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Climate Change Impacts, Food Security, Intra-Africa Trade and Sustainable Land Governance on Food Systems in Africa

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ABSTRACT

Climate change is an escalating environmental crisis affecting continents worldwide, with Africa experiencing a disproportionate burden as a result of reliance on rain-fed agriculture, inadequate adaptive capacities, and non-inclusive land governance systems. Coordinated efforts are essential to enhance inclusive land governance, strengthen resilience and livelihoods through community involvement, secure land tenure systems, and coherent policies. Inclusive land governance plays a vital role in achieving food security in Africa, necessitating equitable land access for smallholder farmers, women, and marginalized groups. The objective of this study is to comprehensively assess inclusive land governance in Africa's agriculture, with a specific focus on food security, climate change, sustainable food systems, and intra-Africa trade. This research employed a mixed-methods approach, including literature reviews and data analytics, integrating qualitative and quantitative data sources. The quantitative data source utilized was the Food and Agriculture Organization Statistics Division's Food Insecurity Experience Scale 2020, generated in January 2023. The results underscored the severe impacts of climate change on food security and African agricultural systems giving credence to the importance of inclusive land governance practices to mitigate climate change effects and promoting intra-African trade as a means of securing sustainable food systems and food-secured communities. Furthermore, the study emphasized the significance of regional collaboration and policy coherence in addressing climate change impacts for enhanced intra-Africa trade. Ultimately, the research emphasizes the crucial role of sustainable food systems, inclusive land governance policies, and enhanced agroecological approaches as key components of climate change adaption and mitigation strategies. Implementing these measures can contribute positively to food-secure African communities, enhancing their resilience against global market fluctuations and price shocks.

Keywords: *Climate change, Intra-Africa trade, Food security, Land governance, Sustainable food systems*

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INTRODUCTION

Inclusive land governance is essential for promoting sustainable development in Africa, particularly in the context of intra-Africa trade, food security, and sustainable food systems (Phiiri *et al*., 2016; Gravito & Alli, 2017; OECD, 2020; FAO, 2021). This plays a crucial role in enhancing intra-Africa trade by ensuring secure land tenure rights, facilitating land access for smallholder farmers and women, and promoting sustainable agricultural practices (Sun *et al.,* 2024). It is closely linked to the development of sustainable food systems by promoting agroecology, sustainable land management practices, and equitable access to land resources. Sustainable land management techniques, such as conservation agriculture, agroforestry, and organic farming, contribute to soil health, biodiversity conservation, and climate change adaptation (Nyamekye *et al*., 2018; Nourou *et al*., 2020; Hlatshwayo *et al*., 2021). Inclusive land governance also encourages the integration of smallholder farmers into value chains, facilitating their access to markets and ensuring fair prices for their produce. It has significant implications for climate change mitigation and adaptation. Climate change is a pressing global issue, and its impacts on Africa are particularly severe. By studying its effects on agriculture and land governance, we can better understand the urgency of addressing these challenges. On the other hand, food security is a fundamental human right, and Africa faces significant food security risks due to climate change (FAO, 2021). It is essential to examine how inclusive land governance can contribute to food security in the region. Consequently, intra-Africa trade has the potential to drive economic growth and reduce poverty. Climate change disruptions to agriculture threaten this potential, making it crucial to investigate the linkages between trade, climate change, and land governance. Sustainable land use practices are essential for long-term environmental and economic sustainability. This study will contribute to identifying strategies for achieving these goals in the context of climate change and intra-African Trade and food security.

Insecure land tenure discourages long-term investments in agriculture and it cannot provide the necessary collateral for accessing finance (Mazibuko & Antwi, 2019). It also fosters an unconducive environment for agricultural value chain development, agro-processing, and investment in rural infrastructure. When not properly managed, achieving food security in Africa will continue to be problematic, since it involves policies and practices that ought to prioritize equitable access to land, especially for smallholder farmers, women, and

marginalized groups. Secure land rights are expected to empower farmers to invest in sustainable agricultural practices, improve land productivity, and enhance resilience to climate change impacts. Climate change is a pressing global crisis (Nourou *et al*., 2020), particularly affecting Africa due to its high vulnerability to shocks stemming from diverse factors and dependence on rain-fed agriculture. Most communities in Africa heavily rely on rain-fed agriculture, lack adaptive capacities, and face challenges with non-inclusive land governance. By not promoting sustainable land use practices, non-inclusive land governance contributes to greenhouse gas emissions, carbon sequestration, and imbalanced climate resilience. Unintegrated land-use planning, noncommunity-based natural resource management, and participatory decision-making processes can hinder the drivers of deforestation and expose fragile ecosystems (Sun *et al*., 2024). Therefore, urgent efforts are needed to strengthen resilience (Phiiri *et al*., 2016) through inclusive land governance, involving community participation, secure land tenure systems, and coherent policies. Inclusive land governance is vital for achieving food security in Africa, prioritizing equitable land access for smallholder farmers, women, and marginalized groups. The objective of this study is to comprehensively assess inclusive land governance in Africa's agriculture, with a specific focus on food security, climate change, sustainable food systems, and intra-Africa trade.

Review of literature

Inclusive land governance is essential for building climate change resilience by integrating climate considerations into land-use planning, promoting climate-smart agriculture, and supporting adaptation strategies. It has implications for intra-Africa trade. Climate-resilient land management practices enhance the productivity and quality of agricultural products, improving competitiveness in regional and international markets. Climate-smart agriculture practices can also contribute to value addition and diversification of agricultural products, supporting trade opportunities. Its implications on Food Security and Sustainable Food Systems (FSSFS) can be achieved through Climate-resilient land management. This enhances the capacity of agricultural systems to adapt to climate change impacts, ensuring food security. The Food and Agriculture Organization highlights that climate-resilient agriculture can increase the productivity and stability of food systems (FAO, 2018). Information on specific aspects of inclusive land governance and its implications for enhanced intra-Africa trade, food security, sustainable food systems, and climate change.

