OPEN ACCESS
International Journal of Applied Research in Social Sciences
P-ISSN: 2706-9176, E-ISSN: 2706-9184
Volume 6, Issue 7, P.No. 1403-1416, July 2024
DOI: 10.51594/ijarss.v6i7.1300
Fair East Publishers
Journal Homepage: www.fepbl.com/index.php/ijarss

Reviewing the impact of climate change on global food security: Challenges and solutions

Adekunle Stephen Toromade[1], Deborah Aanuoluwa Soyombo[2], Eseoghene Kupa[3], & Tochukwu Ignatius Ijomah[4]

[1]Department of Agricultural and Environmental Sciences, School of Biosciences, University of Nottingham, UK
[2]Milky Express Nigeria Limited, Lagos, Nigeria
[3]HSE Director - Frozen Hill Farms, Lagos State, Nigeria
[4]Independent Researcher, Australia

Corresponding Author: Adekunle Stephen Toromade
Corresponding Author Email: adekunle.toromade@nottingham.ac.uk

Article Received: 01-02-24 **Accepted:** 20-05-24 **Published:** 16-07-24

ABSTRACT

This review examines the intricate relationship between climate change and global food security, elucidating the challenges posed by climate variability and exploring potential solutions to mitigate its adverse effects. Climate change presents formidable obstacles to food security worldwide, disrupting agricultural productivity, exacerbating food shortages, and deepening malnutrition. Shifts in temperature and precipitation patterns, coupled with the increasing frequency of extreme weather events, threaten crop yields, livestock health, and food distribution networks, particularly in vulnerable regions. The review identifies key challenges confronting global food security in the context of climate change, including diminished agricultural productivity, heightened food price volatility, and heightened risks of food insecurity and malnutrition. It underscores the disproportionate impact of climate change on marginalized

communities, smallholder farmers, and low-income populations, who bear the brunt of environmental degradation and lack the resources to adapt. In response to these challenges, the review explores a range of solutions and strategies aimed at enhancing food security resilience in a changing climate. It discusses the importance of climate-smart agricultural practices, such as agroforestry, crop diversification, and soil conservation, in bolstering the resilience of agricultural systems and improving resource efficiency. Additionally, the review highlights the significance of enhancing access to climate information, investing in sustainable infrastructure, and promoting gender equity in agriculture to foster inclusive and adaptive food systems. Furthermore, the review underscores the critical role of policy interventions, international collaboration, and community engagement in addressing climate-related food security challenges and advancing sustainable development goals. By integrating climate adaptation and mitigation measures into agricultural policies, promoting research and innovation, and fostering multi-stakeholder partnerships, it is possible to build more resilient and equitable food systems that can withstand the impacts of climate change and ensure food security for all. In conclusion, the review emphasizes the urgency of concerted action to address the complex interplay between climate change and global food security. Through collective efforts and targeted interventions, it is feasible to mitigate the adverse effects of climate change on food systems and pave the way for a more sustainable and food-secure future.

Keywords: Impact, Climate Change, Global, Food Security, Challenges.

INTRODUCTION

Climate change, characterized by shifts in temperature patterns, precipitation levels, and extreme weather events, has emerged as one of the most pressing challenges of our time (El-Sayed and Kamel, 2020). Its far-reaching impacts extend beyond environmental concerns to pose significant threats to global food security. As such, understanding the nexus between climate change and food security is paramount in addressing the complex challenges ahead. Climate change refers to long-term alterations in weather patterns and average temperatures, primarily caused by human activities such as the burning of fossil fuels, deforestation, and industrial processes. These activities release greenhouse gases into the atmosphere, trapping heat and leading to changes in the Earth's climate system. The consequences of climate change are multifaceted, encompassing rising sea levels, more frequent and severe weather events, shifts in precipitation patterns, and alterations in ecosystems (Turner et al.,2020).

The significance of climate change lies in its pervasive and wide-ranging impacts on human societies, ecosystems, and economies (Sen and Seo, 2021). From altering agricultural productivity to exacerbating water scarcity and increasing the frequency of natural disasters, climate change poses a fundamental threat to global stability and well-being. Global food security refers to the condition in which 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. Achieving and maintaining food security is a fundamental goal of sustainable development, as it underpins human health, social stability, and economic prosperity.

In the context of climate change, global food security faces unprecedented challenges. Changes in temperature and precipitation patterns can disrupt agricultural systems, leading to yield losses, crop failures, and reduced food availability. Furthermore, climate-related events such as droughts, floods, and storms can exacerbate food insecurity by destroying crops, livestock, and infrastructure, and disrupting food supply chains (Godde et al.,2021). The purpose of this review is to examine the multifaceted impacts of climate change on global food security, identify the challenges it presents, and explore potential solutions to mitigate its adverse effects. By synthesizing current research, case studies, and policy analyses, this review aims to provide insights into the complex interplay between climate change and food security and inform evidence-based strategies for adaptation and resilience-building (Amoak ,2022).

