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REVIEW

Leveraging FinTech Solutions for Efficient, Resilient, and Sustainable Food Systems in Africa

Emmanuel Ndhlovu [*] ***, Daniel Meyer***

College of Business and Economics, University of Johannesburg, Auckland Park 2006, South Africa

ABSTRACT

African food systems are at a crisis point. Climate change, rapid population growth, hyperinflation, wars, conflicts, and pandemics are among the causes of this disarray. Deliberations on transforming the system and empowering it to meet its mandate are ongoing. This article contributes to these ongoing deliberations by exploring the diagnostic potential of financial technology (FinTech) to improve African food systems, focusing on Sub-Saharan Africa (SSA). This is achieved by identifying the challenges of SSA food systems and exploring how FinTech can be used to address these challenges. The review article draws from a content analysis of secondary literature on food systems and FinTech, focusing on the possibilities of intersection. The article shows that Fintech can help streamline financial processes in SSA food systems, facilitating digital payments and lending, making it easier for food system actors to access credit and insurance, thus improving their operations. FinTech solutions like blockchain can also improve supply chain transparency and traceability. FinTech enables AI-powered tools for monitoring crop and animal health and optimising operations, ultimately contributing to food systems' efficiency, sustainability, and resilience. Despite several challenges, the article concludes that FinTech wields much potential to transform SSA food systems by improving financial access, enhancing transparency, promoting sustainability, and optimising operations across the food chain.

Keywords: FinTech; Food Systems; Resilience; Sustainability; Transformation

*CORRESPONDING AUTHOR:
Emmanuel Ndhlovu, College of Business and Economics, University of Johannesburg, Auckland Park 2006, South Africa;
Email: manundhl@gmail.com

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1. Introduction

Sub-Saharan African (SSA) food systems are at a crisis point due to various factors, ranging from climate change, economic shocks, conflict, and pandemics to a general leadership crisis. These factors have significantly impacted food production, storage, processing, distribution, access, and affordability, leading to prevalent food insecurity and malnutrition [1]. Climate Change results in more recurrent and severe droughts, storms, and floods, disrupting crop production and livestock grazing on the continent. Erratic weather patterns, mainly increasing temperature and reduced precipitation amounts, reduce agricultural productivity and yield [2,3]. Increasing temperature also necessitates extra investments in processing and storage facilities, thus further adversely impacting African food systems actors who traditionally operate under resource constraints. In addition, changing climate patterns exacerbate pest and disease outbreaks, further damaging crops, livestock, and poultry [4].

Economic shocks in African food systems include rising food prices and weak economic growth in many countries, making food less affordable for many people. Trade disruptions, such as pandemic-related lockdowns and other global events, such as the Russia-Ukraine war, disrupt trade routes and supply chains, impacting food availability and affordability [5]. In addition, high poverty levels and income inequality in Africa also limit access to food for many Africans [6]. As a result of this confluence of adverse factors, the continent faces a severe food crisis, with about 20% of the regional population already undernourished in 2022, and about 868 million people were moderately food-insecure, while 342 million people were already severely food-insecure [1]. In 2021, a staggering 78% of the population could not afford a healthy diet, compared with 42% globally [1]. In addition, millions of Africans suffer from prevalent micronutrient deficiencies [7]. Overweight and obesity are already significant public health concerns in many countries. Despite various efforts, Africa is not on track. It has already failed to meet the Malabo Declaration targets of ending hunger and all forms of malnutrition by 2025. It is unlikely to meet Sustainable Development Goal 2 on Zero Hunger by 2030.

The worsening of the food insecurity condition and the lack of substantial progress towards the World Health Organisation's (WHO) global nutrition targets make it imperative for African countries to step up efforts as part of an intervention to eliminate hunger and malnutrition, at least by 2030. The call for food systems transformation in Africa remains genuine and urgent, particularly given the projected lower rates of economic growth, high general and food price inflation, rapid population increase, and increasing borrowing costs on domestic and international markets [8–10].