Land Tenure Security: Land tenure security is a critical aspect of inclusive land governance, ensuring that individuals and communities have secure rights to the land they occupy or use. It provides the foundation for investment, productivity, and sustainable land management practices. This has implications for the intra-Africa trade. Secure land tenure rights enable farmers to make long-term investments, access credit, and engage in commercial agricultural activities. This promotes agricultural productivity, enhances the quality and quantity of produce, and contributes to increased intra-Africa trade in agricultural commodities. On FSSFS, land tenure security is essential for promoting sustainable and productive land use practices. It allows farmers to make long-term investments in land, adopt conservation practices, and implement climate-smart agriculture techniques. This leads to increased food production, improved livelihoods, and greater resilience to climate change impacts. For example: The Land Tenure Regularization Program in Rwanda aimed to provide land tenure security to smallholder farmers. The program issued land titles and certificates, resulting in increased access to credit, reduced land disputes, and improved agricultural productivity, contributing to food security (Deininger *et al.,* 2011).

Inclusive land governance emphasizes equitable access to land, ensuring that marginalized groups, women, and indigenous communities have fair and secure rights to land resources. This supports social justice, empowerment, and economic development. Marginalized groups, including smallholder farmers and women entrepreneurs, can participate in agricultural value chains and engage in trade. By promoting inclusiveness, land governance contributes to diversifying and expanding intra-Africa agricultural trade. Implications for Food Security and Sustainable Food Systems: Equitable access to land ensures that marginalized groups have opportunities to engage in agriculture, contribute to food production, and improve their livelihoods. It also supports the preservation of traditional knowledge and sustainable farming practices, enhancing food security and building sustainable food systems. For example: The National Gender Policy in Rwanda promotes gender equality in land governance and ensures that women have equal access to land resources. The policy has improved women's land rights, empowering them as active participants in agriculture and contributing to increased food production and household food security (Government of Rwanda, 2009). Participatory land governance involves the active involvement of stakeholders, including local communities, farmers, and civil society organizations, in decision-making processes related to land management and administration. This inclusive approach ensures that diverse perspectives are considered and fosters transparency and accountability. Participatory land governance fosters trust, cooperation, and inclusive decision-making among stakeholders involved in land-related activities. This creates an enabling environment for investment, promotes fair trade practices, and supports the growth of agricultural value chains in intra-Africa trade. To FSSFS, participatory land governance allows local communities and farmers to have a say in land-use decisions, leading to sustainable land management practices and the preservation of natural resources. Involving stakeholders in decision-making processes ensures that land policies align with the needs and aspirations of local communities, contributing to improved food security and the development of sustainable food systems. For example, the Community Land Act in Kenya, enacted in 2016, provides a legal framework for recognizing and protecting the land rights of communities. The act mandates the participation of communities in land governance processes, ensuring their involvement in decisions related to land use, conservation, and administration (Government of Kenya, 2016).

Climate Change Resilience and Sustainable Land Management: Inclusive land governance has implications for climate change resilience and sustainable land management practices. Promoting sustainable land-use practices, such as agroforestry, conservation agriculture, and climate-smart farming, contributes to climate change mitigation and adaptation. Implications for Intra-Africa Trade: Sustainable land

management practices foster resilience to climate change, enabling farmers to continue agricultural production even in the face of climate uncertainties. This stability supports the growth of intra-Africa trade by ensuring a reliable supply of agricultural commodities. Implications for Food Security and Sustainable Food Systems: Sustainable land management practices, including soil conservation, water management, and agroecology, enhance the capacity of agricultural systems to adapt to climate change. By promoting these practices, inclusive land governance supports food security, protects natural resources, and builds sustainable and climate-resilient food systems. Example: The Sustainable Land and Water Management (SLWM) project in Senegal focuses on promoting sustainable land management practices. By providing training and support to farmers in sustainable agriculture techniques, the project has enhanced soil fertility, reduced erosion, and improved agricultural productivity, contributing to food security and sustainable food systems (World Bank, 2021). Furthermore, sustainable food systems in Africa are essential for ensuring food security, promoting economic development, and safeguarding the environment. They involve a holistic approach that encompasses production, processing, distribution, consumption, and waste management. Some information, and examples of sustainable food systems in Africa are Agroecology and Organic Farming: Agroecology emphasizes the use of ecological principles and practices to promote sustainable agriculture. Organic farming, a key component of agroecology, eliminates the use of synthetic inputs and emphasizes soil health, biodiversity, and ecological balance. The Participatory Ecological Land Use Management (PELUM) Association promotes agroecology across several African countries. PELUM supports farmers in adopting organic farming practices, agroforestry, and sustainable soil management techniques (PELUM, 2021).

Urban Agriculture and Local Food Systems: Urban agriculture and local food systems contribute to sustainable food production, reduce food miles, and enhance access to fresh and nutritious food in urban areas. They involve practices such as rooftop gardens, community gardens, and farmers' markets (Kironde, 2017). The Dar es Salaam Urban Agriculture Program in Tanzania promotes urban farming and supports small-scale farmers in producing food within the city. The program improves food security, provides employment opportunities, and reduces pressure on rural agricultural land.

Value Chain Development and Market Linkages: Developing robust agricultural value chains and strengthening market linkages improve the efficiency and sustainability of food systems. This involves supporting smallholder farmers, promoting local sourcing, and reducing post-harvest losses. The Alliance for a Green Revolution in Africa (AGRA) supports value chain development in multiple African countries. Through their initiatives, AGRA works to improve market access, enhance value addition, and support smallholder farmers in adopting sustainable agricultural practices (Wise, 2020). Reducing food loss and waste is crucial for sustainable food systems. Efficient post-harvest handling, storage, processing, and distribution systems can minimize losses and ensure food reaches consumers effectively. The Zero Hunger Challenge in Ethiopia aims to reduce food loss and waste along the value chain. The initiative focuses on improved storage facilities, better transportation systems, and capacity-building programs to enhance food system efficiency and sustainability (FAO, 2020). The Zero Hunger Africa Challenge aims to reduce post-harvest losses and food waste in Africa. This initiative led by the African Union focuses on promoting sustainable production and consumption practices, improving food storage and processing technologies, and raising awareness about the impacts of food loss and waste (FAO, 2018). Also, Nutrition-sensitive agriculture focuses on promoting the production and consumption of diverse and nutritious food. It integrates efforts to address malnutrition, improve dietary diversity, and enhance the nutritional value of food. The Home-Grown School Feeding Program in Ghana incorporates locally sourced, nutritious food into school meals. The program supports smallholder farmers, improves children's nutrition, and promotes local food production (FAO, 2014).