The scope of the review encompasses various dimensions of the climate-food security nexus, including the impacts of climate change on agricultural productivity, food access, and nutrition; the vulnerability of different regions and populations to climate-related risks; the role of agricultural practices, technologies, and policies in building resilience; and the importance of international cooperation and governance frameworks in addressing global food security challenges in a changing climate. Through a comprehensive examination of these issues, this review seeks to contribute to the ongoing dialogue and action on climate change adaptation and food security at local, national, and global levels (Steiner et al.,2020).

The Evolution of Challenges and Solutions in Addressing the Impact of Climate Change on Global Food Security

Climate change poses a significant threat to global food security, impacting agricultural systems, food production, and access to nutritious food worldwide (Muluneh, 2021). Over time, as our understanding of these challenges has deepened, so too have the s olutions evolved. This essay delves into the historical progression of challenges and solutions related to the impact of climate change on global food security. The emergence of scientific evidence highlighting the links between climate change and agricultural productivity (Ortiz et al.,.2020). Early warnings about the vulnerability of global food systems to changing climate patterns, including temperature rise, altered precipitation, and increased frequency of extreme weather events. Limited understanding and awareness of the complex interactions between climate change and food systems. Insufficient investment in climate-resilient agricultural practices and technologies. Lack of coordinated global action to address climate change and its implications for food security (Smith et al.,2020).

Evolution of Solutions to Climate Change-induced Food Security Challenges: Adoption of sustainable agricultural practices, such as conservation agriculture, agroforestry, and organic farming, to enhance resilience to climate change (Nyong ,2020). Development and dissemination of climate-resilient crop varieties and livestock breeds through conventional breeding and biotechnology. Promotion of climate-smart agricultural techniques, including precision farming, water-efficient irrigation, and integrated pest management. Integration of climate change adaptation and mitigation strategies into national and international agricultural policies and programs. Strengthening of early warning systems and disaster preparedness measures to enhance resilience to climate-related shocks and disasters (Agbehadji et al.,2023). Investment in research and innovation to develop climate-resilient food systems and value chains, including

improved storage, transportation, and processing technologies. Empowerment of smallholder farmers and rural communities through capacity building, access to finance, and market linkages. Promotion of sustainable diets and food consumption patterns to reduce greenhouse gas emissions and promote human health and nutrition. Engagement of stakeholders across sectors and scales, including governments, civil society organizations, research institutions, and the private sector, in collaborative efforts to address climate change and food security challenges (Islam and Kieu, 2020).

Harnessing of digital technologies, big data, and artificial intelligence to enhance climate resilience and productivity in agriculture (Jung et al.,2021). Scaling up of climate finance and investment in climate-smart agriculture and food systems by governments, development agencies, and private sector actors. Strengthening of international cooperation and partnerships to address global challenges such as climate change, food insecurity, and biodiversity loss. Recognition of the interconnectedness of climate change, food security, and other sustainable development goals, leading to more holistic and integrated approaches to development.

The history of addressing the impact of climate change on global food security is marked by both challenges and solutions (Molotoks, and Dawson, 2021.). While climate change poses significant threats to food systems and livelihoods worldwide, the evolution of solutions reflects humanity's capacity for innovation, adaptation, and resilience. As we continue to confront the complex challenges posed by climate change, it is imperative to build on past successes, learn from past failures, and embrace collaborative, evidence-based approaches to safeguard food security for present and future generations (Cafiero et al.,2022).

Understanding the Impact of Climate Change on Agriculture

Climate change is increasingly recognized as one of the most significant challenges facing agriculture and global food security (Molotoks ,2021). Its effects on agricultural systems are multifaceted, ranging from shifts in temperature and precipitation patterns to more frequent and severe extreme weather events. In this section, we will delve into the various dimensions of how climate change impacts agriculture and the implications for global food production and distribution.

Climate change is characterized by long-term alterations in weather patterns and average temperatures, primarily driven by human activities such as the burning of fossil fuels, deforestation, and industrial processes (Kumar ,2021). These activities release greenhouse gases into the atmosphere, leading to the accumulation of heat and changes in the Earth's climate system. The Intergovernmental Panel on Climate Change (IPCC) has provided comprehensive assessments of climate change trends and projections, highlighting the increasing frequency and intensity of extreme weather events such as heatwaves, droughts, floods, and storms. Furthermore, climate models project further warming of the planet and changes in precipitation patterns, with significant regional variability (Zhang et al.,2021).

