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Impacts of climate change on food systems in Africa: a systematic review

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Background: African countries experience weak food systems due to threats posed by climate change in various parts of the continent. The adverse effects from climate change negatively affect agricultural production.
Objectives: This systematic review examines the impacts of climate change on food systems.
Methodology: Peer-reviewed articles from Google Scholar, Scopus, Science Direct and Gray literature were reviewed. PRISMA guidelines for systematic reviews were followed to come up with relevant articles for this study. A total of 17 articles published between 2014 and 2024 were systematically reviewed. A data extraction table was developed to capture information of all the studies that were included in this systematic review. Studies that did not focus on the production aspect of food systems in Africa were excluded. Quality and risk of bias were checked by using the Newcastle-Ottawa Quality Assessment Scale. Results A review of 17 peer-reviewed studies revealed consistent evidence that climate change is driving persistent hunger across Africa and undermining progress toward ending hunger by 2030. 76% of the studies reported significant declines in staple crop yields linked to ENSO variability, prolonged droughts, and extreme weather events. 59% of the papers highlighted the spread of 2 new pests and diseases, such as fall armyworm, exacerbated by rising temperatures, while Agricultural Production Estimates confirmed widespread production losses in 2022–2023. Nutrition outcomes are worsening, with 71% of the studies documenting increased food insecurity, undernourishment rising from 15.6% in 2014 to 19.7% in 2022, and child stunting persisting above 30% in many regions. Food price volatility was noted in 65% of the papers, with shocks triggering spikes of up to 50%, while 41% reported post-harvest losses and food safety risks. Regional patterns reveal distinct vulnerabilities: chronic desertification in the Sahel, alternating drought–flood cycles in East Africa, heavy reliance on rain-fed maize and ENSO sensitivity in Southern Africa, and water scarcity and heat stress in North Africa. Common cross-cutting challenges include declining nutrient quality, post-harvest losses, and weak institutional capacity to implement adaptation measures.
Conclusion: We found that various policy propositions should be followed by the governments on the continent if sustainable food systems are to be realized.

KEYWORDS
climate change, food systems, sustainability, Africa, production

1 Introduction

Climate change is increasingly recognized as the defining challenge of the 21st century, particularly for regions whose economies and livelihoods are closely tied to natural resources. Nowhere is this more evident than in sub-Saharan Africa, where agriculture remains the primary source of food, employment, and income for over 60% of the population (Ludemann et al., 2024). Despite being responsible for only about 3–4% of global greenhouse gas emissions, African countries are disproportionately vulnerable to the effects of climate change, largely due to high dependence on rain-fed agriculture, limited shock mitigation and adaptive capacity, and socioeconomic fragility (Niang et al., 2010; Lee et al., 2023). In addition, Africa is persistently faced by challenges with high prevalence of malnutrition, CO_2 emission, inflation, foreign direct investment (FDI), GDP per capita, population growth, food imports, and arable land. These variables have been studied and found to directly contribute to worsening the situation of climate change and food insecurity across the continent (Gold, 2024).

Agriculture is a critical sector in Africa, contributing up to 40% of the continent's Gross Domestic Product (GDP) and employing over 70% of its labor force (Nash et al., 2013). With over 60% of Africans living in rural areas, agriculture plays a key role in general livelihood improvement, rural development, poverty reduction, and empowerment of women and youth (Diao et al., 2020). However, across the continent, climate change is altering temperature and rainfall patterns, increasing the frequency and severity of extreme weather events such as floods, droughts, and cyclones. Average temperatures in Africa have already risen by 0.7–1.2 °C over the past century and are projected to increase by at least 2 °C by 2050 under moderate emission scenarios (Dagnachew et al., 2022). These shifts are significantly disrupting agricultural calendars, lowering crop yields, and affecting livestock productivity. According to the African Development Bank (2021), climate change could shrink Africa's GDP by up to 3% annually by 2030, largely due to its impact on agriculture and food systems.

The consequences for food security are profound. Crop models project that climate change could reduce yields of major staples such as maize, millet, and sorghum by up to 20–30% in several African countries by 2050 (Thornton et al., 2018; Rosenzweig et al., 2014). Simultaneously, climate-induced disruptions in value chains, market access, and food prices threaten to deepen existing inequalities, particularly for women, youth, and smallholder farmers who already face systemic disadvantages. In East and Southern Africa, recurring droughts and erratic rainfall have led to multi-year food crises, requiring both humanitarian response and long-term adaptation investments (Ayanlade et al., 2023).

Figure 1 presents a food systems framework developed by the Food and Agriculture Organization of the United Nations (FAO) with an aim to bring together the interconnectedness of various aspects that make food systems viable and more sustainable. Africa adopted this framework in 2018 and adjustments are still being made to make it more representative of the country dynamics (FAO, Food and Agriculture Organisation of the United Nations, 2018).

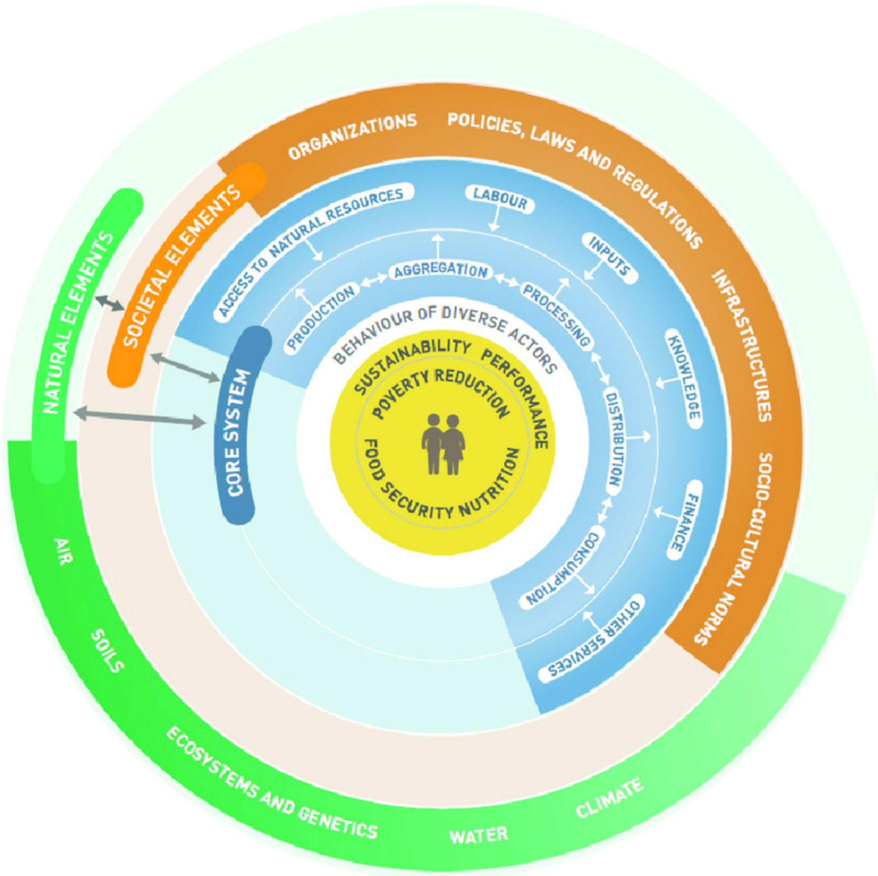
While African countries have demonstrated remarkable innovation in climate-smart agriculture and local adaptation strategies, their efforts are often undermined by systemic barriers, including inadequate financing, weak institutional coordination, and limited access to climate information. This dynamic creates an urgent need for country-level research that not only diagnoses the impact of climate change on food systems but also identifies locally relevant solutions that can inform both policy and practice.