Local and Regional Food Networks: Promoting local and regional food networks helps reduce the carbon footprint associated with long-distance transportation and supports local producers. It enhances food sovereignty, strengthens local economies, and improves access to fresh, nutritious food. The "Buy Local, Grow Local" campaign in South Africa encourages consumers to support local farmers and purchase locally produced food. The campaign initiated by the South African Department of Agriculture, Land Reform, and Rural Development in 2021, raises awareness about the importance of sustainable food systems and the benefits of buying from local sources (Muimba-Kankolongo, 2018). The Scaling Up Nutrition (SUN) Movement, active in several African countries, works to improve nutrition outcomes by integrating nutrition-sensitive agriculture into national policies and programs. SUN focuses on diverse farming practices, bio-fortification, and nutrition education to address malnutrition (Conceição *et al*., 2016).

Agroecology and Organic Farming: Agroecology and organic farming practices prioritize ecological sustainability, minimizing the use of synthetic inputs, and promoting biodiversity conservation. These practices contribute to soil health, reduce water pollution, and enhance ecosystem services. The Kilimanjaro Native Cooperative Union (KNCU) in Tanzania supports smallholder coffee farmers in adopting organic farming practices. By promoting agroecology, the cooperative protects the environment, enhances coffee quality, and ensures sustainable livelihoods for farmers (KNCU, 2021). Sustainable Fisheries and Aquaculture: Sustainable fisheries and responsible aquaculture contribute to sustainable food systems by promoting responsible fishing practices, protecting aquatic ecosystems, and ensuring the long-term viability of fish stocks. This supports food security and the livelihoods of fishing communities. The Fish for Livelihoods program in Malawi promotes sustainable fishing practices and supports small-scale fishers in adopting responsible fishing methods. The program focuses on improving fishing gear, enhancing fish processing and storage facilities, and conserving aquatic habitats (Fish for Livelihoods, 2021).

Food security in Africa has been a significant concern due to various factors, including population growth, climate change, and socio-economic challenges. Efforts to achieve food security involve ensuring access to nutritious food, increasing agricultural productivity, and addressing systemic issues. Here is some information, examples, and references up to 2021 on the topic of food security in Africa: Current Food Security Situation in Africa: According to the United Nations' Food and Agriculture

Organization (FAO), Africa continues to face food security challenges. The prevalence of undernourishment remains high, with an estimated 246 million people in sub-Saharan Africa suffering from hunger in 2020 (FAO, 2021). Climate Change Impacts on Food Security: Climate change poses significant threats to food security in Africa, with increased frequency and intensity of extreme weather events, droughts, and changing rainfall patterns. These factors affect agricultural productivity, exacerbating food insecurity (Intergovernmental Panel on Climate Change) (IPCC, 2019).

Agricultural Productivity and Investments: Improving agricultural productivity is crucial for achieving African food security. Investments in research and development, modern farming techniques, infrastructure, and access to credit can enhance agricultural productivity and efficiency. The African Green Revolution Forum (AGRF) is an annual platform that brings together stakeholders to discuss and promote agricultural transformation in Africa. It focuses on increasing productivity, improving market access, and strengthening the agricultural value chain to enhance food security (African Green Revolution Forum) (AGRF, 2021). Smallholder Farmers and Rural Development: Smallholder farmers play a crucial role in African agriculture, and their empowerment is essential for achieving food security. Supporting smallholder farmers through access to land, finance, improved seeds, and technology can enhance their productivity and contribute to food security. The National Smallholder Farmers' Association of Malawi (NASFAM) is a farmer-led organization that promotes smallholder agriculture in Malawi. NASFAM provides farmers with training, access to markets, and improved farming practices, contributing to increased food production and farmer livelihoods (National Smallholder Farmers' Association of Malawi) (NASFAM, 2021). Social Safety Nets and Nutrition Programs: Social safety nets and nutrition programs are critical for addressing immediate food security challenges and improving nutrition outcomes. These programs provide vulnerable populations with access to food, nutrition education, and income support. The National Home-Grown School Feeding Program in Nigeria aims to provide school children with nutritious meals sourced from local farmers. This program not only improves nutrition but also supports local agricultural production, contributing to food security and economic development (Federal Ministry of Humanitarian Affairs, Disaster Management and Social Development, 2021).

Case studies

The East African Community (EAC) has made efforts to promote inclusive land governance through the adoption of the EAC framework and guidelines on Land Policy in 2010. This framework aims to harmonize land policies among member states, enhance land tenure security, and facilitate cross-border investments and trade in the region (EAC, 2010). The Agricultural Development Program in Nigeria has implemented the Growth Enhancement Support Scheme, which provides subsidized fertilizers and improved seeds to smallholder farmers (FMARD, 2021). This initiative, coupled with efforts to strengthen land rights and improve land administration, has contributed to increased agricultural productivity and improved food security in the country. The Kilimanjaro Native Cooperative Union (KNCU) in Tanzania promotes sustainable coffee production practices among smallholder farmers (KNCU, 2021). Through training and capacity building, KNCU has supported farmers in adopting agroecological techniques, reducing reliance on synthetic inputs, and improving their resilience to climate change. The Nyungwe Nziza Project in Rwanda aims to restore degraded landscapes and protect the Nyungwe Forest National Park (Rwanda Development Board, 2020). It involves community-led initiatives, such as agroforestry, terracing, and sustainable agriculture practices, to improve land management, conserve biodiversity, and enhance climate resilience. The National Adaptation Plan for Agriculture in Rwanda integrates climate change considerations into agricultural planning, focusing on sustainable land management practices, climate-smart agriculture, and capacity building for farmers. This approach enhances climate resilience, food security, and sustainable agricultural development (MINAGRI, 2018). The Land Tenure Regularization Program in Rwanda aimed to provide land tenure security to smallholder farmers. The program issued land titles and certificates, resulting in increased access to credit, reduced land disputes, and improved agricultural productivity, contributing to food security. The Farmer Managed Natural Regeneration (FMNR) approach in Niger has restored millions of hectares of degraded land through reforestation and sustainable land management practices. FMNR has led to increased crop yields, improved food security, and enhanced climate resilience (ICRAF, 2012).