Climate change alters temperature and precipitation patterns, leading to shifts in growing seasons, water availability, and crop suitability (Yoon and Choi, 2020). Warmer temperatures can accelerate plant growth but may also increase water stress and heat stress in crops, particularly in regions with limited irrigation infrastructure. Changes in precipitation patterns can result in more frequent droughts or floods, affecting soil moisture levels and crop productivity.

Climate change is associated with an increase in the frequency and severity of extreme weather events, such as heatwaves, storms, and heavy rainfall. These events can cause significant damage to crops, livestock, and infrastructure, leading to yield losses, crop failures, and disruptions in food supply chains. Moreover, extreme weather events can exacerbate existing vulnerabilities in agricultural systems, particularly in regions with limited adaptive capacity (Omerkhil et al.,2020).

The impacts of climate change on agriculture are diverse and multifaceted, affecting crop yields, livestock productivity, and fisheries in various ways (Bilali et a.,2020). Heat stress and water stress can reduce crop yields and quality, leading to economic losses for farmers and food shortages for consumers. Similarly, changes in temperature and ocean acidity can disrupt marine ecosystems, affecting fish stocks and seafood production. The impacts of climate change on agriculture have significant implications for global food production and distribution. Changes in crop yields and productivity can affect food availability, prices, and access, particularly for vulnerable populations in developing countries (Maja, and Ayano, 2021.). Moreover, disruptions in food supply chains due to extreme weather events or environmental degradation can exacerbate food insecurity and undermine efforts to achieve food security and nutrition goals. Climate change also poses challenges for global food distribution systems, which rely on complex networks of trade, transportation, and storage to deliver food from producers to consumers. Disruptions in these systems can lead to food shortages, price volatility, and market instability, affecting both producers and consumers worldwide (Savary et al.,2020).

In conclusion, climate change poses significant challenges for agriculture and global food security, with far-reaching implications for food production, distribution, and access (Rasul, 2021). Addressing these challenges requires a coordinated and multi-dimensional approach, including investments in climate-resilient agriculture, sustainable land management practices, and adaptive capacity-building measures. By understanding the complex interplay between climate change and agriculture, policymakers, farmers, and other stakeholders can develop effective strategies to mitigate the impacts of climate change and ensure the resilience and sustainability of agricultural systems for future generations (Srivastav et al.,2021).

Challenges to Global Food Security Arising from Climate Change

Climate change presents significant challenges to global food security, exacerbating existing vulnerabilities and threatening the stability and sustainability of agricultural systems worldwide (Bilali ,2020). In this section, we will explore the multifaceted challenges posed by climate change to global food security, including the vulnerability of agricultural systems and smallholder farmers, threats to food availability, access, and utilization, risks of malnutrition and food insecurity, and the economic and social implications at local, national, and global scales.

Agricultural systems are highly vulnerable to the impacts of climate change due to their dependence on climate-sensitive factors such as temperature, precipitation, and soil moisture (Shukla et al.,2021; Fabian et al., 2023). Changes in temperature and precipitation patterns can affect crop growth, livestock productivity, and pest and disease dynamics, leading to yield losses, crop failures, and economic hardship for farmers. Smallholder farmers, who often lack access to resources, technology, and support services, are particularly vulnerable to climate-related risks,

as they rely heavily on rain-fed agriculture and have limited capacity to adapt to changing conditions (Amir et al.,2020; Uchechukwu et al., 2023).

Climate change poses significant threats to food availability, access, and utilization, affecting the entire food supply chain from production to consumption (Godde et al.,2021). Changes in temperature and precipitation patterns can disrupt agricultural production, leading to reductions in crop yields, livestock productivity, and fish stocks. Extreme weather events such as droughts, floods, and storms can destroy crops, livestock, and infrastructure, causing food shortages, price volatility, and market instability. Moreover, disruptions in food supply chains due to climate-related disasters or environmental degradation can impede access to food, particularly for vulnerable populations in rural and urban areas (Adeleke et al., 2019; Malik et al.,2021).

Climate change increases the risks of malnutrition and food insecurity by exacerbating existing vulnerabilities and limiting access to nutritious and affordable food (Mirzabaev et al.,2023). Changes in temperature and precipitation patterns can affect the availability and diversity of food sources, leading to shifts in dietary patterns and nutrient deficiencies. Moreover, climate-related disasters such as droughts, floods, and storms can destroy crops, livestock, and food storage facilities, disrupting food production and distribution systems and exacerbating food shortages and price volatility. As a result, vulnerable populations, including children, women, and the elderly, are at increased risk of malnutrition and food insecurity, undermining their health, well-being, and resilience to future climate-related risks (Ilugbusi et al., 2020; Anukwonke et al.,2022).

