (Table 2). The data were collected using semi-structured questionnaires in 2016 and 2017 (January to March 2017 from Kenya, March to April 2017 from Madagascar and September to October 2016 from Mozambique) (Reys, 2016; Reys and Burnod, 2017; Reys and Mutea, 2017).

Table 2. Countries sample size

Country	District	Number of households interviewed	Household category		
			Total households employee in LSAIs	Total households engaged in contract	Non-engaged households
Kenya	Nanyuki	546	46	58	442
Madagascar	Satrokala and Ambatofinadrahana	601	61	124	416
Mozambique	Gurue and Monapo	504	121	-	383
	Total sample	**1651**	**228**	**182**	**1241**

Households were classified into three categories based on their engagement in LSAIs, namely households:

i. with a member employed by an LSAI (employed),
ii. in an out-grower contract with an LSAI (contract) and
iii. in the same communities where a member was neither employed nor contracted to an LSAI (non-engaged households).

3.2. Methods of data analysis

The study used the Coping Strategies Index (CSI) to measure food security and vulnerability (Maxwell and Caldwell 2008). The data were collected for a seven-day recall period, and the score calculated as (Maxwell and Caldwell 2008) follows:

$$CSI = (frequency\ CS1 * severity\ CS1) + (frequency\ CS2 * severity\ CS2) + \cdots + (frequency\ CS12 * severity\ CS12 \quad (1)$$

where CSI: is the coping strategy index; CS1 to CS12 indicated the various type of coping strategies.

The frequency (how many days in the last week a household had adopted a strategy) was scored as never (0) to every day (7). The frequency was multiplied by the severity weighting taken from Maxwell and Caldwell (2008); weighted as four for the most severe category of strategies; three for the next-less severe category; two for the less severe category and one for the least severe category. The CSI was the sum of the frequency multiplied by the severity for the 12 coping strategies. The higher CSI represented greater food insecurity (Maxwell and Caldwell, 2008; Ibrahim *et al.,* 2016).

Principal Component Analysis (PCA) was used to identify the more frequently practised coping strategies by each household category. PCA is a multivariate analysis technique that describes the underlying relationships amongst the variables by creating new indicators (factors or principal components) (Conte, 2005). The first factor in PCA captures the maximum variation between the factors. The subsequent components capture new but lower levels of variation (Field, 2009).

Finally, an ordered probit model was used to identify the determinant factors of household coping ability during food shortages based on the results of the CSI scores. The CSI was taken as an outcome variable (Y_i) and ranked into four ordered values (j = 1, 2, 3, 4) based on Maxwell *et al's.* (2014) cut off points, where CSI <=2 categorised under food secure; CSI >= 3 and <=12 categorised as mildly food insecure; CSI >=13 and <=40 categorised as moderately food insecure and CSI >40 categorised as severely food insecure. The ordered probit was derived from a latent (unobservable) random variable Y_i^*, which is expressed in the following equation as follows:

$$Y_i^* = X_i\beta + \varepsilon_i \quad (2)$$

Where Y_i^*: is the latent outcome variable (CSI); X_i: is a vector of explanatory variables (predictors) that describe the adaptive capacity of the households (employed, contract and non-engaged), sex of the household head, education status, marital status, household size, livestock holding, land size, migration status and households that had lost their land rights (see Table 1); β: is a vector of the

parameter to be estimated and ε_i: is the error term that is assumed to be normally distributed. The observed CSI (Y_i) is coded into four discrete categories as follows: -

$Y_i = 1$ if $0 <= Y_i^* <= 2$ (Food secure)

$Y_i = 2$ if $3 <= Y_i^* <= 12$ (Mildly food insecure)

$Y_i = 3$ if $13 <= Y_i^* <= 40$ (Moderately food insecure)

$Yi = 4$ if $Yi^* > 40$ (Severely food insecure)

The coefficients $\beta_1, \beta_2, \beta_3, ..., \beta_k$ were estimated with cut-off points $\mu_1, \mu_2, ... \mu_{k-1}$. The estimated cut-off points followed the order $\mu_1 < \mu_2 < \mu_3$ following Greene (2000). The marginal effects showed the probabilities that the CSI in any of the four food security status groups (food secure, mildly food insecure, moderately food insecure and severely food insecure) would change due to a unit change in a particular variable (Gloy *et al.,* 2000; Ibrahim *et al.,*016).