MATERIALS AND METHODS

Data set

To ensure a food-secured continent with enhanced intra-Africa Trade and sustainable land governance, this research employed a mixed-methods approach, including literature review and data analytics, integrating qualitative and quantitative data sources to explore the impacts of climate change on African agriculture. The quantitative data source utilized was the Food and Agriculture Organization Statistics Division's Food Insecurity Experience Scale 2020, generated in January 2023. This data set focused on Sustainable Development Goal (SDG) target 2.1 which commits countries to end hunger and ensure access by all people to safe, nutritious, and sufficient food all year round. The prevalence of moderate or severe food insecurity based on the Food Insecurity Experience Scale (FIES) provides internationally-compared estimates of the proportion of the population facing difficulties in accessing food. The FIES survey module includes the following questions to compute the FIES-based indicators. During the last 12 months, was there a time when, because of lack of money or other resources, were you worried you would not have enough food to eat? Were you unable to eat healthy and nutritious food? Did you eat only a few kinds of food? Did you have to skip a meal? Did you eat less than you thought you should? Did your household run out of food? Were you hungry but did not eat? Did you go without eating for a whole day? In addition to the FIES questions, socio-economic information of the respondent/household including gender, age, urban or rural area, region, education, and composition of households was collected.

Sampling procedure

A random digit dialing (RDD) approach was used to form a random sample of phone numbers. Stratified phone numbers made available from telephone service providers or

administrative registers were also used to integrate RDD when needed. Socio-demographic characteristics collected in the survey were then compared with the available information from recent national surveys to verify the extent to which the sample mirrored the total population structure. In case of discrepancies, post-stratification sampling weights were computed to adjust for the under-represented populations, typically using sex and education level.

Data analysis

Multinomial logistic regression (MNL)

The probability of severely insecure and moderately insecure were grouped into nine different scores. The scores were bunched together to make a significant whole (0 and 1). The best mode of analysis would have been binary regression analytical models like the binary logit or probit. To use any of these binary models, we categorized severely food insecure as 1 and moderately food insecure as 0. However, it was discovered that the variables were not converging hence the need to use the nine categories obtained from the dataset as independent variables. Which gave rise to the use of the multinomial regression model. The probability of severely insured was used separately against the independent variables while the probability of moderately food insecure scores was also used against the same independent variables at another time. In other words, we came about two separate results from these models. In describing the MNL as used in this study, the dependent variable Y representing the probability of being severely insecure was categorized into 9 scores/levels.

This can be specified as follows:

$$Y = Severely\ Food\ Insecure \quad (1)$$

$$X = Socio - demographic\ factors \quad (2)$$

$$Y = Severely\ Food\ Insecure = 0,1,2,3, \ldots \ldots 8 \quad (3)$$

Where 0= 0.000000, 1=0.0000231, 2=0.0000242, 3=0.0001754, 4=0.0024248, 5=0.0294845, 6=0.1907038, 7=0.5883225, 8=0.8791708

The MNL model can be specified as

$$\Pr(Y = K)\frac{1}{1 + \sum_{k=1}^{k-1} e^{\beta k - Xi}} \quad (4)$$

The regression equation can therefore be specified explicitly as:

$$Y = \beta + \beta X1 + \beta X2 + \beta X3 + - - - - - - - - - \beta X9 + e \quad (5)$$

$$F(Zi) = \beta + \beta X1 + \beta X2 + \beta X3 + - - - - - - - - - \beta X9 \quad (6)$$

β_k is the regression coefficient associated with k, for Z possible outcomes, running Z-1 independent regression models, one outcome is chosen as a 'pivot' and the other K-1 outcomes are separately regressed against the pivot outcome.

$$\Pr(Y_1 = 0) = \Pr(Yi = K)\, e\beta^{x} \quad (7)$$

$$\Pr(Y_1 = 1) = \Pr(Yi = K) e\beta^{x2} \quad (8)$$

Where variable K represents all the probability scores of food insecurity, the X(s) are the socio-demographic characteristics.

RESULTS AND DISCUSSION

Profile of respondents by socio-demographic characteristics

The study emphasized the importance of inclusive land governance practices in mitigating climate change effects and promoting intra-African trade for sustainable food systems and secure communities. Regional collaboration and policy coherence were highlighted as key factors in addressing climate change impacts for enhanced intra-Africa trade. Respondents sampled based on data obtained from the Food Insecurity Experience Scale of FAO Statistics showed 65% females and 35% males **(Table 1)**. Respondents by educational attainment showed that 51% had tertiary education, 39% went to secondary school, and less than 9% attended an elementary school or otherwise refused to answer the question. Respondents (68%) were in the 21-40 years age group, with a mean age of approximately 35 years. Respondents living in town/rural areas constituted 63%, while those living in the urban/suburban areas made up 37% **(Table 1)**.

Table 1. Profile of Respondents by sociodemographic characteristics.