Several proposals exist to steer SSA food systems and make them meet their mandate. These include joint venture partnerships, contract farming, land reforms, and the adoption of digital technologies. Joint ventures in food systems encompass partnerships between different entities, such as farmers and buyers, to attain shared food production, distribution, and consumption goals. Joint venture arrangements combine resources, expertise, and networks of stakeholders to confront food system challenges, such as improving nutrition, enhancing efficiency, or promoting sustainability [11,12]. Contract farming is when farmers agree in advance with buyers on the terms and conditions of producing and marketing their produce [13]. This approach can assist smallholder farmers in accessing markets, improving their incomes, and addressing market failures, especially in the modern agricultural value chain [14]. Digitalising food systems involves using digital technologies and data to improve efficiency, sustainability, and accessibility across the food supply chain [15]. This involves using various technologies such as digital platforms, mobile apps, and data analytics to address food systems challenges, such as food security, nutrition, and environmental sustainability. This article adds to these proposed interventions by building on how Fintech can be leveraged for overall food system efficiency in SSA.

Fintech refers to using technology to improve and innovate financial services [16]. It incorporates various digital solutions to make financial services more accessible, faster, and often affordable. Examples include mobile banking apps, online lending platforms, digital payment systems, and robo-advisors. In the context of food systems, FinTech can be used to ensure financial inclusion, streamline transactions, and enable traceability throughout the supply chain. This can lead to increased

access to finance for smallholder farmers, improved efficiency in payments and logistics, and greater transparency for consumers and retailers. Although the financial condition of food systems actors in SSA is diverse and complex, many face challenges like limited access to finance, high food prices, and climate change impacts. While sectors such as commercial farming are comparatively well-developed, smallholder farmers, who make up the majority of all farmers on the continent, continue to struggle with low incomes and food insecurity [9]. Moreover, rising food prices, driven by global supply issues and evolving dietary patterns, worsen these challenges. This article explores the role of FinTech in transforming the ailing SSA food systems.

The article (i) identifies the challenges of SSA food systems and (ii) explores how FinTech can be leveraged to address the challenges. By drawing policy and practical attention to the diagnostic potential of FinTech to improve SSA food systems, this article showcases how FinTech can improve food system efficiency, resilience, and sustainability by enhancing the access of SSA food system to financial services, streamlining transactions, and improving data management, eventually supporting food security and nutrition. Therefore, the article holds vital information for SSA food system actors. Policymakers, politicians, students, academics, and other stakeholders working in the diverse sub-sectors of SSA food systems can also find the article interesting to read.

This article proceeds as follows: The following sections review the literature related to the study and present the theoretical framework for the study, respectively. A presentation of the research methodology follows this. Thereafter, the article identifies challenges of Africa's food systems and then shows how various aspects of FinTech solutions can be leveraged to build efficient, resilient, and sustainable food systems in SSA. Lastly, conclusions and recommendations are drawn from the discussion.

2. Literature Review: State of Sub-Saharan Africa Food Systems

Reviewed literature shows that SSA food systems are currently unable to meet their mandate due to numerous challenges, including high rates of food insecurity, malnutrition, and the impact of COVID-19, climate change, food price hikes, and a general leadership crisis [2,17,18]. The reviewed literature also posits that Africa's food systems heavily depend on natural resources, which are facing exhaustion and degradation, impacting biodiversity and climate change resilience [19,20]. Transforming SSA food systems requires a multi-faceted approach which includes investment in infrastructure, promoting sustainable agricultural practices, strengthening food storage, processing, and distribution systems, as well as enhancing nutrition education [5,17,21]. All sub-regions across SSA continue to face challenges in their food systems.

In West Africa, Nigeria faces significant food systems challenges, including high food insecurity, malnutrition, and reliance on imports [6,22]. These challenges are worsened by low agricultural productivity, weak institutions, and an incongruity between supply and demand [23]. While Nigeria has a large agricultural sector, it struggles to meet the growing demands of its population [24]. In Ghana, Aberman et al. [25] found that the food system faces challenges regarding diet quality, nutrition security, and food safety. Sambu et al. [26] found that while Ghana has reduced food insecurity, a substantial portion of the population still struggles to afford a healthy diet, leading to macro and micronutrient deficiencies. Quarm and Begho [27] state that food safety issues, including the unsafe use of agrochemicals and poor storage practices, also challenge the Ghanaian food system. Likewise, according to FAO [28], Senegal's food system faces significant challenges, including food insecurity, climate change impacts, and dependence on imports. Nébié et al. [29] observed that climate change is worsening these issues through heatwaves, droughts, and floods, affecting agricultural production and livelihoods, particularly for women and vulnerable groups. While agriculture is important to the Senegalese economy, the country struggles with low yields and is highly susceptible to climate variability [30].