4. RESULTS

The results of the analysis are presented in the following three sections. The first section explains the descriptive results of the sampled household. The second section focuses on the results of principal component analysis. The final section provides the determinant factors of household coping ability during food shortages (food insecurity).

4.1. Descriptive statistic results

The summary of descriptive statistics results is presented in Table 3. In general, the majority of sampled households in the three countries were headed by males. Only a few household heads had not attended school. More than half the household heads had completed primary education. Around 20 percent of the sample households had completed secondary school. Only a few household heads had attended college or university.

There were more married household heads in Mozambique than in Kenya and Madagascar. The Kenyan sample had the fewest married household heads. On average, contract farming and non-engaged households in Madagascar were larger than other households in this country and in Kenya and Mozambique. In Kenya, LSAI-employed member households were the smallest (Table 3).

More LSAI-employed household heads had migrated from neighbouring communities in the Kenyan and Malagasy samples. On average, more households in Mozambique had lost their land rights than in Kenya and Madagascar. Non-engaged households in Madagascar had more livestock and more extensive landholdings than other households in all three countries. In general, households with members employed by an LSAI and non-engaged households in Mozambique had the lowest number of livestock (Table 3).

Table 3. Descriptive results of the total sampled households

Variable	Description	Category	Kenya			Madagascar			Mozambique	
			Employed (%)	Contract (%)	Non-engaged (%)	Employed (%)	Contract (%)	Non-engaged (%)	Employed (%)	Non-engaged (%)
SEX	Sex of the household head, 1 if sex of the household head male = 1, 0 for female	Male	58	75	60	85	89	85	94	87
		Female	42	25	40	15	11	15	6	13
EDU	Education status of the household head, If the household head no schooling = 0, primary = 1, secondary = 2, & college = 3	No school	17	21	21	18	8	15	16	16
		Primary	52	53	49	47	69	64	51	49
		Secondary	31	26	28	35	23	21	26	27
		College	0	0	2	0	0	0	7	8
MARST	Marital status of the household head, 1 if the household head married, 0 otherwise	Married	71	74	65	73	82	83	92	85
		Single/div	29	25	35	26	18	17	8	15
MIGR	Migration status of the household, 1 for migrant and 0 if non- migrant	Migrant	85	84	17	75	32	31	54	53
		Non-migrant	15	16	83	25	68	69	46	47
LANRL	Land rights lost, 1 if yes, 0 otherwise	Yes	2	5	5	5	0	0	25	18
		No	98	95	95	95	100	100	75	82
			Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
HHS	Household size		3.9	4.5	4.1	4.8	5.8	6.1	4.8	4.8
LVSK	Livestock holdings in tropical livestock unit (TLU)		2.3	4.5	2.9	2.1	1.4	14.3	0.1	0.1
LAND	Land size (hectares)		1.3	1.0	1.3	2.2	1.1	7.8	2.2	2.3
	Observation		46	58	442	61	124	416	121	383

4.2. The application of coping strategies by sampled households

A range of food consumption coping strategies was practised to mitigate food shortages. Consuming less expensive foods and limiting portion sizes were the most prevalent coping strategies among the households. Households with LSAI employed members in Kenya typically purchased food on credit and reduced the number of meals eaten in a day. In Madagascar, LSAI employed member households practised more coping strategies than non-engaged households, including borrowing food from friends or relatives, restricting adults' food consumption and skipping entire days without eating. Households in Mozambique borrowed food, gathered wild foods and reduced the number of meals eaten per day. More non-engaged households in Mozambique consumed seed stock held for the next season. Sending household members to eat elsewhere, sending household members to beg and feeding working members at the expense of non-working members were not frequently practised in the sampled households (Figure 1).