Africa provides a compelling case study within this broader continental context. The continent has made notable progress in expanding food production, especially through the introduction on mega farms, the shift into more commercial and mechanized farming, the use of genetically modified varieties to improve both animal and crop yields (Caradus, 2022). Improved farming methods and the provision of input support programs that are mostly targeted to small holder farmers across the continent (Ludemann et al., 2024). Africa has also benefited from investments in irrigation, agricultural extension, and local seed systems. These successes, however, are increasingly undermined by a rapidly changing climate.

Recent decades have seen most parts of Africa experience rising temperatures, shifting rainfall patterns, and an increased frequency of extreme weather events affecting crop and animal production. Between 1960 and 2020, the country's mean annual temperature rose by approximately 1 °C, with projections suggesting a further rise of up to 2.5 °C by mid-century (Lee et al., 2023). Rainfall has become less predictable, with shortened seasons and more frequent mid-season dry spells, especially in the southern and central parts of the continent. At the same time, major disasters such as Cyclone Idai which occurred in 2019 and Cyclone Freddy which followed in 2023 have inflicted widespread damage on crops, infrastructure, and livelihoods, pushing millions into food insecurity more especially in countries present in the southern part of the continent such as Malawi, Mozambique and Zimbabwe (Aderinto, 2023).

Agricultural production in Africa is especially sensitive to these changes. Maize, rice, cassava, yams and other dominant staple crops, suffers from both drought and waterlogging, while livestock systems face heat stress, water shortages, and reduced pasture availability. Models predict that maize yields in Africa could decline by up to 30% by 2050 under a high-emissions scenario unless adaptive measures are scaled up (Thornton et al., 2018). Furthermore, women and youths, who make up over 60% of Africa's agricultural workforce, are disproportionately affected due to limited access to resources such as land, credit, and climate information (Khoza et al., 2022; Ludemann et al., 2024).

Despite the growing urgency, there remains a gap in evidence on how climate change affects entire food systems not only beyond just primary production but also how local communities are adapting across the value chain. Africa's food systems, like many others in the region, are composed of interconnected actors and institutions that span production, processing, storage, distribution, consumption, and waste. Climate change affects all these stages, influencing not only the availability of food but also its affordability, nutritional value, and stability over time (Masipa and Masipa, 2017). Understanding these



Food System Wheel (FAO, 2018).

FIGURE 1
Food systems framework (Source: FAO, 2018).

dynamics at the local level is essential for designing equitable, climate-resilient food system interventions.

Despite growing interest in the intersection of climate change and food security, the existing literature in Africa remains predominantly production-focused, often limited to crop-specific modeling and lacking a comprehensive food systems perspective. Critical components such as processing, market dynamics, and consumer behavior under climate stress remain underexplored. Moreover, many studies do not disaggregate their findings by gender or actor type, thereby overlooking differentiated vulnerabilities and adaptive capacities across the system. Methodologically, most research relies on biophysical projections, with limited incorporation of local knowledge, institutional analysis, or feedback loops inherent in food systems. These gaps hinder the development of inclusive, context-specific climate resilience strategies for Africa's food system.

1.1 Study objectives

This study therefore explored the complex linkages between climate change and food systems in Africa with special focus on production. The study assessed the effects of climate change on crop and livestock production. It also examined how climate-related risks and trends affect various components of the food system, and what institutional mechanisms can support transformative resilience. Finally, the paper establishes adaptation and mitigation strategies vital in managing the adverse effects of climate change. The following research questions were addressed to show a clear link between climate change and its effects on food systems in Africa:

i How has climate change influenced food systems in Africa?
ii What are the observed effects on crop and livestock production?
iii How do these changes impact food security and rural livelihoods in different African regions?
iv What strategies have been developed to reduce the impact of climate change in African agriculture?

To comprehensively understand these attributes, this paper is presented in the following sections; introduction, methodology, results, discussion and concluding remarks and recommendations.

2 Methods

A thorough literature review was conducted to gather relevant articles for this paper in a systematic manner following the standard PRISMA guidelines for systematic review. This method was chosen for its structured and robust approach, which aims to identify, select, and summarize existing research on the effects of climate change on food systems in Africa (Okoli, 2015).

2.1 Scope of the systematic review

The review focused on how climate change affects African food systems. It explored how changes driven by climate impact agricultural productivity and food availability across the continent. To understand these effects fully, the review looked at how various regions in Africa experience these impacts based on climate differences, crop types, and the adaptation strategies used to manage the different factors contributing to climate change.

2.2 Literature search strategy

The systematic review was based on only literature from peer-reviewed journals. Google scholar, Science direct, Scopus databases and gray literature were used to search and retrieve relevant literature. Search terms included combinations of the following keywords: "climate change AND food systems," "climate change AND Africa," "agricultural production AND climate change," and "mitigation measures AND climate impacts." The systematic review concentrated on literature published between 2014 and 2024 to ensure inclusion of current research as climate science keeps on revolving rapidly while also considering foundational studies that provide historical context.