The Food Insecurity Experience Scale (FIES) shows that food security remains a significant challenge in Senegal, where about half of the population faces either a moderate or severe food insecurity level [1]. Poor di-

etary diversity further worsens limited access to food in Senegal [31].

In East Africa, food systems face significant challenges, with widespread food insecurity and malnutrition, particularly in areas affected by climate change, economic crises, and conflicts [32]. These issues affect millions of people in the region [33], highlighting the urgency for strengthening food security and improving food systems. For instance, Kenya's food system is characterised by high food insecurity and malnutrition levels, particularly among women and children [34]. Kenya's food system is also highly susceptible to climate change and substantially impacts the environment, contributing to greenhouse gas emissions and biodiversity loss [35]. While agricultural output has increased [36], the burden of malnutrition persists, and the proportion of the population with severe food insecurity has risen [37]. In Uganda, although the country has a high potential for food security due to favourable climate and agro-ecological conditions, food insecurity continues, particularly in the poorest regions of Karamoja, West Nile, Lango, and Acholi. An estimated 10 million out of 44 million people experience food insecurity [38], with 2.3 million people experiencing acute food insecurity [39]. However, it is reported that Uganda also has the potential to become a food basket for the Eastern Africa subregion, with a positive trade balance in agriproducts [37]. Tanzania's food system also faces a complex challenge, marked by prevalent malnutrition, including stunting and hidden hunger, together with growing overweight and obesity [40]. While crucial for livelihoods, the agricultural sector faces problems in ensuring food and nutrition security for all, particularly for women who are a vital part of the labour force but often lack resources [41]. Tanzania is also grappling with the impact of climate change on its rain-fed agriculture and the need to adapt to changing rainfall and temperature patterns [42].

In Southern Africa, the South African food system faces significant challenges, including increasing hunger, rising food costs, lack of dietary diversity, and rising obesity alongside malnutrition [43,44]. Although some reports indicate improved access to food overall, many South Africans still struggle with food insecurity [1]. The South African system is also grappling with challenges such as food waste, foodborne illnesses, and the need for a just transition towards a more sustainable and equitable food system [45]. Zimbabwe's food system also faces substantial challenges, including food insecurity, malnutrition, and the impact of climate change [46,47]. About 60% of the population experiences food insecurity [48], with many resorting to extreme measures to cope. Climate change worsens these challenges, leading to droughts and declining agricultural productivity [49]. Sustainable agricultural practices are also lacking, contributing to soil degradation and reduced yields. Likewise, Malawi's food system also faces significant challenges, marked by prevalent food insecurity, a high incidence of stunting in children, and dependence on rain-fed agriculture vulnerable to climate change [50]. While agriculture is the backbone of the economy, low productivity and lack of access to essential inputs such as fertilisers hinder its potential [51]. These issues are worsened by factors such as weak economic growth, high debt, and the impact of climate disasters [52].

Reviewed literature also suggests that African food systems can be improved by focusing on sustainable agricultural practices, increasing intra-African trade, empowering women and youth, and investing in technology and research [23,36,44]. Specifically, this includes encouraging climate-smart agriculture, supporting community-led initiatives, and improving access to markets. The reviewed literature, however, does not provide a detailed discussion on how FinTech can be leveraged to contribute towards overall efforts on food system transformation. This is a gap that warrants investigation. This article closes this knowledge gap.

3. Theoretical Framework

The theoretical argument supported in this article is that the possibility of transformation in SSA food systems is premised on the availability of financial resources to fund activities and operations. The concept of inclusive finance being supported here is directly linked to the Theory of Change (ToC). ToC is a wide-ranging and overt model that explains how and why a desired change is anticipated to occur in a specific context [53]. It is a powerful tool used in planning, execution, and

evaluation across various sectors, particularly in social development, philanthropy, and government [54]. A ToC aims to bridge the gap between an intervention's activities and its long-term goals. Instead of simply listing what a programme will do, a ToC maps out the order of outcomes and preconditions that must occur for the ultimate goal to be achieved [55]. At its core, a ToC identifies the causal relationships. It defines long-term objectives and then works backwards, identifying all the essential short-term and intermediate outcomes that need to be in place, and how these outcomes are causally related to one another. A critical component of a ToC is making clear the assumptions about why particular activities will lead to specific outcomes, and why those outcomes will, in turn, contribute to the larger goal [54]. Identifying and testing these assumptions is important for the ToC's robustness and for learning and adaptation during implementation. A ToC is both a process and a product [56]. The aspect of 'process' involves a cooperative and reflective effort among stakeholders to articulate their shared understanding of how change will occur, fostering consensus and alignment. The aspect of 'product' entails the outcome being a narrative document accompanied by a visual diagram, outlining the logic of change.