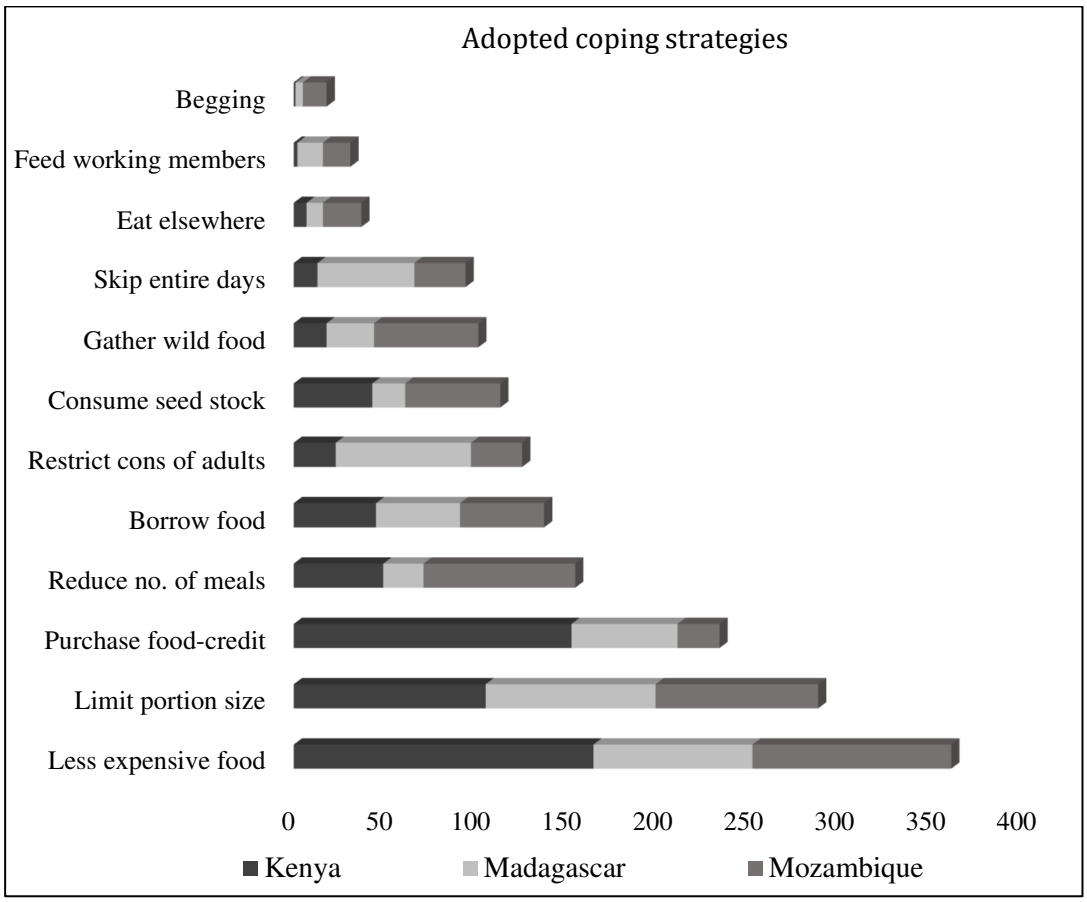

Fig 1. Adopted coping strategies (prepared by authors from 2016 and 2017 data).

Table 4 illustrates the patterns of household coping strategy adoption. The PCA results showed that households with LSAI employed members and non-engaged households in Kenya and Madagascar adopted more coping strategies than other households. Contract farming households in Kenya and Madagascar and households with employed members in Mozambique adopted fewer coping strategies than other households. In Kenya, contract farming households were more food secure than other households, only practising eight out of 12 coping strategies (Table 4).