The economic and social implications of climate change on food security are profound and far-reaching, affecting livelihoods, incomes, and food systems at local, national, and global scales (Enthoven and Broeck, 2021). Climate-related disasters and crop failures can lead to loss of income and assets for farmers, exacerbating poverty and inequality in rural communities. Moreover, disruptions in food supply chains can affect food prices, trade, and market stability, impacting consumers, businesses, and economies worldwide. At the same time, climate change can exacerbate social tensions, conflicts, and displacement, as communities compete for dwindling resources and struggle to adapt to changing conditions. As a result, addressing the challenges of climate change and food security requires coordinated action and investment at all levels, from local adaptation measures to global cooperation and governance frameworks (Vincent et al., 2021; Jiménez et al.,2020).

In conclusion, climate change poses significant challenges to global food security, threatening the stability and sustainability of agricultural systems and undermining the well-being and resilience of vulnerable populations worldwide (Savary et al.,2020). Addressing these challenges requires a comprehensive and multi-dimensional approach, including investments in climate-resilient agriculture, sustainable food systems, and social protection measures, as well as efforts to promote equitable and inclusive development and enhance adaptive capacity at all levels. By addressing the root causes of vulnerability and building resilience to climate-related risks, we can create a more sustainable and food-secure future for all (Behnassi et al.,2021).

Strategies and Solutions for Addressing Climate Change-induced Food Security Challenges

Climate change poses significant threats to global food security, jeopardizing the availability, accessibility, and stability of food systems worldwide (Brenton ,2022). As temperatures rise,

weather patterns become more erratic, and extreme events increase in frequency and intensity, the need for proactive strategies to mitigate these impacts and ensure food security becomes paramount. This comprehensive review explores a range of strategies and solutions to address climate change-induced food security challenges, encompassing adaptation measures for agricultural resilience, mitigation efforts to reduce greenhouse gas emissions from agriculture, policy interventions and institutional frameworks, and international cooperation and partnerships (Cheng et al.,2021).

Crop diversification involves cultivating a variety of crops with different traits and growth requirements to spread risk and enhance resilience to climate variability (Zsögön et al.,2022). By planting diverse crops, farmers can mitigate the impacts of extreme weather events, pests, and diseases, ensuring a more stable and secure food supply. Additionally, breeding resilient crop varieties through conventional breeding and biotechnology can enhance tolerance to heat, drought, floods, and other climate-related stresses, improving yields and food security in the face of climate change.

Sustainable land management practices play a crucial role in enhancing the resilience of agricultural systems to climate change while promoting soil health, biodiversity, and ecosystem services (De, 2020). Conservation agriculture, agroforestry, and organic farming are examples of sustainable land management practices that can improve soil structure, water retention, and nutrient cycling, reducing erosion, enhancing soil fertility, and mitigating the impacts of climate variability on crop productivity.

Water conservation and efficient irrigation techniques are essential for optimizing water use efficiency and reducing the vulnerability of agricultural systems to water scarcity and drought (v et al.,2020). Drip irrigation, sprinkler irrigation, and precision irrigation technologies can deliver water directly to the root zone of crops, minimizing evaporation and runoff and maximizing water uptake. Additionally, rainwater harvesting, soil moisture conservation, and wastewater reuse can augment water supplies and buffer against climate-related fluctuations in precipitation, ensuring a reliable and sustainable water source for agriculture (Khan et al.,2021).

Carbon sequestration in soils and vegetation can help offset greenhouse gas emissions from agriculture and mitigate climate change while enhancing soil fertility and productivity. Practices such as cover cropping, crop residues retention, and agroforestry can increase the organic carbon content of soils and biomass, sequestering carbon dioxide from the atmosphere and storing it in terrestrial ecosystems. Additionally, restoring degraded lands, conserving natural habitats, and reforestation efforts can further enhance carbon sequestration potential and promote biodiversity conservation.

Reducing reliance on fossil fuels and transitioning to renewable energy sources such as solar, wind, and bioenergy can mitigate greenhouse gas emissions from agricultural operations and reduce the carbon footprint of food production. Renewable energy technologies such as solar-powered irrigation systems, biogas digesters, and wind turbines can provide clean and sustainable energy for powering farm operations, processing facilities, and transportation networks. Furthermore, the adoption of low-emission technologies such as improved livestock management practices, methane capture systems, and anaerobic digestion can reduce methane emissions from enteric fermentation and manure management.