Socio-economic characteristics	Freq.	Percent	Cum.
Gender			
Male	2900	34.78	34.78
Female	5439	65.22	100.00
Total	8339	100.00	
Education			
College	4289	51.43	51.43
Don't know	36	0.43	51.86
Elementary or less	665	7.97	59.84
Refused	63	0.76	60.59
Secondary	3286	39.41	100.00
Total	8339	100.00	
Age (years)			
0-20	587	7.04	7.04
21-40	5662	67.90	74.94
41-60	1719	20.61	95.55
61-80	204	2.45	98.00
81-100	167	2.00	100.00
Mean	35.269		
Total	8339	100.00	
Area			
Don't know	19	0.23	0.23
Refused	10	0.12	0.35
Towns/Rural	5250	62.96	63.30
Urban/Suburb	3060	36.70	100.00
Total	8379	100.00	

Source: FAO Statistics Division, 2020

Food insecurity experience scale (FIES) of respondents

The main aim of this section is to assess based on information provided by the respondents, access to good and quality food in the last twelve months. This was captured in the data by some qualitative indicators called the food insecurity experience scale (FIES), while the responses were recorded in a quantitative manner using 'yes' and 'no' **(Table 2)**. This was captured by asking respondents if they were at any point in the last 12 months worried about not having food. Eighty-two (82%) percent said 'yes' while 18% said 'no' **(Table 2)**. The implication of this was that the majority of the households were not always certain of getting food. This has become more intense considering different happenings in Sub-Saharan Africa, such as coups, the effect of climate change, the aftermath of COVID-19, farmer-herder clashes, etc. This therefore means that more households will be pushed into the food insecure state in Africa. Only 26% of the respondents were able to eat healthy food based on the result seen in **Table 2** while 73% were unable to eat healthy. The FIES outcome further shows that 75% of households had access to different food varieties, 73% skipped meals, 75% ate less than they should, and 53% ran out of food **(Table 2)**. Some respondents (58%) were hungry and could not eat while 29% were hungry throughout and did not have access to food.

Table 2. Profile of respondents by Food Insecurity Experience Scale (FIES).

FIES Scale	Freq.	Percent
Worried about not having enough food		
No	1487	17.83
Yes	6852	82.17
Unable to eat healthy		
No	2221	26.63
Yes	6118	73.37
Total	8339	100.00
Had few kinds of food		
No	2052	24.61
Yes	6287	75.39
Total	8339	100.00
Skip a meal for lack of food		
No	225	26.68
Yes	6114	73.32
Total	8339	100.00
Ate less than you should		
No	2128	25.52
Yes	6211	74,48
Total	8339	100.00
Ran out of food		
No	3965	47.55
Yes	4374	52.45
Total	8339	100.00
Hungry and did not eat		
No	3979	47.72
Yes	4360	52.28
Total	8339	100.00
Without eating for a whole day		
No	5903	70.79
Yes	2436	29.21
Total	8379	100.00

Source: FAO Statistics Division, 2020

Respondents by the probability of severely food insecure

This section assesses the respondent's insecurity state, by the probability of moderate food insecurity. The probability score was from 0 to 0.9 with none of the scores having a score of 20%. The highest as seen in the table was 19.86%, followed by 15.55% and 12%, respectively while the lowest score was 4.64%. This implies that the respondents have been well impacted by the effects of food insecurity **(Table 3)**.

Table 3. Profile of respondents by the probability of severely food insecure.

Probability of severely food insecure	Freq.	Percent
0.000000	1020	12.23
0.0000231	387	4.64
0.0000242	401	4.81
0.0001754	491	5.89
0.0024248	646	7.75
0.0294845	1240	14.87
0.1907038	1201	14.40
0.5883225	1656	19.86
0.8791708	1297	15.55
Total	8339	100.00

Probability of moderately food insecure

Below is an assessment of the respondent's insecurity state, by the probability of being moderately food insecure **(Table 4)**. The probability score was from 0 to 0.9 with none of the scores having a score of 20%. The highest as seen in the table was 19.86% while the lowest score was 4.64%. This implies that the respondents have been well impacted by the effects of food insecurity.

Table 4. Profile of respondents by the probability of Moderately food insecure.

Probability of Moderately food insecure	Freq.	Percent
0.0000000	1020	12.23
0.0368068	401	4.81
0.1200377	387	4.64
0.3365101	491	5.89
0.6439012	646	7.75
0.8751644	1240	14.87
0.967842	1201	14.40
0.9912806	1656	19.86
0.9979686	1297	15.55
Total	8339	100.00

Determinants of food insecurity

To further understand some of the effects of food insecurity on respondents, the probability of moderate food insecurity or severe food insecurity was regressed against their socio-demographic variables. The multinomial regression model was

used. This was preferred against other choice models ordered probit or logit, binary probit or logit because the individual values assigned to each independent variable i.e., moderately food insecure or severely food insecure were taken as an independent entity. Although respondents were not faced with any choice sets or diverse options as regards their food insecurity scores, the choice of MNL was a result of the selection of one among mutually exclusive alternatives (Carson, 1994; Osabohien, 2022). The MNL regression was used to estimate the correlates of severe food insecurity in this study **(Table 5)**. The result as shown in **Table 5** has a chi-square of 385.373, pseudo r-squared of 0.11, number of observations of 8339, Prob. > $\chi 2$ (0.0000) which is significant at 1% ($p < 0.01$). This implies that the model is significant as a whole in explaining the explanatory variables when compared to a null model without predictors. The base category for the entire variable severe food income was 0.58832252025. The older the respondents the more likely they would be severely food insecure at 1% level ($p < 0.01$). This implies that relative to their probability score of 0.000, older respondents would prefer to sacrifice their daily food portions for the younger ones. Educational level was significant but negative at 1% ($p < 0.01$), this implied that for any respondents who are educated, the likelihood of being severely poor relative to the base outcome (0.000) was negative (-0.069). The implication of this is that African countries should focus more on the education of their citizen to enhance their access to productive jobs that would reduce the incidence of severe food insecurity (National Archives, 2020). The likelihood of being food insecure was more negative for female respondents than for males. The female respondents ($p < 0.01$) have access to run different forms of employment activities that would provide for their households than the males, so the likelihood of severe food insecurity was reduced (-0.305). This is part of the ways rural women as seen to reduce poverty and improve their livelihood (FAO, 2016). Respondents with fewer children are less likely to be severely food insecure compared to those with many children. The outcome in **Table 5** showed a significant value ($p < 0.01$) however negative implying that respondents with fewer children are less likely to be severely food insecure (Harvey *et al*., 2014).