Households with LSAI-employed members in Kenya frequently adopted seven coping strategies as set out as the first principal components in Table 4. Households with employed members and households with non-engaged households in Kenya generally adopted the same seven coping strategies. Contract farming households in Kenya were more food secure than other groups of households. They frequently adopted five of the less severe coping strategies. In contrast, non-engaged households adopted more severe coping strategies, including consuming seed stock held for the next season, sending a household member to beg and gathering wild foods or harvesting immature crops (Table 4).

In Madagascar, households with LSAI-employed members frequently adopted six coping strategies (Table 5). While contract farming households in Madagascar frequently adopted five coping strategies. The most severe coping strategies (such as sending household members to beg, consuming seed stock held for the next season and skipping entire days without eating) were not widely practised in Madagascar.

Table 4. Patterns of principal components of coping strategies in Kenya

Coping strategy	Employed			Coping strategy	Contract			Coping strategy	Non-engaged		
	PC1	PC2	PC3		PC1	PC2	PC3		PC1	PC2	PC3
Less expensive food	0.599			Less expensive food	0.388			Less expensive food	0.392		
Borrow food	0.345			Purchase food _credit	0.428			Borrow food	0.321		
Restrict cons. of adults	0.382			Restrict cons. of adults	0.441			Purchase food _ credit	0.357		
Limit portion size	0.304			Reduce the no. of meals	0.424			Restrict cons. of adults	0.307		
Gather wild food	0.327			Gather wild food	0.474			Limit portion size	0.392		
Eat elsewhere	0.332			Borrow food		0.330		Reduce the no. of meals	0.409		
Skip entire days	0.339			Limit portion size		0.579		Skip entire days	0.321		
Feed working members		0.422		Consume seed stock			0.345	Eat elsewhere		0.554	
Purchase food _credit		0.413		Skip entire days				Begging		0.602	
Consume seed stock			0.563	Eat elsewhere				Gather wild food			0.679
Reduce the no. of meals			0.673	Begging				Feed working members			0.692
Begging				Feed working members				Consume seed stock			0.839
Eigenvalue	5.75	1.58	0.99	Eigenvalue	3.14	1.61	0.98	Eigenvalue	3.00	1.62	1.15
Percentage variability	52.3	14.3	9.1	Percentage variability	43.0	20.1	12.3	Percentage variability	25.0	13.5	9.6

Table 5. Patterns of principal components of coping strategies in Madagascar

Coping strategy	Employed			Coping strategy	Contract			Coping strategy	Non-engaged		
	PC1	PC2	PC3		PC1	PC2	PC3		PC1	PC2	PC3
Less expensive food	0.374			Purchase food _ credit	0.385			Less expensive food	0.342		
Borrow food	0.389			Restrict cons. of adults	0.391			Borrow food	0.354		
Purchase food _ credit	0.346			Limit portion size	0.385			Restrict cons. of adults	0.300		
Restrict cons. of adults	0.375			Gather wild food	0.312			Reduce the no. of meals	0.351		
Limit portion size	0.399			Reduce the no. of meals	0.415			Purchase food _credit		-0.443	
Gather wild food	0.329			Feed working members		0.704		Begging		0.393	
Begging		-0.484		Consume seed stock		0.482		Limit portion size		-0.327	
Feed working members		0.535		Less expensive food		0.375		Feed working members			0.436
Reduce the no. of meals			0.469	Begging			0.992	Consume seed stock			0.779
Consume seed stock			0.931	Skip entire days			0.614	Skip entire days			0.296
Eat elsewhere			0.686	Borrow food			0.453	Eat elsewhere			0.794
Skip entire days				Eat elsewhere				Gather wild food			-0.363
Eigenvalue	4.28	1.70	1.38	Eigenvalue	3.88	1.33	1.22	Eigenvalue	4.45	1.53	1.28
Percentage variability	38.9	15.5	12.6	Percentage variability	35.3	12.1	11.1	Percentage variability	37.0	12.7	10.7

Employed member households and non-engaged households in Mozambique adopted fewer coping strategies than households in Kenya and Madagascar. Restricting adults' food consumption, limiting portion sizes, reducing the number of meals eaten in a day and skipping entire days without eating were practised frequently by households with employed members in Mozambique. Non-engaged households in Mozambique regularly implemented five coping strategies (see Table 6). As in Madagascar and Kenya, the most severe coping strategies were not widely practised in Mozambique (Table 6).