Reducing food loss and waste along the entire food supply chain from production to consumption can help mitigate greenhouse gas emissions and improve the efficiency and resilience of food systems (Bajželj et al.,2020). Food loss and waste occur at various stages of the supply chain, including harvesting, processing, storage, distribution, and consumption. Strategies to reduce food loss and waste include improving post-harvest handling and storage practices, optimizing transportation and logistics systems, enhancing packaging and labeling technologies, promoting consumer education and behavior change, and establishing policies and regulations to incentivize waste reduction and promote circular economy approaches.

Integration of climate adaptation and food security policies is essential for promoting synergies and coherence between climate change adaptation and food security strategies. This involves mainstreaming climate change considerations into agricultural and rural development policies, programs, and investments, and vice versa. By aligning policy objectives and priorities, governments can enhance coordination, resource allocation, and effectiveness in addressing climate change-induced food security challenges. Additionally, establishing institutional mechanisms and coordination structures at national, regional, and local levels can facilitate collaboration and knowledge sharing among relevant stakeholders and enhance adaptive capacity and resilience in the agriculture sector.

Investment in agricultural research and extension services is critical for developing and disseminating climate-resilient technologies, practices, and knowledge to farmers and rural communities (Osumba ,2021). Research institutions, universities, and extension agencies play a crucial role in conducting applied research, testing innovative solutions, and providing technical assistance and capacity-building support to farmers. By investing in research and extension services, governments can empower farmers with the information, skills, and resources they need to adapt to climate change, improve productivity, and enhance food security.

Smallholder farmers and rural communities are disproportionately affected by climate change and food insecurity due to their limited resources, access to markets, and capacity to adapt (Raj et al.,2022). Providing targeted support and investments to smallholder farmers and rural communities is essential for enhancing their resilience and livelihoods in the face of climate-related risks. This includes improving access to credit, inputs, and markets, strengthening social safety nets and insurance schemes, promoting sustainable land management practices, and investing in rural infrastructure and services. Additionally, empowering women and marginalized groups with access to resources and decision-making opportunities can enhance their adaptive capacity and contribute to more inclusive and equitable development outcomes.

Collaborative initiatives for knowledge sharing and capacity building are essential for fostering international cooperation and collaboration in addressing climate change-induced food security challenges. Platforms such as the Global Alliance for Climate-Smart Agriculture, the CGIAR Research Program on Climate Change, Agriculture, and Food Security, and the FAO's Climate-Smart Agriculture Sourcebook provide opportunities for sharing best practices, lessons learned, and technical expertise among countries and stakeholders. By fostering partnerships and networks, governments, research institutions, civil society organizations, and the private sector can leverage collective expertise and resources to accelerate progress towards climate-resilient and sustainable food systems.

Climate financing mechanisms for agriculture play a crucial role in mobilizing resources and investments to support climate change adaptation and mitigation efforts in the agriculture sector. Initiatives such as the Green Climate Fund, the Adaptation Fund, and the World Bank's Climate Smart Agriculture Investment Plan provide financial support for climate-resilient agriculture projects, technologies, and capacity-building activities in developing countries. By leveraging climate finance and innovative financing mechanisms such as climate bonds, carbon markets, and public-private partnerships, countries can mobilize additional resources to scale up climate-resilient agriculture interventions and achieve sustainable development goals.

Multilateral agreements and platforms for collective action are essential for promoting international cooperation and coordination in addressing climate change and food security at the global level. Agreements such as the Paris Agreement, the United Nations Framework Convention on Climate Change (UNFCCC), and the Sustainable Development Goals (SDGs) provide frameworks for setting ambitious targets, monitoring progress,

Case Studies and Best Practices

Brazil has implemented successful conservation agriculture practices, such as minimum tillage, crop rotation, and cover cropping, to enhance soil health, water retention, and biodiversity while mitigating the impacts of climate change. By reducing soil erosion, improving water infiltration, and increasing carbon sequestration in soils, conservation agriculture has enhanced the resilience of agricultural systems to extreme weather events and variability in precipitation, contributing to improved crop yields and food security for smallholder farmers.

In Kenya, agroforestry systems have been widely adopted to diversify income sources, improve soil fertility, and provide climate-resilient food and fuel resources for rural communities. By integrating trees and shrubs into agricultural landscapes, agroforestry systems provide multiple benefits such as shade, windbreaks, and nutrient cycling, while enhancing biodiversity and ecosystem services. Agroforestry practices such as alley cropping, silvopasture, and agroforestry homegardens have improved the adaptive capacity of farmers to climate change and variability, reducing vulnerability and enhancing food security.

In India, climate-smart crop breeding programs have developed and disseminated resilient crop varieties that are adapted to local climatic conditions and tolerant to heat, drought, pests, and diseases. Through participatory plant breeding and genomic selection techniques, researchers have accelerated the development of high-yielding and stress-tolerant crop varieties, such as drought-tolerant rice, heat-tolerant wheat, and pest-resistant maize, which have significantly improved farm productivity and food security for smallholder farmers in vulnerable regions.