2.3 Inclusion and exclusion criteria

To keep the review focused and relevant, the inclusion and exclusion criteria to guide in retrieving information for the study were pre-determined. Literature that specifically addressed the impacts of climate change on African food systems was included. The review also included: Peer-reviewed articles that investigated the relationship between climate change and food security in Africa. Studies that provide insights into how climate change alters agricultural production patterns and food security. Articles that explore adaptation measures and strategies within food systems were also included in this systematic analysis.

On the other hand, the review excluded studies that did not focus on Africa or did not examine the relationship between climate change, agricultural productivity and food systems. Review papers and theoretical papers without empirical evidence were not included.

2.4 Thematic data synthesis

The extracted data were organized into thematic areas to facilitate synthesis and enhance clarity. This process highlighted the impact of climate change on specific areas, allowing the authors to develop a detailed discussion along with practical recommendations. The themes included; (i) the impact of a compromised African Agri-Food system; (ii) climate change and the food environment; (iii) The economic impact of climate change on food affordability; (iv) climate change, food utilization and safety; (v) Mitigation measures. In addition to these thematic areas, the systematic review provided guidance on policy that governments on the continent can follow to improve the current food systems as we know them.

2.5 PRISMA flow diagram

To demonstrate how the articles were selected. The authors developed a PRISMA flow diagram that shows a step-by-step approach until the final articles were selected. The flow diagram also presents reasons why some articles were left out despite being found following the search using the combination of key words that was conducted on google scholar search engine for academic research.

2.6 Data extraction

To come up with the actual articles for this systematic review. A data extraction table was developed with different columns to capture the names of authors, year of article publication, geographic location, methodology, study focus areas, key findings and study limitations. The data extraction can be found in the repository that was created to house all relevant files that were used in this systematic review.

2.7 Methodological rigor

Following a full-text review, the studies included in this systematic review were independently assessed by all the authors of this article. Among the 17 articles included in the present systematic review, 9 used mixed methods, 5 was purely qualitative, and 3 used purely quantitative approaches for data collection. All studies included in this systematic review were cross-sectional in design. The studies had varying climate change and food security focus areas ranging from the different roles of key players and stakeholders from production to consumption of various foods that later translate into food security at national and continental levels. Therefore, the appropriate version of the Newcastle-Ottawa Quality Assessment Scale was used for the quality assessment of these studies. This risk of bias tool covers three domains: selection criteria, comparability criteria, and outcome/exposure criteria, where each study is scored for each domain by stars. The selection criteria were allotted a maximum of four stars, comparability criteria a maximum of two stars, and outcome criteria a maximum of four stars. Table 1 presents the quality assessment ratings for each study that was included in this systematic review. Studies with 7–9 stars are rated as of high quality, studies with 4–6 stars are rated as being of moderate quality while studies with 0–3 stars are rated as of low quality.

2.8 Quality assessment

Following a full-text review, the studies included in this systematic review were independently assessed by all the authors (MC, MM, MM, RC, KM, MB, DK, BM, WB, and WK). The selected studies had varying focus areas on the effects of climate change on African Food Systems capturing various areas that play a crucial role in production of food to the point it reaches the consumer.

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TABLE 1 The Newcastle-Ottawa Quality Assessment Scale for cross-sectional studies.

Author(s)	Year	Country	Representativeness	Sample size	Non-respondents	Exposure ascertainment	Comparability	Outcome	Total Score (/10)	Rating
Esmail et al.	2023	Iran	1	1	1	1	1	2	7	High
Franklin et al.	2021	Kenya	0.5	1	0	1	1.5	1	5	Moderate
Isaac and Ayansina	2023	Nigeria	1.5	1	0	0	1	1	4.5	Moderate
Jacob et al.	2025	Tanzania	1	1	0	1	1	1	5	Moderate
Junren et al.	2025	Zambia	0.5	1	0	0	1	1	3.5	Low
Mustapha et al.	2024	Nigeria	1	1	0	1	1.5	1	5.5	Moderate
Olowatimilehi and Ayantade	2023	Nigeria	1	1	1	1	1	1.5	6.5	Moderate
Osama et al.	2025	Morocco, Senegal, Egypt, and Italy	1	1	1	1	1	1.5	6.5	Moderate
Andate et al.	2023	Kenya	0.5	1	1	1	1	1	5.5	Moderate
Pedro et al.	2024	Angola	0.5	1	1	1	1	1	5.5	Moderate
Claudia et al.	2010	Subsaharan Africa	1	1	0	1	1	2	6	Moderate
Omobolaji and Olugbenga	2024	Nigeria	1	1	0	1	1	1	5	Moderate
Phillip et al.	2011	Subsaharan Africa	1	1	0.5	1	1	1	5.5	Moderate
Gold	2024	West Africa	1	1	1	1	1	2	7	High
Vermeulen	2012	West Africa	1	1	1	1	1	2	7	High
Paeth et al.	2008	Subsaharan Africa	0.5	0	0	1	1	1	3.5	Low
Myers et al.	2017	Nigeria	0.5	0	0	2	1.5	1.5	5.5	Moderate

3 Results

A review of 17 peer-reviewed studies revealed consistent evidence that climate change is undermining agricultural production and food security across Africa. Approximately 76% of the studies reported significant declines in staple crop yields, particularly maize, sorghum, millet, cassava, and rice, largely attributed to prolonged droughts, ENSO variability, and extreme weather events. Around 59% of the papers highlighted the emergence and spread of pests and diseases, such as fall armyworm and desert locusts, as key threats exacerbated by rising temperatures. Evidence from the Agricultural Production Estimates (APES) further confirmed widespread production losses during the 2022–2023 growing season.

The review also demonstrated worsening nutrition outcomes. About 71% of the papers documented rising food insecurity and malnutrition, with the prevalence of undernourishment increasing from 15.6% in 2014 to 19.7% in 2022, and child stunting persisting above 30% in most regions. Food price volatility was noted in 65% of the studies, with some documenting price spikes of up to 50% following climate shocks, thereby reducing household access to diverse and nutritious foods. Post-harvest losses and food safety risks, particularly aflatoxin contamination, were reported in 41% of the reviewed literature.

Regional differences emerged across the continent. About 53% of the studies identified Southern Africa as the most climate-sensitive, owing to its dependence on rain-fed maize and ENSO cycles. The Sahel was consistently characterized by chronic desertification and declining yields of sorghum and millet, while East Africa was noted for alternating drought–flood cycles that disrupt both crop and livestock systems. In contrast, North Africa's vulnerability was strongly linked to water scarcity and heat stress, threatening irrigated cereals and horticultural crops. Despite these regional distinctions, common cross-cutting challenges include reduced nutrient quality, persistent post-harvest losses, and weak institutional implementation of adaptation measures.