Table 6. Patterns of principal components of coping strategies in Mozambique

Coping strategy	Employed				Coping strategy	Non-engaged			
		PC1	PC2	PC3			PC1	PC2	PC3
Limit portion size	0.364				Restrict cons. of adults	0.351			
Restrict cons. of adults	0.449				Borrow food	0.323			
Reduce the no. of meals	0.352				Consume seed stock	0.329			
Skip entire days	0.388				Skip entire days	0.322			
Purchase food with credit		0.223			Purchase food _credit	0.257			
Eat elsewhere		0.354			Feed working members		0.433		
Feed working members		0.359			Limit portion size		0.521		
Less expensive food			0.201		Reduce the no. of meals		0.506		
Borrow food			0.331		Begging		-0.347		
Gather wild food			0.345		Gather wild food			0.772	
Consume seed stock			0.605		Less expensive food			0.866	
Begging			-0.367		Eat elsewhere			0.306	
Eigenvalue	2.89	1.66	1.31		Eigenvalue	3.32	1.54	1.04	
Percentage variability	24.1	13.8	10.9		Percentage variability	27.7	12.9	8.69	

4.3. Household vulnerability to food insecurity among sample households

No predictor variables in Mozambique were statistically significant in determining food insecurity. This indicated that both food secure and insecure (mildly, moderately and severely food insecure) households were equally vulnerable to worsened food insecurity levels should shocks occur.

Table 7 and 8 present the ordered probit model results of the four groups of households (food secure and mildly, moderately and severely food insecure households) in Kenya and Madagascar. The overall ordered probit model findings for Kenya and Madagascar were significant at a one percent level of significance ($p<0.01$) (see Tables 7 and 8). The estimated cut-off points (μ) for the two countries achieved the required conditions (that $\mu1 < \mu2 < \mu3$), indicating that these categories of food insecurity were ranked in order (as per Knight *et al.*, 2005). The first cut-off point Y=0 for food secure group was used as a benchmark.

The findings showed that the household category (i.e. households with a LSAI-employed or contracted members or non-engaged households) and the household head's education status were common predictors of households' adaptive capacity in Kenya and Madagascar (Table 7 and 8). In addition, the variables household size and land size were also predictors of adaptive capacity in Kenya. In Madagascar, the household head's marital and migration status were additional predictors of households adaptive capacity. However, in Mozambique, no variables were statistically significant.

This indicated that households with employed members and non-engaged households were equally vulnerable to food insecurity in Mozambique. This might be because food security was generally lower among sample households in Mozambique than in Kenya and Madagascar. The lower level of livestock that could be liquidated to cope with food shortages in Mozambique could also have influenced this outcome.

The household category (HHCATG) was a significant predictor of the level of food insecurity in Kenya. The negative coefficient showed that LSAI-employed member households were less food insecure than non-engaged households. The marginal effect (ME) revealed that if a member of a non-engaged household was to be employed by an LSAI, the household would likely remain food secure.

The more educated the household head was in Kenya, the less likely the household was food insecure. The marginal effect showed that an improvement in the education of the head would make the household less vulnerable to food insecurity. The household size was also a significant determinant of the level of food insecurity in Kenya. The positive coefficient indicated that larger households were more food insecure (Table7). The marginal effect revealed that an increase in household size rendered a household more vulnerable to deeper levels of food insecurity.

In addition, plot size was a significant predictor of moderately and severely food insecure households in Kenya. The larger the plot size, the less food insecure the household was. The findings concurred with the results of other studies (for example, Dunga and Duga 2017; Ibrahim *et al*., 2016; Mendy *et al*., 2020) as set out in Table 1.