In Ethiopia, innovative livestock management practices such as stall-feeding, breed improvement, and community-based animal health services have been implemented to enhance the resilience of pastoral and agro-pastoral communities to climate change. By improving livestock productivity, health, and nutrition, these interventions have diversified livelihoods, reduced dependence on rain-fed agriculture, and increased household resilience to climate-related shocks and stresses, contributing to improved food security and nutrition outcomes in rural areas.

Successful examples of climate-resilient agriculture demonstrate the importance of integrating adaptation, mitigation, and food security objectives into agricultural development strategies and

programs. By promoting synergies and coherence between climate change adaptation and food security policies, governments can enhance resilience, sustainability, and equity in agricultural systems, ensuring the well-being and livelihoods of farmers and communities.

Innovative approaches to enhancing food security in the face of climate change require collaboration and partnerships among governments, research institutions, civil society organizations, and the private sector. By fostering innovation, knowledge sharing, and technology transfer, stakeholders can leverage collective expertise and resources to develop and scale up climate-resilient agricultural practices and solutions, addressing the multifaceted challenges of climate change and food security.

Empowering farmers and rural communities with access to resources, information, and decision-making opportunities is essential for building resilience and adaptive capacity to climate change. By promoting participatory approaches, community-based adaptation initiatives, and gender-responsive strategies, policymakers and practitioners can ensure that the needs and priorities of vulnerable populations are addressed, strengthening social cohesion, inclusiveness, and sustainability in agricultural development.

In conclusion, successful examples of climate-resilient agriculture and innovative approaches to enhancing food security provide valuable lessons and insights for policymakers and practitioners seeking to address the challenges of climate change and global food security. By integrating adaptation measures, mitigation efforts, and policy interventions, and fostering innovation, collaboration, and empowerment, stakeholders can build more resilient, sustainable, and equitable food systems that can withstand the impacts of climate change and ensure food security for present and future generations.

CONCLUSION

In reviewing the impact of climate change on global food security and exploring the associated challenges and solutions, several key findings and insights have emerged. Firstly, it is evident that climate change poses significant threats to agricultural productivity, food availability, and nutrition security worldwide. The increasing frequency and intensity of extreme weather events, shifts in temperature and precipitation patterns, and disruptions to ecosystems are all contributing to heightened vulnerability within food systems.

Secondly, addressing climate change is imperative for ensuring global food security. Without urgent action to mitigate greenhouse gas emissions and adapt to changing climatic conditions, the ability to sustainably produce and distribute food will continue to be compromised. The interconnectedness of climate change with other socio-economic and environmental factors underscores the urgency of adopting holistic approaches to safeguard food security.

Moreover, a call to action is needed for coordinated efforts and investments at all levels. Governments, international organizations, civil society, the private sector, and individuals must come together to prioritize climate-resilient agriculture, promote sustainable food systems, and address the underlying drivers of food insecurity. This includes supporting smallholder farmers, enhancing agricultural research and extension services, and integrating climate adaptation into food security policies and programs.

Looking ahead, future research directions and priorities should focus on advancing our understanding of the complex interactions between climate change, food systems, and human

well-being. This includes exploring innovative technologies and practices, harnessing the potential of digital agriculture and big data analytics, and engaging with local communities to co-develop context-specific solutions. Additionally, there is a need for interdisciplinary research that integrates natural and social sciences to inform evidence-based decision-making and policy formulation.

In conclusion, the challenges posed by climate change to global food security are immense, but they are not insurmountable. By recognizing the urgency of the situation, mobilizing collective action, and investing in sustainable solutions, we can build more resilient and equitable food systems that can withstand the impacts of climate change and ensure food security for present and future generations. It is time to act decisively and collaboratively to secure a sustainable and food-secure future for all.

Refernce

Adeleke, O.K., Segun, I.B., & Olaoye, A.I.C. (2019). Impact of internal control on fraud prevention in deposit money banks in Nigeria. *Nigerian Studies in Economics and Management Sciences*, *2*(1), 42-51.

Agbehadji, I.E., Schütte, S., Masinde, M., Botai, J., & Mabhaudhi, T. (2023). Climate risks resilience development: a bibliometric analysis of climate-related early warning systems in Southern Africa. *Climate*, *12*(1), 3.

Amoak, D., Luginaah, I., & McBean, G. (2022). Climate change, food security, and health: Harnessing Agroecology to build climate-resilient communities. *Sustainability*, *14*(21), 13954.