3.1 Discussion

Agriculture is a critical sector in Africa, contributing up to 40% of the continent's Gross Domestic Product (GDP) and employing over 70% of its labor force (Nash et al., 2013). With over 60% of Africans living in rural areas, agriculture plays a key role in rural development, poverty reduction, and empowerment of women and youth (Diao et al., 2016). However, climate change has increasingly threatened the agri-food systems sector, with prolonged droughts, erratic rainfall, and extreme weather events reducing yields and limiting growth prospects (Malhi et al., 2021). Climate change induces biotic and abiotic stresses, including rising temperatures, altered precipitation, increased heat waves, shifting pest populations, and atmospheric Carbon Dioxide (CO_2) and Ozone fluctuations (Rani et al., 2020). These changes have significantly impacted agricultural productivity, leading to food production declines and rising food prices (Thornton et al., 2018). Droughts and temperature increases have reduced yields in the Sahel region, while cyclones and dry spells have affected Southern Africa, including Africa (Agnolucci et al., 2024).

The impact of climate change has contributed to worsening food insecurity and malnutrition (Owino et al., 2022). The World Health Organization reported that undernourishment in Africa increased from 15.6 percent in 2014 to 19.7 percent in 2022. Stunting in children under five remained high at 30 percent, with Central Africa recording the highest rate at 37.4 percent (Sotiraki et al., 2022). These statistics emphasize the need for urgent adaptation and mitigation measures to protect food security (FAO, AUC, ECA, WFP, 2023). From 2019 to 2023, staple food production declined across Southern Africa (Table 1) due to climate-related shocks, particularly El Niño with key crops such as maize, wheat, rice, cassava, sorghum, and millet suffering fluctuations in yields. In 2023, all five staple crops saw reductions in South Africa, Zambia, Zimbabwe, and Africa due to El Niño (Mbow et al., 2020). Africa experienced significant crop losses in 2022 and 2023, as confirmed by assessments by the Ministry of Agriculture through the Agriculture Production Estimates Survey (APES).

3.2 Impacts of a compromised African agri-food systems

Africa remains the world's hungriest continent, with diets that are both unaffordable and inaccessible for many households and with food insecurity and undernutrition closely linked to unsustainable food systems (Mensah, 2021; Bongaarts, 2020). Rapidly intensifying climate change manifest in rising temperatures, shifting precipitation patterns, and increasingly frequent floods, cyclones, droughts, and dry spells has further impaired these systems, widening the gap between attainable and actual farm yields (Moyo and Chirwa, 2025). Although these pressures are continent-wide, the severity, timing, and dominant hazards differ markedly by region, shaping distinct vulnerabilities and policy needs.

In recent years, in Southern Africa, El Niño and La Niña cycles have brought successive droughts that sharply reduced maize and sorghum harvests in South Africa, Zambia, and Zimbabwe, prolonging the lean season and increasing dependence on humanitarian relief (Mugiyo et al., 2023; Liu et al., 2025). West Africa's Sahel faces progressive aridification and soil degradation, where chronic water deficits and recurrent multi-year droughts depress millet and sorghum and yields and necessitate intensive soil- and water-restoration practices such as half-moon bunds (Elagib et al., 2024; Ayoumbissi Keugmeni et al., 2025). East Africa has endured alternating extremes with a record multi-season drought from 2020 to 2023 followed by destructive floods in 2023–24 which decimated crops and livestock and triggering widespread displacement (Odongo et al., 2025). North Africa, while less drought-prone in the short term, faces chronic water scarcity and rising heat stress that threaten irrigated cereal and horticultural systems in Morocco, Tunisia, and Egypt, where groundwater depletion and upstream Nile variability compound the risks (Townend et al., 2023; Daoudy et al., 2024).

These regional experiences show clear divergences. Southern Africa's vulnerability is tied to high dependence on rain-fed maize and the strong influence of natural climate pattern involving periodic fluctuations in sea surface temperatures in the Central and Eastern Tropical Pacific Ocean which occurs every 2–7 years called ENSO cycle. The Sahel grapples with long-term desertification and fragile dryland soils; East Africa contends with the unpredictability of rapid swings between drought and flood; and North Africa is constrained by structural water scarcity and escalating heat extremes. Socio-economic contexts also diverge: for example, North African countries often have higher irrigation coverage and more developed markets, while many Sahelian communities rely on subsistence rain-fed farming with limited infrastructure (Sivakumar, 2020).

Yet there are important common grounds. Across all regions, erratic rainfall and shortened drying windows heighten post-harvest losses and food-safety hazards, including increased aflatoxin contamination in grains and legumes (Mugiyo et al., 2023). Undernourishment has risen continent-wide from 15.6% in 2014 to 19.7% in 2022 while child stunting remains stubbornly high at about 30%, peaking at 37% in Central Africa (Hassan et al., 2023). Market disruptions and production shocks have elevated food prices everywhere, eroding the affordability of nutrient-rich diets.

Adaptation responses likewise exhibit both shared themes and region-specific pathways. Southern Africa has pioneered anticipatory action linked to ENSO forecasts and the adoption of drought-tolerant crop varieties and small-scale irrigation (Mugiyo et al., 2023). Sahelian countries are scaling traditional soil- and water-conservation methods to restore degraded land and stabilize yields (Ayoumbissi Keugmeni et al., 2025). In East Africa, livelihood diversification such as Kenya's emerging coastal seaweed farming and climate-risk financing provide alternative income streams and buffers against shocks (Nyambura, 2025). North African strategies emphasize water-use efficiency, drip irrigation, and high-value horticulture, though these face governance and resource constraints (Townend et al., 2023; Daoudy et al., 2024). Despite the diversity of approaches, all regions converge on the need for stronger early-warning systems, climate-smart agriculture, and social protection measures to reduce vulnerability and stabilize food supplies. Figure 2 shows the hunger hotspots on the African continent as of 2022.

Furthermore, climate change has created favorable conditions for pests such as locusts and fall armyworms (Skendžić et al., 2021; Adunola et al., 2021; Zanzana et al., 2024), leading to their multiplication and a subsequent reduction in food crop production. This is largely due to climate conditions like drought and erratic rainfall, which stress plants and create entry points for pests, including stalk borers and fall armyworms. In addition, the changing climate conditions cause pests like locusts to migrate to human fields as their natural habitats in wild areas become desiccated. The increased presence of pests and diseases drives up the cost of crop production, negatively impacting the entire food supply chain (Singh et al., 2023).