There are several benefits associated with a ToC. These include ensuring improved planning. By this, the theory helps stakeholders design more effective programmes by clearly linking activities to desired results and identifying necessary preconditions. It provides a framework for measuring progress and evaluating the effectiveness of interventions, going beyond just outputs to assess outcomes and impact. In addition, it creates a common language and vision among stakeholders, improving communication and collaboration. Moreover, by articulating assumptions, a ToC helps identify potential risks and challenges early on. Furthermore, it is a 'living document' that can be revised and refined based on new evidence and learning, enabling programmes to adapt and improve over time [57]. **Figure 1** summarizes a ToC.

In essence, a ToC helps answer the fundamental questions: 'How do we expect change to happen?' and 'Why do we believe our actions will lead to the desired results?' It provides a rigorous, evidence-informed basis for strategic action.

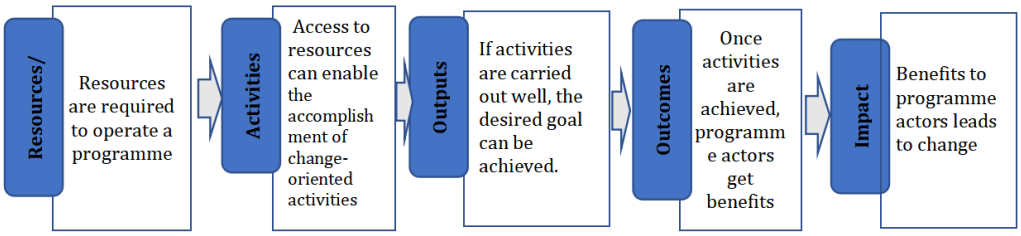

Figure 1. Theoretical framework of change.

Source: Adapted from various works.

4. Materials and Methods

This article is based on a review of primary and secondary literature on African food systems, mainly policy documents by regional and international policy and research institutions. These policy documents were identified based on whether they explore or describe food system-related in issues in Africa. There were no rigorous strategies used but rather, the authors used the words 'food systems' and 'food security' as search terms. The inclusion criteria included that a document needed to be written or translated to English, published after 01 January 2000, and cover more than one African country. Documents that did not meet these criteria were excluded.

This search generated 16 reports and policy documents that served as the basis for analysis. These documents are summarised in **Table 1**.

In addition to policy documents, a semi-systematic review of academic texts was conducted. Articles for review were obtained from Web of Science (WoS) and Scopus databases as the leading and most comprehensive databases containing peer-reviewed texts. The keywords 'food systems', 'agriculture', 'farming' and 'food security' in Africa were used to search for relevant articles from the two databases. **Table 2** shows the retrieval limits for academic texts.

Table 1. Reports and policy documents analysed.

Author	Title
FAO (2017)	The state of food security and nutrition in the world 2017. Building resilience for peace and food security
FAO (2020)	Real-time evaluation of FAO's response to desert locust upsurge (2020–2021)—Phase 1.
FAO., AUC., ECA., WFP. (2023)	Africa-Regional Overview of Food Security and Nutrition 2023: Statistics
AfDB. (2020).	African Economic Outlook.
IFPRI. (2021).	Global Food Policy Report: Transforming Food Systems after COVID-19
World Bank. (2023).	Kenya National Agriculture and Rural Inclusive Growth Project.
World Bank (2021)	Poverty and Equity Brief: Africa Eastern & Southern—Zimbabwe
WFP. (2020).	Global Report on Food Crises: Joint Analysis for Better Decisions.
AUDA. (2023).	Africa Common Position on Food Systems
AU. (2003).	Comprehensive Africa Agriculture Development Programme.
UNICEF. (2022).	Learning from the integration of social protection and nutrition in Eastern and Southern Africa.
InfraCo Africa. (2024).	Market insights: Food loss and waste—how infrastructure supports farmers facing the impacts of climate change.
InOnAfrica. (2024).	Securing Africa's food security against new challenges.
AU. (2022).	African Union 2022 year of nutrition: Strengthening resilience in nutrition and food security on the African continent
CAADP (2015).	Implementation Strategy and Roadmap to Achieve the 2025 Vision on CAADP
Food Security Information Network, (2020).	Global report on food crises: Joint analysis for better decisions.