Anukwonke, C.C., Tambe, E.B., Nwafor, D.C., & Malik, K.T. (2022). Climate change and interconnected risks to sustainable development. In *Climate Change: The Social and Scientific Construct* (pp. 71-86). Cham: Springer International Publishing.

Bajželj, B., Quested, T.E., Röös, E., & Swannell, R.P. (2020). The role of reducing food waste for resilient food systems. *Ecosystem Services*, *45*, 101140.

Brenton, P., Chemutai, V., & Pangestu, M. (2022). Trade and food security in a climate change-impacted world. *Agricultural Economics*, *53*(4), 580-591.

Cafiero, C., Blanco Fonseca, M., Chelle, M., Egamberdieva, D., Kanter, R., Kimani, S., Malde, M.K., Neufeld, L., Oliveira, L., Schader, C., & Shyam, S. (2022). Data collection and analysis tools for food security and nutrition. Towards enhancing effective, inclusive, evidence-informed, decision making.

Cheng, Y., Liu, H., Wang, S., Cui, X., & Li, Q. (2021). Global action on SDGs: Policy review and outlook in a post-pandemic era. *Sustainability*, *13*(11), 6461.

De Corato, U. (2020). Towards new soil management strategies for improving soil quality and ecosystem services in sustainable agriculture: Editorial overview. *Sustainability*, *12*(22), 9398.

El Bilali, H., Bassole, I.H.N., Dambo, L., & Berjan, S. (2020). Climate change and food security. *Agriculture & Forestry/Poljoprivreda i Sumarstvo*, *66*(3).

El-Sayed, A., & Kamel, M. (2020). Climatic changes and their role in emergence and re-emergence of diseases. *Environmental Science and Pollution Research*, *27*, 22336-22352.

Enthoven, L., & Van den Broeck, G. (2021). Local food systems: Reviewing two decades of research. *Agricultural Systems*, *193*, 103226.

Fabian, A.A., Uchechukwu, E.S., Okoye, C.C., & Okeke, N.M., (2023). Corporate outsourcing and organizational performance in Nigerian investment banks.

Godde, C.M., Mason-D'Croz, D., Mayberry, D.E., Thornton, P.K., & Herrero, M. (2021). Impacts of climate change on the livestock food supply chain; a review of the evidence. *Global Food Security*, *28*, 100488.

Ilugbusi, S., Akindejoye, J.A., Ajala, R.B., & Ogundele, A. (2020). Financial liberalization and economic growth in Nigeria (1986-2018). *International Journal of Innovative Science and Research Technology*, *5*(4), 1-9.

Islam, M.S., & Kieu, E. (2020). Tackling regional climate change impacts and food security issues: A critical analysis across ASEAN, PIF, and SAARC. *Sustainability*, *12*(3), 883.

Jiménez, A., Saikia, P., Giné, R., Avello, P., Leten, J., Liss Lymer, B., Schneider, K., & Ward, R. (2020). Unpacking water governance: A framework for practitioners. *Water*, *12*(3), 827.

Jung, J., Maeda, M., Chang, A., Bhandari, M., Ashapure, A., & Landivar-Bowles, J. (2021). The potential of remote sensing and artificial intelligence as tools to improve the resilience of agriculture production systems. *Current Opinion in Biotechnology*, *70*, 15-22.

Khan, N., Ray, R.L., Sargani, G.R., Ihtisham, M., Khayyam, M., & Ismail, S. (2021). Current progress and future prospects of agriculture technology: Gateway to sustainable agriculture. *Sustainability*, *13*(9), 4883.

Kumar, V., Ranjan, D., & Verma, K. (2021). Global climate change: the loop between cause and impact. In *Global Climate Change* (pp. 187-211). Elsevier.

Li, M., Xu, Y., Fu, Q., Singh, V.P., Liu, D., & Li, T. (2020). Efficient irrigation water allocation and its impact on agricultural sustainability and water scarcity under uncertainty. *Journal of Hydrology*, *586*, 124888.

Maja, M.M., & Ayano, S.F. (2021). The impact of population growth on natural resources and farmers' capacity to adapt to climate change in low-income countries. *Earth Systems and Environment*, *5*, 271-283.

Malik, A., Li, M., Lenzen, M., Fry, J., Liyanapathirana, N., Beyer, K., Boylan, S., Lee, A., Raubenheimer, D., Geschke, A., & Prokopenko, M. (2022). Impacts of climate change and extreme weather on food supply chains cascade across sectors and regions in Australia. *Nature Food*, *3*(8), 631-643.

Mirzabaev, A., Kerr, R.B., Hasegawa, T., Pradhan, P., Wreford, A., von der Pahlen, M.C.T., & Gurney-Smith, H. (2023). Severe climate change risks to food security and nutrition. *Climate Risk Management*, *39*, 100473.