When the base outcome was 0.0000231100002566, the education of respondents, the area where respondents live, the number of adults, and the number of children were the only significant variables. Those who had one form of education or the other were less likely to be severely food insecure, the significant level was 1 percent ($p < 0.1$) while the beta value was -0.11. Respondents residing in the urban or suburbs were less likely to be severely food insecure (Pereira *et al*., 2021), the variable area was significant at 5% ($p < 0.05$) with a beta value of 0.509. Respondents with more adults were less likely to become severely insecure. The implication is that with more adults in the household, respondents will be able to seek other opportunities that would enhance their standard of living. This might involve engaging in menial jobs but at the end of the day, these adults will provide food for the family. This variable is significant at 1 percent ($p < 0.01$), with a value of 0.069. At 1 percent ($p < 0.01$) the probability of a household with fewer children becoming severe was -0.093. This implies that the higher the number of children in the household the more the responsibility to feed them. This therefore pushes households deeper into food insecurity status.

Table 5. Multinomial logistic regression of respondents by the probability of severe food insecurity.

Probability of Severe food insecure	Coef.	St. Err.	t-value	p-value	Interval	Sig
0.0000						
Age	0.009	.003	3.36	.001	.014	***
Education	-0.069	.021	-3.22	.001	-.027	***
Area	0.053	.081	0.66	.508	.211	
Gender	-0.305	.083	-3.67	0	-.142	***
Number of Adults	-0.018	.019	-0.98	.327	.018	
Number of children	-0.118	.017	-6.92	0	-.084	***
0.0000231100002566						
Age	-0.001	.004	-0.27	.789	.007	
Education	-0.058	.03	-1.93	.053	.001	*
Area	0.246	.113	2.18	.029	.468	**
Gender	-0.141	.118	-1.19	.233	.091	
Number of Adults	0.01	.026	0.39	.693	.061	
Number of children	-0.099	.024	-4.13	0	-.052	***
Constant	-1.494	.504	-2.96	.003	-.506	***
0.0000242299993261						
Age	-0.001	.004	-0.33	.738	.007	
Education	-0.111	.03	-3.67	0	-.052	***
Area	0.509	.111	4.57	0	.727	***
Gender	-0.129	.117	-1.10	.271	.101	
Number of Adults	-0.069	.027	-2.59	.01	-.017	***

Number of children	-0.093	.024	-3.91	0	-.047	***
Constant	-1.831	.501	-3.65	0	-.849	***
0.0001754499971867						
Age	-0.002	.004	-0.65	.515	.005	
Education	-0.031	.027	-1.13	.257	.023	
Area	0.040	.104	0.39	.698	.243	
Gender	-0.008	.109	-0.08	.938	.205	
Number of Adults	-0.015	.024	-0.61	.539	.032	
Number of children	-0.058	.021	-2.71	.007	-.016	***
Constant	-0.828	0.46	-1.80	.072	.073	*
0.0024247800465673						
Age	0.005	.003	1.46	.143	.011	
Education	-0.059	.025	-2.38	.017	-.01	**
Area	0.132	.093	1.41	.158	.314	
Gender	-0.031	.098	-0.32	.751	.162	
Number of Adults	-0.002	.021	-0.08	.935	.04	
Number of children	-0.060	.019	-3.11	.002	-.022	***
Constant	-1.063	.414	-2.57	.01	-.252	**
0.0294844508171082						
Age	-0.005	.003	-1.79	.074	0	*
Education	-0.145	0.02	-7.08	0	-.105	***
Area	-0.172	0.08	-2.24	.025	-.022	**
Gender	0.001	0.08	0.01	.995	.158	
Number of Adults	-0.001	.017	-0.05	.958	.033	
No. of children	-0.043	.016	-2.80	.005	-.013	***
Constant	1.042	.337	3.09	.002	1.703	***
Mean dependent var				0.286		
Pseudo r-squared				0.011		
Chi-square				385.373		
Akaike crit. (AIC)				34471.438		

Source: FAO Statistics Division, 2020; *** p<.01, ** p<.05, * p<.1 *** Base outcome= 0.58832252025.

The second outcome shown in **Table 6** was the probability of respondents being moderately food insecure. The MNL results as seen in **Table 6** have a chi-square of 385.373, pseudo r-squared of 0.11, number of observations of 8339, Prob. > $\chi 2$ (0.0000), which is significant at 1 percent ($p < 0.01$). This implies that the model is significant as a whole in explaining the explanatory variables when compared to a null model without predictors. The base category for the entire variable severe food income was 0.9912805557250977. With education respondents were less likely to be moderately food insecure, the probability of not being moderately food insecure was 0.009 significant at 1 percent ($p < 0.01$) when the base outcome was 0.000. Respondents who had a level of education were less likely to be moderately food insecure compared to those who had no form of education at all. The variable education was significant at 1 percent ($p < 0.01$) with a value of -0.069, which implies that education has a significant role in lifting people out of food insecurity (Bada *et al*., 2023). Females were less likely to be moderately food insure than males **(Table 6)**. The females were known for engaging in diverse income-generating activities aside from the main source of income, which serves as a shock absorber when the main income is not flowing as it should. The variable gender is significant at 1 percent ($p < 0.01$) while the beta value or coefficient was -0.305.

Table 6. Multinomial logistic regression of respondents by probability of moderately food insecure.

Probability of Moderately Food Insecure	Coef.	St. Err.	t-value	p-value	Sig.
0.0000					
Age	0.009	.003	3.36	.001	***
Education	-0.069	.021	-3.22	.001	***
Area	0.053	.081	0.66	.508	
Gender	-0.305	.083	-3.67	0	***