3.3 Climatic challenges and Africa's food production

The recurrent and successive waves of climatic disasters disseminating the African region, continue to show no imminent de-escalation. The recent flooding in the Sahelian region (Chad, Niger, Mali, Mauritania, and Northern Burkina Faso) is a testament as it recorded an amount of rainfall of 120–600 percent above the average of the reference period between 1991 and 2020 (Ludemann et al., 2024). Areas deemed not prone to floods are now flooded. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) 2024 report on the West and Central Africa flooding underscores the

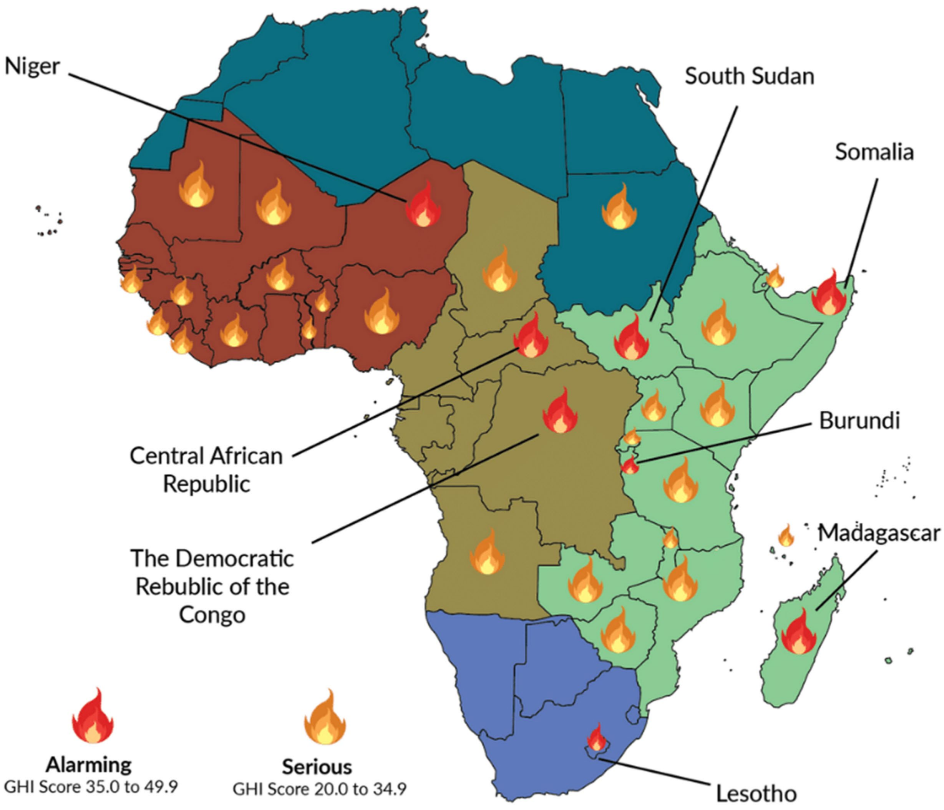

FIGURE 2
Hunger hotspots in Africa. Source: FAO and WFP (2022).

severe impacts inflicted on the food systems as 951,000 hectares are unsuitable for crop and livestock production, 128,000 heads of cattle swept away and communities vulnerable to food and nutritional security far greater than in previous years (Tholstrup and Vazquez, 2024). These climatic disasters are now in their own category of a pandemic. For the past 5 years, each region has been affected by either one or two climatic disasters within a rainy season and covering a large scope (OCHA, 2020; OCHA, 2021; OCHA, 2022; OCHA, 2023a; OCHA, 2023b; OCHA, 2023c; OCHA, 2024a; OCHA, 2024b; and OCHA, 2024c). This is shown in Appendix Table 2.

Disaggregating these impacts reveals that smallholder farmers, particularly women and youth, bear a disproportionate burden (Chabwera and Madhlopa, 2025). These groups often lack access to climate-resilient technologies, financial resources, and extension services, exacerbating their vulnerability. For instance, in Malawi, where over 70% of the population relies on small-scale, rain-fed agriculture, the 2024 El Niño-induced drought led to the loss of 70% of the maize harvest, severely impacting food availability and livelihoods. The value chains of key staple crops such as maize, sorghum, and millet are increasingly disrupted by climate-induced shocks. These disruptions lead to increased post-harvest losses, especially in regions lacking adequate storage and transportation infrastructure. For example, in West Africa, higher humidity and warmer temperatures have caused produce to rot in storage or transit, increasing food waste and reducing market availability.

Furthermore, climate change exacerbates food insecurity by affecting both the supply and demand sides of food systems. On the supply side, reduced agricultural productivity leads to lower food availability, while on the demand side, increased food prices make it difficult for vulnerable populations to access nutritious food. This dual impact is particularly severe for low-income households that spend a significant portion of their income on food. Collectively, this results in a failed food system for the entire continent at its core, thus production as both crops and animals have been greatly affected. Regions within the African continent could fail to act as food systems buffer zones for each other as they are all gripped with climatic bottlenecks (FAO, AUC, ECA, WFP, 2023).

3.4 Climate change and the food environment

Due to the adverse effects of climate change, meeting both current and future demand for food is a challenge especially when the food environment is taken into consideration within the context of food systems impact pathways. The food environment is defined as a set of parameters that includes affordability, acceptability, information and marketing, food quality and safety and policy conditions (Herforth and Ahmed, 2015). These variables are significant in ensuring equitable access to quality and diversified foods.

Figure 3 is an illustration of the pathways for the impact of climate change on food systems, food security, and undernutrition. As observed, climate change relates to food access by affecting affordability. Such challenges are largely present in Africa where 27 percent of the population (Addae-Korankye, 2014) live below the poverty line exposing them to price shocks. It is therefore imperative for governments to consider a multidisciplinary approach (focusing on markets, policy, and food standards and regulations, economic growth etc.) to transform food systems amidst climate change risks and shocks (Kumar, 2021).