Molotoks, A., Smith, P., & Dawson, T.P. (2021). Impacts of land use, population, and climate change on global food security. *Food and Energy Security*, *10*(1), e261.

Muluneh, M.G. (2021). Impact of climate change on biodiversity and food security: a global perspective—a review article. *Agriculture & Food Security*, *10*(1), 1-25.

Nyong, A.P., Ngankam, T.M., & Felicite, T.L. (2020). Enhancement of resilience to climate variability and change through agroforestry practices in smallholder farming systems in Cameroon. *Agroforestry Systems*, *94*, 687-705.

Omerkhil, N., Chand, T., Valente, D., Alatalo, J.M., & Pandey, R. (2020). Climate change vulnerability and adaptation strategies for smallholder farmers in Yangi Qala District, Takhar, Afghanistan. *Ecological Indicators*, *110*, 105863.

Ortiz-Bobea, A., Ault, T.R., Carrillo, C.M., Chambers, R.G., & Lobell, D.B. (2021). Anthropogenic climate change has slowed global agricultural productivity growth. *Nature Climate Change*, *11*(4), 306-312.

Osumba, J.J., Recha, J.W., & Oroma, G.W. (2021). Transforming agricultural extension service delivery through innovative bottom–up climate-resilient agribusiness farmer field schools. *Sustainability*, *13*(7), 3938.

Raj, S., Roodbar, S., Brinkley, C., & Wolfe, D.W. (2022). Food Security and climate change: Differences in impacts and adaptation strategies for rural communities in the Global South and North. *Frontiers in Sustainable Food Systems*, *5*, 691191.

Rasul, G. (2021). A framework for addressing the twin challenges of COVID-19 and climate change for sustainable agriculture and food security in South Asia. *Frontiers in Sustainable Food Systems*, *5*, p.679037.

Savary, S., Akter, S., Almekinders, C., Harris, J., Korsten, L., Rötter, R., Waddington, S., & Watson, D. (2020). Mapping disruption and resilience mechanisms in food systems. *Food Security*, *12*, 695-717.

Seo, S.N., & Seo, 2021. *Climate change and economics*. Springer International Publishing.

Shukla, R., Gleixner, S., Yalew, A.W., Schauberger, B., Sietz, D., & Gornott, C. (2021). Dynamic vulnerability of smallholder agricultural systems in the face of climate change for Ethiopia. *Environmental Research Letters*, *16*(4), 044007.

Smith, P., Calvin, K., Nkem, J., Campbell, D., Cherubini, F., Grassi, G., Korotkov, V., Le Hoang, A., Lwasa, S., McElwee, P., & Nkonya, E. (2020). Which practices co-deliver food security, climate change mitigation and adaptation, and combat land degradation and desertification?. *Global Change Biology*, *26*(3), 1532-1575.

Steiner, A., Aguilar, G., Bomba, K., Bonilla, J.P., Campbell, A., Echeverria, R., Gandhi, R., Hedegaard, C., Holdorf, D., Ishii, N., & Quinn, K.M. (2020). Actions to transform food systems under climate change.

Turner, M.G., Calder, W.J., Cumming, G.S., Hughes, T.P., Jentsch, A., LaDeau, S.L., Lenton, T.M., Shuman, B.N., Turetsky, M.R., Ratajczak, Z., & Williams, J.W. (2020). Climate change, ecosystems and abrupt change: science priorities. *Philosophical Transactions of the Royal Society B*, *375*(1794), 20190105.

Uchechukwu, E.S., Amechi, A.F., Okoye, C.C., & Okeke, N.M. (2023). Youth Unemployment and Security Challenges in Anambra State, Nigeria.

Vincent, A.A., Segun, I.B., Loretta, N.N., & Abiola, A. (2021). Entrepreneurship, agricultural value-chain and exports in Nigeria. *United International Journal for Research and Technology*, *2*(08), 1-8.

Yoon, P.R., & Choi, J.Y. (2020). Effects of shift in growing season due to climate change on rice yield and crop water requirements. *Paddy and Water Environment*, *18*, 291-307.

Zhang, W., Furtado, K., Wu, P., Zhou, T., Chadwick, R., Marzin, C., Rostron, J., & Sexton, D. (2021). Increasing precipitation variability on daily-to-multiyear time scales in a warmer world. *Science Advances*, *7*(31), eabf8021.

Zsögön, A., Peres, L.E., Xiao, Y., Yan, J., & Fernie, A.R. (2022). Enhancing crop diversity for food security in the face of climate uncertainty. *The Plant Journal*, *109*(2), 402-414.