Four statistically significant predictors affected food insecurity in Madagascar, namely the household category and the education, marital and migration status of the household head (Table 8). As for Kenya, the positive coefficient for education status indicated that the more educated the household head was, the more food secure a household was in Madagascar. Similarly, an improvement in the education of the head would make the household less vulnerable to food insecurity.

A positive sign for the marital status of the household head indicated that married household heads were more food secure than single household heads. This result concurs with previous studies that show that married household heads were likely to be less food insecure (for example, Mthethwa and Wale, 2021; Mustapha *et al*., 2016; Nkegbe *et al*., 2017). The majority of the sampled household heads were married in Madagascar.

Table 7. Determinants of food insecurity among farming households in Kenya

Variable	Coefficient	Food secure			Mildly food insecure			Moderately food insecure			Severely food insecure		
		SE	z-vale	ME (dy/dx)	SE	z-vale	ME (dy/dx)	SE	z-vale	ME (dy/dx)	SE	z-vale	ME (dy/dx)
HHCATG	-0.624	0.065	3.65***	0.237	0.023	-1.60	-0.037	0.038	-4.14***	-0.156	0.010	-4.34***	-0.044
SEX	0.146	0.037	-1.37	-0.051	0.003	-0.77	-0.002	0.028	1.36	0.039	0.011	1.35	0.015
EDU	-0.202	0.024	2.92***	0.071	0.004	0.90	0.003	0.019	-2.87***	-0.053	0.008	-2.73***	-0.022
MARST	0.094	0.039	-0.86	-0.033	0.002	-0.63	-0.001	0.029	0.85	0.025	0.011	0.85	0.009
HHS	0.149	0.009	-5.21***	-0.052	0.003	-0.92	-0.001	0.008	4.87***	0.039	0.004	4.34***	0.015
LVSK	-0.015	0.005	1.07	0.005	0.001	0.71	0.001	0.004	-1.07	-0.004	0.001	-1.06	-0.0012
LAND	-0.063	0.013	1.76	0.022	0.001	0.83	0.001	0.009	-1.75*	-0.017	0.004	-1.72*	-0.006
MIGR	0.060	0.046	-0.45	-0.021	0.002	-0.41	-0.001	0.016	0.45	0.016	0.014	0.45	0.006
LANLR	0.279	0.081	-1.21	-0.098	0.006	-0.74	-0.004	0.061	1.20	0.074	0.024	1.19	0.028
Cut 1	0.153												
Cut 2	1.076												
Cut 3	2.309												

Model specification: observations: 497; LR chi2 =53.43; Prob>chi2= 0.0000; log likelihood= -598.846; ***, * 0.01and 0.1 significance levels, respectively

Table 8. Determinants of food insecurity among households in Madagascar

Variable	Coefficient	Food secure			Mildly food insecure			Moderately food insecure			Severely food insecure		
		SE	z-vale	ME (dy/dx)	SE	z-vale	ME (dy/dx)	SE	z-vale	ME (dy/dx)	SE	z-vale	ME (dy/dx)
HHCATG	0.314	0.069	-1.67*	-0.117	0.027	1.81*	0.049	0.041	1.55	0.063	0.005	1.08	0.005
SEX	0.135	0.082	-0.57	-0.047	0.041	0.55	0.023	0.039	0.59	0.023	0.002	0.59	0.001
EDU	-0.135	0.027	1.77*	0.049	0.013	-1.72*	-0.022	0.014	-1.74*	-0.025	0.001	-1.21	-0.002
MARST	0.427	0.085	-1.80*	-0.154	0.040	1.75*	0.071	0.044	1.77*	0.078	0.004	1.20	0.005
HHS	0.002	0.010	-0.08	-0.001	0.005	0.08	0.001	0.005	0.08	0.001	0.000	0.08	0.000
LVSK	-0.001	0.001	0.43	0.001	0.004	-0.43	-0.001	0.004	-0.43	-0.001	0.000	-0.41	-0.000
LAND	-0.008	0.002	1.22	0.003	0.001	-1.18	-0.001	0.001	-1.22	-0.002	0.000	-0.99	-0.000
MIGR	-0.734	0.058	4.55***	0.264	0.032	-3.84***	-0.121	0.032	-4.16***	-0.134	0.006	-1.51	-0.009
LANLR	0.225	0.133	-0.63	-0.084	0.049	0.70	0.035	0.077	0.60	0.046	0.007	-1.13	0.004
Cut 1	-0.738												
Cut 2	0.034												
Cut 3	1.489												