Table 2. Article Retrieval Limits from Selected Databases.

Item	Description
Database	Scopus/Web of Science
Search field	Title, Abstract, Keywords
Keywords	'Food systems', 'agriculture', 'farming' and 'food security' in Africa
Accessibility	All
Years	01/01/2020–31/01/2024
Author name	Exclude undefined names
Subject area	All
Publication stage	Final
Document type	All
Language	English

Generic searches in the two databases first yielded 63 and 47 articles, respectively. When the searches were further refined, 42 and 33 articles were retained, respectively. The search for articles was done on 29 April 2025, and it was carried out from the title and abstract only to prevent certain irrelevant articles from being extracted. After the removal of duplicates through abstract screening, 27 articles remained in WoS and 22 in Scopus. This left 49 article eligible for full screening. After full screening, 17 articles were eliminated for lack of relevance and for narrow focus, leaving 32 eligible for analysis. **Figure 2** shows a flowchart of how articles were selected.

Content analysis, a method of understanding a situation or environment by examining the broader factors that influence it, was used in the study [58]. The method was used to gain a deeper understanding of the food system challenges in Africa, going beyond surface-level observations to identify underlying causes and potential impacts [59]. Content analysis is also reliable for identifying and analysing challenges and opportunities associated with a decision or project [60], and therefore, was crucial for this study since food systems comprise a confluence of projects. Furthermore, a thorough context analysis would also provide a foundation for developing effective and appropriate strategies for improving African food systems. The method would also help inform food system transformation decisions by considering the broader implications of transformation and potential consequences.

In using content analysis, attention was placed on a variety of factors that had the potential to generate an in-depth understanding of the conditions of African food systems. First, attention was placed on the factors (internal and external) that impact African food systems. Analysing the larger environment, including economic trends, social changes, political landscape, and techno-

logical advancements, enabled the authors to identify the key sources of the challenges and opportunities for African food system transformation. In essence, context analysis is vital for understanding a situation comprehensively, making informed decisions, and developing effective strategies.