Number of Adults	-0.018	.019	-0.98	.327	
Number of children	-0.118	.017	-6.92	0	***
Constant	0.302	.354	0.85	.394	
0.0368068218231201					
Age	-0.001	.004	-0.33	.738	
Education	-0.111	.03	-3.67	0	***
Area	0.509	.111	4.57	0	***
Gender	-0.129	.117	-1.10	.271	
Number of adults	-0.069	.027	-2.59	.01	***
Number of Children	-0.093	.024	-3.91	0	***
Constant	1.831	.501	-3.65	0	***
0.1200376972556114					
Age	-0.001	.004	-0.27	.789	
Education	-0.058	.03	-1.93	.053	*
Area	0.246	.113	2.18	.029	**
Gender	-0.141	.118	-1.19	.233	
Number of Adults	0.010	.026	0.39	.693	
Number of Children	-0.099	.024	-4.13	0	***
Constant	1.494	.504	-2.96	.003	***
0.3365100622177124					
Age	-0.002	.004	-0.65	.515	
Education	-0.031	.027	-1.13	.257	
Area	0.04	.104	0.39	.698	
Gender	-.0008	.109	-0.08	.938	
Number of Adults	-.0015	.024	-0.61	.539	
Number of Children	-.0058	.021	-2.71	.007	***
Constant	-.0828	.46	-1.80	.072	*
0.6439012289047241					
Age	0.005	.003	1.46	.143	
Education	-0.059	.025	-2.38	.017	**
Area	0.132	.093	1.41	.158	
Gender	-0.031	.098	-0.32	.751	
Number of Adults	-0.002	.021	-0.08	.935	
Number of children	-0.06	.019	-3.11	.002	***
Constant	1.063	.414	-2.57	.01	**
0.8751644492149353					
Age	-0.005	.003	-1.79	.074	*
Education	-0.145	.02	-7.08	0	***
Area	-0.172	.077	-2.24	.025	**
Gender	0.001	.08	0.01	.995	
Number of Adults	-0.001	.017	-0.05	.958	
Number of children	-0.043	.016	-2.80	.005	***
Constant	1.042	.337	3.09	.002	***
0.9678420424461365					
Age	0	.003	-0.11	.916	
Education	-0.028	.02	-1.37	.169	
Area	-0.145	.077	-1.88	.06	*
Gender	-0.111	.08	-1.39	.165	
Number of Adults	0.001	.018	0.06	.952	
Number of children	-0.023	.016	-1.48	.14	
Constant	0.533	.338	1.58	.115	

0.9979685544967651					
Age	-0.002	.003	-0.56	.573	
Education	0.054	.02	2.76	.006	***
Area	-0.264	.076	-3.47	.001	***
Gender	0.076	.08	0.96	.339	
Number of Adults	-0.007	.017	-0.42	.677	
Number of children	0.051	.015	3.42	.001	***
Constant	0.196	.334	0.59	.557	
Mean dependent var	0.699				
Pseudo r-squared	0.011				
Chi-square	385.373				
Akaike crit. (AIC)	34471.438				

Source: FAO Statistics Division, 2020; *** p<.01, ** p<.05, * p<.1 ***

CONCLUSION

The outcomes from both the qualitative and quantitative results underscored the significance of sustainable food systems and the need to mitigate food insecurity among households in Africa. Inclusive land governance policies and agroecological approaches in climate change adaptation and mitigation strategies are ways that can enhance food production, and livelihoods and better the lives of Africans in the long run. By implementing these measures, African communities can enhance their resilience against global market fluctuations and price shocks, contributing to a more food-secure continent. Furthermore, to secure a continent that is food secure, this research employed the mixed-methods approach involving literature reviews and data analytics, integrating both qualitative and quantitative data sources. The quantitative data source was the Food and Agriculture Organization Statistics Division on Food Insecurity Experience Scale 2020, generated in January 2023. Results obtained highlighted the severe impacts of climate change on African agricultural systems. It also identified the importance of inclusive land governance practices to mitigate the impact of climate change and promote intra-African trade as a means of securing sustainable food systems and food-secured communities. Furthermore, the study underscores the role of regional collaboration and policy coherence in addressing climate change impacts for enhanced intra-Africa trade expounded by the country's literature reviewed.

As shown from the different literature reviewed and the regression results, inclusive land governance is a fundamental prerequisite for achieving enhanced food security, and sustainable food systems while addressing the challenges posed by climate change, which will eventually lead to enriched intra-Africa trade. By ensuring secure land tenure rights, empowering smallholder farmers, promoting sustainable land management practices, and involving local communities in decision-making processes, African countries can unlock the potential of their land resources. Concerted efforts, supported by sound policies, capacity-building initiatives, and financial investments, are necessary to prioritize inclusive land governance as a pathway toward sustainable development in Africa. Through inclusive land governance, Africa can foster inclusive economic growth, reduce poverty, ensure food security, and build climate-resilient communities. Inclusive land governance, encompassing land tenure security, equitable access to land, participatory approaches, and sustainable land management practices, has significant implications for enhanced intra-Africa trade, food security, sustainable food systems, and climate change resilience. The examples and references provided offer insights into successful initiatives and programs that have embraced inclusive land governance principles to address these interconnected challenges.

Sustainable food systems in Africa encompass a range of practices and approaches that promote food security, economic development, and environmental sustainability. By adopting agroecology, supporting urban agriculture, strengthening value chains, reducing food loss and waste, and promoting nutrition-sensitive agriculture, African countries can build resilient and sustainable food systems. Food security remains a significant challenge in Africa, but efforts are being made to address it. By focusing on agricultural productivity, climate resilience, empowering smallholder farmers, and implementing social safety nets, progress can be made toward achieving food security. Organizations and initiatives such as the AGRF, NASFAM, and nutrition programs like the National Home-Grown School Feeding Program in Nigeria are working towards improving food security outcomes in Africa.

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REFERENCES

African Green Revolution Forum (AGRF) (2021). AGRF summit.

African Union (2021). Zero hunger Africa challenge.

Alliance for a Green Revolution in Africa (AGRA) (2021). AGRA annual report.

Bada, M. M., Mohammed, S. T., Shettima, B. G., Sambo, A. S., Abdulaziz, K., & Ghide, A. A. (2023). Effects of post-harvest losses on poverty status of vegetable farming households in Kano State, Nigeria. *Journal of Agricultural Economics, Environment and Social Sciences*, *9*(2), 103-118. doi:10.56160/jaeess202392011

Carson, R. T. (1994). Experimental analysis of choice. *Department of Economics, University of California, San Diego, La Jolla, CA, 619*, 534-6319.

Conceição, P., Levine, S., Lipton, M., & Warren-Rodríguez, A. (2016). Toward a food secure future: Ensuring food security for sustainable human development in Sub-Saharan Africa. *Food Policy*, *60*, 1-9. doi:10.1016/j.foodpol.2016.02.003

Deininger, K., Ali, D., & Alemu, T. (2011). Impacts of land tenure regularization on investment and agricultural productivity: Evidence from Rwanda.