Model specification: observations: 302; LR chi2 =50.51; Prob>chi2= 0.0000; log likelihood= -251.002; ***, * 0.01 and 0.1 significance levels, respectively

Households with migrant household heads in Madagascar were less food insecure than local household heads. The marginal effect revealed that a change in migration status of the household head (from non-migrant to migrant) did not lead to greater vulnerability to food insecurity (Table 8).

Besides the predictors mentioned above, the household group was another predictor of food secure and mildly food insecure households in Madagascar. Unlike in Kenya, in Madagascar, the household category's positive coefficient indicated that households with an employed member were more food insecure than non-engaged households. This might be because food security was generally higher among sample households in Kenya than in Madagascar.

Figure 2 depicts the summary of the outcomes. The households were classified into four groups (food secure, mildly, moderately, and severely food insecure) based on the CSI. Households were vulnerable to food insecurity if they were larger, had smaller plot sizes or had less educated household heads. Engaging in contract farming or having an LSAI-employed member improved household food security (Figure 2). Contract farming households with adequate food intake but worried about future food access typically practised less severe coping strategies (Figure 2). However, in Kenya, LSAI-employed member households were more likely to be moderately to mildly food insecure.

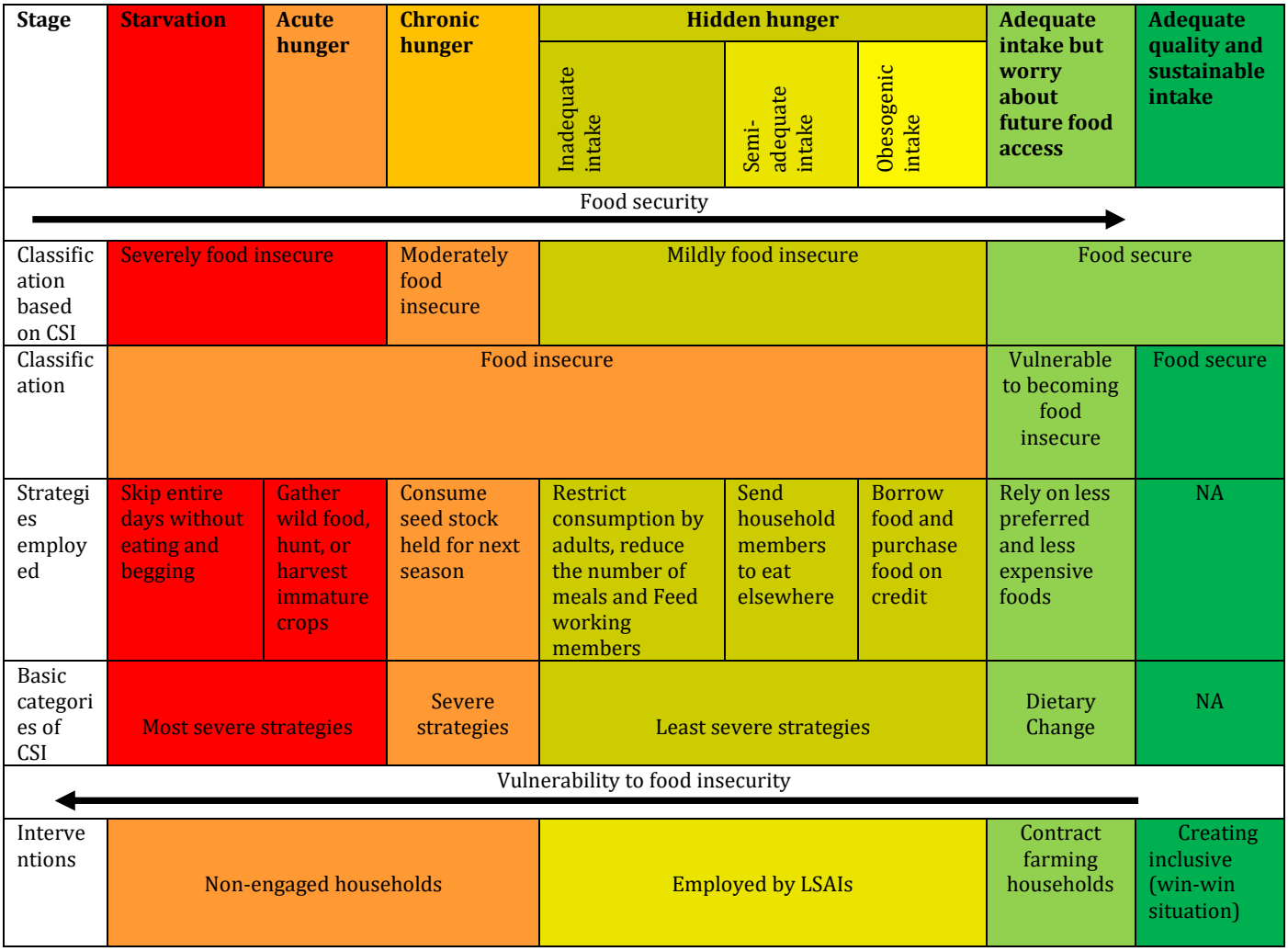

Figure 2. Continuum of food insecurity, coping strategies and LSAI interventions (adapted from Hendriks 2015).

5. CONCLUSIONS

This study assessed the role of large-scale agricultural investment on household vulnerability to food insecurity in Kenya, Madagascar and Mozambique. The findings revealed that households with members engaged in contract agreements with LSAIs adopted fewer coping strategies and were less food insecure than other households. Contract farming households seemed to cope better during food shortages (based on the marginal effects of the model). In comparison, households with members employed by a LSAI adopted more coping strategies than contract farming households.