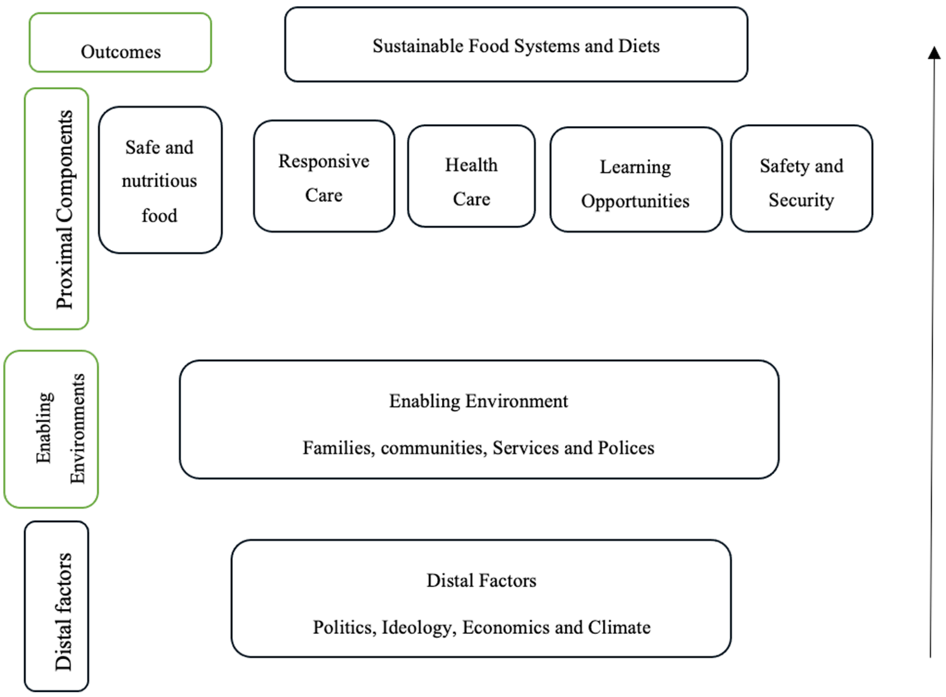

FIGURE 3
Climate change and global food systems: potential impacts on food security and undernutrition. Source: FAO (2024).

3.5 Economic impact of climate change on food affordability

The economic impact of climate change is profound, particularly in the context of food affordability. As climate change progresses, the increased frequency and intensity of extreme weather events such as droughts, floods, and storms disrupt agricultural production and supply chains. These disruptions lead to significant price volatility in food markets, which disproportionately affect vulnerable populations (Talukder et al., 2024). The Food and Agriculture Organization documented significant fluctuations in food prices across various regions, particularly in Africa. According to FAO, these fluctuations are often driven by climate-related disruptions that impact the agriculture sector. In Africa for example, the price of Maize, which is the main staple food, skyrocketed with the aftermath of El Niňo experienced in 2024. In Zimbabwe, the 2024 El Niňo induced-drought resulted in significant widespread crop failure, which affected the livelihoods and purchasing power of refugees in camps, who mostly rely on farming (Ludemann et al., 2024). The current 2024/2025 growing season presents a daunting future for food security as the effects of climate change continue to affect the southern African region with dry spells, resulting in significant crop failure.

Similarly, in 2016, a notable phenomenon occurred in Southern Africa. A severe drought, one of the worst in decades, profoundly affected agricultural productivity in Zimbabwe, Zambia, and South Africa. The resulting decrease in crop yields led to a sharp increase in food prices. Some staples saw increases of up to 50% or more (Toromade et al., 2024). For low-income households and the urban poor, this spike in prices worsened their ability to secure sufficient and nutritious food (Codjoe et al., 2014).

The implications of these economic changes are not limited to immediate price increases. Over time, persistent food affordability challenges lead to broader societal issues, including increased poverty rates, heightened social tensions, and public health crises (Vandamme et al., 2022). As families struggle to afford nutritious food, they may resort to cheaper, less healthy options, leading to long-term health problems such as obesity and diet-related diseases (Myers et al., 2017).

3.6 Climate change, food utilization and safety

Food utilization is significantly impacted by climate change in Africa (Kotir, 2011). Climate induced events such as drought and floods contribute to reduced nutritional quality of food, safety and access. In Sub Saharan Africa, climate-induced floods make the region vulnerable to cholera outbreaks. Water is directly affected while food is indirectly affected through washing and cooking with contaminated water causing illness and malabsorption of food to those exposed (Kotir, 2011). Similarly, climate-induced drought frustrates issues of food safety and food quality due to inadequate water during such periods (Thornton et al., 2018). In Ethiopia, recurrent droughts have caused water shortages, hindering food preparation and increasing foodborne illness risks (Kumar et al., 2022). Furthermore, inadequate sanitation raises food contamination risks, impairing nutrient absorption, especially in regions with weak food safety regulations (Palupi et al., 2024).

Rising temperatures and humidity create conditions favorable for pests and diseases, reducing both crop yields and nutrient content. Studies indicate that extreme climate variability could decrease crop output in some African countries by up to 50% by 2030, affecting staple crops like maize and sorghum, crucial for food security (Ludemann et al., 2024). Furthermore, climate change impacts not only food quantity but also nutritional quality. Rising CO_2 levels can lower crop nutrient density, leading to potential deficiencies. A study by Smith and Myers (2018) found that 550 ppm CO_2 could decrease protein, iron, and zinc in major crops by 3–17%, potentially resulting in 175 million more individuals with zinc deficiency, 122 million more with protein deficiency, and increased risks of iron deficiency, especially for women and children in Asia and Africa. This emphasizes the importance of addressing climate change's effect on micronutrient intake and global nutrition efforts. Dietary changes may help reduce some effects, but tackling this issue remains essential (Thomas et al., 2021).

Food safety is also threatened by increased aflatoxin contamination in staple crops like maize and groundnuts. Aflatoxins, produced by *Aspergillus fungi*, are highly toxic and carcinogenic, posing severe health risks such as liver cancer and immune suppression (Awuchi et al., 2020). Climate change increases the vulnerability of crops to such contamination, exacerbating food and nutrition security concerns in Sub-Saharan Africa (Warnatzsch et al., 2020).

Poor storage facilities and infrastructure further hinder food utilization. Without proper storage, harvested crops are prone to spoilage and contamination. For example, Cyclone Idai in Mozambique in the year 2019 caused widespread flooding, destroying crops and storage facilities, leading to food losses (Toromade et al., 2024). Additionally, extreme weather events disrupt transportation networks, delaying market access and increasing food spoilage, and therefore reducing nutritional quality of food (Ludemann et al., 2024).