East African Community (EAC) (2010). EAC framework and guidelines on land policy.

FAO (2014). *The state of food insecurity in the world. Strengthening the enabling environment for food security and nutrition* (E-ISBN 978). www.fao.org/publications

FAO (2016). *RIMA-II: Moving forward the development of the resilience index measurement and analysis model*. http://www.fao.org/3/a-i5298e.pdf

FAO (2018). *Achieving zero hunger in Africa by 2025 taking stock of progress* (Food and Agriculture Organization (FAO) (ed.); African Un, Issue January). FAO. www.fao.org/contact-us/licence-request

FAO (2020). *Food and Agriculture Statistics-Crops, livestock and food*. Food and Commodity Balances 2010–2020. Global, Regional and Country Trends. https://www.fao.org/food-agriculture-statistics/data-release/crop-livestock-and-food/en/

FAO (2021). *Knowledge Sharing Platform on Emergencies and Resilience*. doi:10.4060/cb2947en

Federal Ministry of Agriculture and Rural Development (FMARD) (2020). Growth enhancement support scheme (GESS).

Federal Ministry of Humanitarian Affairs, Disaster Management and Social Development (2021). National home-grown school feeding program.

Fish for Livelihoods (2021). Fish for livelihoods program in Malawi.

Food and Agriculture Organization (FAO) (2018). Climate-resilient agriculture: A framework for decision-making.

Food and Agriculture Organization (FAO) (2021). The state of food security and nutrition in the world.

Government of Kenya (2016). Community Land Act.

Government of Rwanda (2009). National gender policy.

Gravito, L., & Alli, A. (2017). Infrastructure financing in sub-Saharan Africa-best practices from ten years in the field. *Development Finance Agenda (DEFA)*, *3*(3), 18-19. https://journals.co.za/doi/10.10520/EJC-ad6009be2

Harvey, C. A., Rakotobe, Z. L., Rao, N. S., Dave, R., Razafimahatratra, H., Rabarijohn, R. H., Rajaofara, H., & MacKinnon, J. L. (2014). Extreme vulnerability of smallholder farmers to agricultural risks and climate change in Madagascar. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *369*(1639), 20130089. doi:10.1098/rstb.2013.0089

Hlatshwayo, S. I., Ngidi, M., Ojo, T., Modi, A. T., Mabhaudhi, T., & Slotow, R. (2021). Evidence from the land reform beneficiaries in the central. *Sustainability (Switzerland)*, *13*(14).

Intergovernmental Panel on Climate Change (IPCC) (2019). Climate change and land: An IPCC special report.

Kilimanjaro Native Cooperative Union (KNCU) (2021). Coffee cooperative sustainability report.

Kilimanjaro Native Cooperative Union (KNCU) (2021). Organic farming and coffee quality enhancement.

Kironde, J. M. (2017). Enhancing urban food security through urban agriculture: A review of the Dar es Salaam urban agriculture program in Tanzania.

Mazibuko, N. V. E., & Antwi, M. A. (2019). Socio-economic factors influencing smallholder farmers agricultural infrastructure availability, accessibility and satisfaction: A case on North West Province in South Africa. *OIDA International Journal of Sustainable Development*, *12*(05), 11-26.

Ministry of Agriculture and Animal Resources (MINAGRI) (2018). National adaptation plan for agriculture.

Muimba-Kankolongo, A. (2018). *Food crop production by smallholder farmers in Southern Africa* (1st ed.). ScienceDirect (ELSEVIER).

National Archives (2020). *Black, Asian and minority ethnic histories-The national archives*. https://www.nationalarchives.gov.uk/education/resources/black-asian-and-minority-ethnic-histories/

National Smallholder Farmers' Association of Malawi (NASFAM) (2021). NASFAM annual report.

Nourou, A. I. M., Saidou, A. K., & Aune, J. B. (2020). Farmers' soil fertility management in niger and opportunities for improvements through mechanization, microdosing, and seed coating. *Frontiers in Sustainable Food Systems*, *4*, 570561.

Nyamekye, C., Thiel, M., Schönbrodt-Stitt, S., Zoungrana, B. J. B., & Amekudzi, L. K. (2018). Soil and water conservation in Burkina Faso, west Africa. *Sustainability, 10*(9), 3182. doi:10.3390/su10093182

Organization for Economic Co-operation and Development (OECD) (2020). COVID-19 in Africa: Regional socio-economic implications and policy priorities. *OECD*, 1–22.

Osabohien, R. A. (2022). *Technology adoption, post-harvest losses and agricultural productivity in Nigeria*. Covenant University, Otta.

Participatory Ecological Land Use Management (PELUM) Association (2021). PELUM Strategy.

Pereira, A., Handa, S., & Holmqvist, G. (2021). Estimating the prevalence of food insecurity of households with children under 15 years, across the globe. *Global Food Security*, *28*, 100482. doi:10.1016/j.gfs.2020.100482

Phiiri, G. K., Egeru, A., & Ekwamu, A. (2016). Climate change and agriculture nexus in Sub-Saharan Africa: The agonizing reality for smallholder farmers. *International of Current Research Review*, *8*(2), 57-64.

Rwanda Development Board (2020). Nyungwe nziza project: Landscape restoration for climate resilience.

Scaling Up Nutrition (SUN) Movement (2021). SUN countries.

South African Department of Agriculture, Land Reform and Rural Development (2021). Buy local, grow local campaign.

Sun, J., Li, J., & Cui, Y. (2024). Does non-farm employment promote farmland abandonment. *MDPI*, *13*(129), 1-20. doi:10.3390/land13020129

The World Bank (2021). Senegal sustainable land and water management project.

Wise, T. A. (2020). Failing Africa's farmers: An impact assessment of the Alliance for a Green Revolution in Africa. In *Working Paper - Global Development and Environment Institute, Tufts University*. https://sites.tufts.edu/gdae/files/2020/07/20-01_Wise_FailureToYield.pdf

World Agroforestry Centre (ICRAF) (2012). Regreening Africa.