This might be because households with employed members had smaller numbers of livestock and smaller landholdings. Many LSAIs jobs were seasonal and low-paid, making the household less able to cope with food shortages. The study confirmed that households with more educated heads, smaller households, larger plot sizes and more livestock were less likely to slip into deeper levels of food insecurity should they face adversity. Most employed household heads had migrated from nearby districts. The job opportunities helped migrant workers mediate food insecurity. These results suggest that governments hosting LSAIs can promote plantation and contract farming that protect the land ownership of smallholder farmers, transfer good agricultural practices to improve agricultural production, household incomes and food security of smallholder farmers.

6. ACKNOWLEDGMENT

WF would like to acknowledge Land Matrix Initiative for a postgraduate bursary.

7. FUNDING

This research was funded by Agriculture, Food Security and Climate Change (FACCE-JPI) African Food, Agriculture, Land and Natural Resource Dynamics (AFGROLAND) project.

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Wegayeh Fitawek: Conceptualisation, methodology, formal analysis, software, investigation, writing original draft preparation, visualisation.

Sheryl Hendriks: Project administration, conceptualisation, investigation, writing review and editing, visualisation, supervision, funding acquisition.

All authors have read and agreed to the published version of the manuscript

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11. KEY TERMS AND DEFINITIONS

Large-scale land acquisitions: land purchases, leases or concessions of lands of 200 hectares or more by an external actor for long periods of time for the purpose of agricultural production (food or agro-fuel production), timber extraction, carbon trading, mineral extraction, conservation and tourism (Nolte *et al.,* 2016).

Food security: is defined as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (HLPE 2020).

Vulnerability: is defined as the range of factors that place people at risk of becoming food insecure, including factors that affect their ability to cope.