3.7 Mitigation measures

Climate change exerts profound impacts on food systems, particularly in the Global South, leaving millions vulnerable to food insecurity. Agriculture is both a major victim of climate variability and a significant contributor to greenhouse gas emissions, yet it also presents opportunities for mitigation and adaptation (Zaman et al., 2021). Interventions within the sector are therefore critical not only for food security but also for addressing broader environmental challenges that affect food availability. Farming households that once experienced bumper harvests now face sharply reduced yields, with previously productive land often yielding half of prior outputs, thereby exacerbating food and nutrition insecurity. This situation underscores the need to reassess and strengthen climate mitigation strategies targeting food systems. While agrifood systems are negatively impacted by climate change, they also contribute to it through emissions, highlighting a dual challenge. At COP29, discussions emphasized the potential of transforming agrifood systems into climate solutions. However, in regions such as Africa, financial constraints often necessitate prioritizing immediate hunger relief over long-term climate mitigation initiatives (UNFCCC, 2023). Timely disbursement of pledged climate finance is therefore essential to support Nationally Determined Contributions (NDCs) and ensure that mitigation strategies are both effective and scalable.

A growing body of evidence highlights Climate-Smart Agriculture (CSA) as a cornerstone of adaptation and mitigation strategies for climate-resilient food systems (Mnukwa et al., 2025). Recent studies have demonstrated that CSA practices can reduce greenhouse gas emissions while simultaneously enhancing food security outcomes (Zhao et al., 2023). Interventions such as agroforestry, conservation tillage, and integrated crop-livestock systems have shown promise in improving resilience to extreme weather events and maintaining soil health (Tendall et al., 2015). Similarly, a meta-analysis of CSA adoption across smallholder farms in Sub-Saharan Africa found that practices including improved crop rotations and precision irrigation systems can reduce emissions by up to 30 percent, while increasing yields by an average of 20 percent (Mnukwa et al., 2025). These findings indicate that CSA is not only effective at mitigating climate change impacts but is also scalable, particularly in regions most vulnerable to climate variability, provided that adequate technical support and financing mechanisms are in place.

Carbon sequestration in agricultural soils represents another critical mitigation strategy (Zhu et al., 2022). Research examining sustainable soil management practices, including reduced tillage, cover cropping, and organic farming, indicates that these practices can offset up to 15 percent of annual agricultural emissions by increasing soil organic carbon (SOC) stocks (Liu et al., 2024). When combined with agroforestry interventions, total carbon sequestration can reach up to 25 percent, illustrating the potential for synergistic benefits. However, trade-offs exist. A study in European farming systems evaluating conservation tillage found that while soil carbon storage increased significantly, regional variations in soil texture and water retention occasionally led to reduced crop yields (O'sullivan et al., 2024). These findings highlight that effectiveness and scalability depend on context-specific assessments, emphasizing the importance of tailoring soil management strategies to local agroecological conditions.

Technological innovations have also emerged as pivotal tools in enhancing both mitigation and adaptation in agrifood systems. Digital agriculture technologies such as remote sensing, artificial intelligence, and blockchain enable precision agriculture practices that optimize resource use and reduce emissions (Balasundram et al., 2023). For instance, precision irrigation and fertilizer management can cut nitrogen emissions by up to 40 percent while improving crop yields by 15 percent (Singh et al., 2024). Similarly, biotechnology innovations, including drought-tolerant and pest-resistant genetically modified (GM) crops, have shown potential for large-scale adoption in arid regions, reducing water use by 30 percent and lowering pesticide-related emissions (Patel et al., 2022). The effectiveness and scalability of these technologies, however, depend on complementary policies that ensure equitable access, infrastructure development, and farmer training, particularly in low-income countries.

3.8 Policy recommendations on climate change and food systems in Africa

3.8.1 Governance

Effective governance is the backbone of a climate-resilient food system. Across regions, policy frameworks have proven vital in promoting climate action and coordinating resources toward agricultural sustainability. In Latin America, national climate policies have incorporated mechanisms such as subsidies for climate-resilient crops, strategic irrigation investments, and targeted support for smallholder farmers (Nunez, 2013). These governance tools not only strengthen productivity but also embed resilience into the agricultural sector. Similarly, the European Union's Green Deal and its Farm to Fork strategy exemplify how structured governance can drive emission reductions, though their success hinges on regional implementation and sustained financial incentives (Wang et al., 2025). In Africa, the Comprehensive Africa Agriculture Development Programme (CAADP) launched in 2003 has served as a central governance instrument to boost investment and coordination in the agricultural sector. The Maputo Declaration's commitment of 10% of national budgets to agriculture and the 2014 Malabo Declaration's targets on hunger, poverty, and resilience underscore the continent's ambition. However, recent CAADP biennial reviews reveal that most countries are off-track, prompting the launch of a new post-Malabo CAADP agenda, which aims to guide food systems transformation through a more systematic and sustainability-focused approach by 2035.

3.8.2 Mitigation and adaptation

Climate change mitigation in food systems focuses on reducing greenhouse gas emissions while maintaining or improving agricultural productivity. Recent global and regional initiatives highlight a shift toward low-emission farming methods that are both practical and scalable. For instance, the COP29 outcomes emphasized soil carbon sequestration, which enhances soil fertility while capturing atmospheric carbon, and promoted water-efficient agriculture to minimize energy-intensive irrigation systems (UNFCCC, 2023). Agro ecological practices that reduce dependency on chemical inputs and foster ecosystem health are also recognized for their dual role in mitigation and sustainability. In Europe, the Farm to Fork strategy under the EU Green Deal aims to cut agricultural emissions by 20% by 2030, demonstrating how coherent mitigation policies can contribute to climate targets if backed by regional planning and appropriate financial instruments (Roberts et al., 2017). Brazil and Mexico offer further evidence, where the integration of mitigation goals into agricultural policy through promotion of climate-smart farming has contributed to emission reductions while maintaining food production.

Climate change adaptation involves building adaptive capacity within food systems is essential to withstand the adverse effects of climate variability, especially for smallholder farmers in vulnerable regions. Adaptation strategies must prioritize resilience-building across the production landscape, from seed systems to water use. Policies that support the cultivation of climate-resilient crop varieties help farmers manage changing rainfall patterns, pests, and diseases. Investments in irrigation infrastructure, as seen in Latin America's climate policy frameworks, enable farmers to buffer against drought and reduce reliance on increasingly erratic rainfall (Nunez, 2013). Agro ecological farming systems characterized by biodiversity, soil conservation, and integrated pest management enhance resilience at both farm and ecosystem levels. The new CAADP agenda in Africa places strong emphasis on adaptation, aiming to transition toward sustainable food systems that are better equipped to handle climate shocks. Similarly, the promotion of climate-smart agriculture at COP29 highlights the importance of tailoring practices to local agro ecological conditions to build long-term resilience while sustaining productivity (UNFCCC, 2023).

3.9 Collaborative approaches in addressing climate change

A growing body of research emphasizes the need for collaborative governance that involves multiple stakeholders such as governments, private sectors, civil society, and international organizations to effectively mitigate climate change impacts on food systems. Hernandez Garcia et al. (2024) found that multi-stakeholder initiatives, such as the Global Alliance for Climate-Smart Agriculture, have been instrumental in fostering cross-border collaboration and knowledge-sharing, particularly in the context of scaling up sustainable practices in developing countries. These initiatives have enabled farmers to access climate-smart tools and resources, as well as financial mechanisms to transition to more sustainable farming models (Hernandez Garcia et al., 2024).

Similarly, Smith (2023) evaluated the role of public-private partnerships in promoting sustainable food systems in Southeast Asia. They observed that such partnerships facilitated development of climate-resilient supply chains, particularly in the palm oil and rice sectors, by providing farmers with access to better farming practices and climate risk insurance. The study further advocated for a more integrated approach to policy-making that incorporates both local and global actors to create synergies between mitigation, adaptation, and development goals.

3.9.1 Mechanization of agricultural practices

Africa needs to transform its farming practices by increasing medium and large scale mechanization. The mechanization process should start from ploughing to harvesting to reduce time, food loss and wastage which in turn will increase agricultural productivity. The traditional ways of farming should be forgotten. Farmers must embrace the modern ways. When agricultural mechanization is accessible and effective it is likely to contribute to economic transformation in Africa (Diao et al., 2016). Considering the impact of some farming machinery on soil health, it is more imperative to promote farming machinery that is compatible with conservation agriculture and sustainable soil management.

3.9.2 Enabling conditions for adaptation

The availability of farmer-friendly finances and tax regimes plays a significant role in enhancing food production by providing farmers with capital or incentives to boost agricultural production (Mokgomo et al., 2022). COP 29 gathering also recommended financing of food systems in relation to the current trends in climate change as an important way of increasing food production recommendation. The conference further agreed that countries should make special efforts to create climate finance mechanisms for food systems and adaptation that will help local farmers in low and middle-income countries to access various prices needed for sustainable production of food in their respective localities (UNFCCC, 2023). Secondly, all the challenges which farmers meet when accessing finances must be removed (Khan et al., 2024). The government must make sure that taxes are reduced or removed on loans for food production. This will make more people venture into farming and produce at large scales, and be able to buy inputs in time thereby making farming work easier. In addition, parties to COP 29 also agreed to capitalize on the newly introduced rules of carbon markets as stipulated in the Article 6 of the Paris Agreement. This has the power to help in ensuring that carbon credits are real, additional and also contributing significantly to the reduction of global emissions.

Scaling up ICT services in African countries can significantly increase efficiency, productivity and sustainability of food production in the continent as farmers will be able to access information about farming easily and at a manageable cost. Intensification of ICT will further bring efficiencies in the provision of extension and advisory services through digitalization and will also result in efficient utilization of resources through precision farming (Gebru et al., 2019).

3.9.3 Study limitations

The authors used only google scholar as the search database with a basis that most search engines are linked to google scholar. However, we acknowledge the chances of missing on other articles that are not present on this search engine. The study also focused on research that was conducted in English and within the past 10 years which limits our search since food systems have existed from time in memorial and some insightful studies could have been published years before our cut off. Because the review included only 17 articles and used a restricted search strategy therefore the findings may not be fully generalizable to all food systems across the African continent. The authors acknowledge that relevant studies outside the selected scope could have been missed, and the small sample limits the ability to draw broad conclusions.

4 Conclusion

To effectively safeguard Africa's food systems against the escalating threats posed by climate change, there is an urgent need for a comprehensive and coordinated research agenda that not only deepens our understanding of region-specific climate impacts but also prioritizes inclusive, evidence-based interventions. This agenda should focus on generating locally relevant data, exploring the scalability of climate-smart innovations, assessing the socio-economic implications of adaptation strategies, and strengthening policy frameworks that bridge science, governance, and community action. Without timely, targeted, and sustained research efforts, the continent risks further setbacks in food security, rural livelihoods, and long-term agricultural resilience.

4.1 Policy implications

The systematic review process and article sparked thoughts in the authors' minds that can inform policy decisions for African countries in regard to climate change and food systems. The policy implications of climate change on food systems in Africa present the urgent need for comprehensive and adaptive strategies. Furthermore, strengthening climate-smart agriculture policies will be crucial to promoting drought-resistant crops, sustainable water management, and soil conservation techniques (Thierfelder et al., 2021). Additionally, enhancing climate financing for agriculture will enable African governments to access international funds for investing in mitigation and adaptation strategies, such as improved irrigation infrastructure and sustainable farming practices (Mungai et al., 2021).

To safeguard food security, governments should implement targeted social protection programs, including food aid, nutrition initiatives, and crop insurance schemes to support vulnerable populations (Devereux, 2016). Investing in agricultural research and innovation is also vital, with a focus on agro-ecological practices, biotechnology, and digital farming tools to enhance resilience. The findings in this review also guide the importance of developing robust early warning systems and disaster response mechanisms which help mitigate the impacts of extreme weather events on food production and distribution. Finally, aligning national agricultural policies with global climate agreements, such as the Paris Agreement and COP resolutions, will enable countries to access climate finance and technical support while strengthening their climate adaptation efforts (UNFCCC, 2023).

4.2 Final remarks

Understanding the impacts of climate change on food systems in Africa is important as it helps countries come up with interventions that help to reduce the adverse effects of climate change whilst improving the sustainability of food systems and diets. The current food systems in Africa leave a lot to be desired coupled with recurring natural disasters and shocks. Through understanding these impacts, policymakers will be better placed to make informed decisions that respond to the current trend of climate change. Research that focuses on specific countries and regions would be ideal for providing relevant information that is tailored to localities so that localized climate change interventions can be made.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

MC: Writing – original draft. MMc: Writing – original draft. UM: Writing – original draft. RC: Writing – original draft. KM: Writing – review & editing. MMa: Writing – original draft. EN: Writing – original draft. MB: Writing – original draft. DK: Writing – original draft. BM: Writing – review & editing. WB: Writing – review & editing. WK: Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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