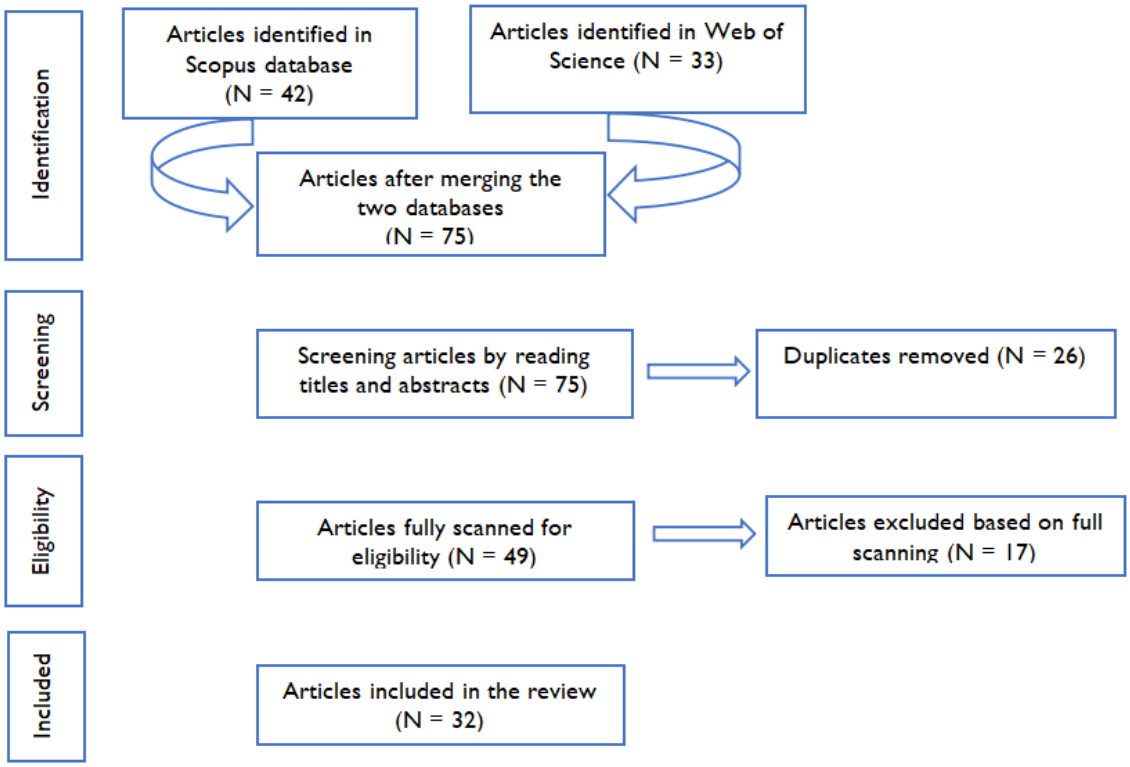

Figure 2. Flowchart summarising the identification of texts.

Articles not written in English, articles with undefined author names, focusing on a single country, and preprints were excluded from the study.

Latent analysis, a research method that involves exploring the underlying, implicit meanings and assumptions within text data to uncover more profound understandings of social phenomena, was used in the study. Unlike manifest analysis, which focuses on surface-level content, latent analysis digs into the interpretative level to uncover the 'why' and 'how' behind the explicit expressions. This approach was particularly valuable because it allowed the authors to explore the complex contexts of African food systems regarding their financial conditions. Thematic analysis was then used to group the key recurring aspects in the texts. Four key themes, particularly in relation to small producers and Small and Medium Enterprises, were identified. These themes were infrastructural shortages, resource inadequacy, social Inequalities, and institutional mismanagement and corruption. These challenges hindered the ability of African food system actors to transition to sustainable practices, increase scale, and improve food security.

5. Findings: Africa's Food System Challenges

The review shows that African food systems face several challenges. **Table 3** summarises the key challenges identified in the review. Most of the reviewed texts identified more than a single challenge to African food systems. Therefore, some texts were recorded more than once in the analysis. **Table 3** shows that resource inadequacy was the major challenge appearing in both reports and policy documents as well as in academic texts. This was followed by institutional management challenges that impede food systems development and transformation. Infrastructural challenges were the third main challenge while social challenges received little attention in both categories of the reviewed texts.

Table 3. Main African Food Systems Challenges.

Challenge	Nº of R&P	Nº of A
Infrastructural deficit	8	21
Resource inadequacy	17	32
Social challenges	6	9
Institutional mismanagement	17	16

Note: R&P—denotes reports and policy documents; A—denotes academic documents.

In addition, challenges such as land degradation, water scarcity, and global shocks emerged in the analysis. The following sub-sections summarise the key themes emerging from the analysis.

5.1. Infrastructural Shortages

The review showed that African food systems face infrastructural shortages that significantly hamper the efficiency and productivity of food systems, impeding the continent's ability to feed its growing population and achieve food security [61,62]. These challenges manifest in many interconnected ways, but include limited transport networks and internet connectivity. A substantial share of roads, particularly in rural areas, are not paved or are poorly maintained [1]. Only 20% of African roads are paved. This condition increases transportation costs, travel time, and the risk of damage and spoilage of agricultural produce during transit from farms to markets [63,64]. Inadequate and inefficient railway and port infrastructure further confounds food movement, leading to delays and increased costs [65]. African food systems also face insufficient storage facilities [66]. Inadequate on-farm and centralised storage facilities lead to substantial post-harvest losses due to spoilage, pest infestation, and lack of proper preservation [67,68]. It is estimated that 30–50% of food is lost in SSA because of the lack of suitable post-harvest infrastructure, such as cold storage [69]. Inadequate and sporadic electricity, in SSA, for instance, in Zimbabwe, Zambia, and South Africa, where loadshedding can last for up to 18 hours per day [70], hinders agricultural processing, irrigation, and the operation of storage facilities, including cold storage. About half of Africa's population lacks access to reliable electricity [68]. Reliance on expensive and polluting diesel-powered irrigation facilities due to a lack of reliable and affordable electricity increases production costs for food system actors [71]. For instance, Southern African countries such as Zimbabwe, Zambia, and South Africa, experience electricity loadshedding that sometimes takes up to 18 hours, impacting food systems, from production to consumption [9,47].

The review also shows that African food systems battle challenges related to Information and Communication Technology (ICT) Infrastructure shortages. Poor internet access, especially in rural areas, restricts farmers' access to crucial information on weather patterns, market prices, and contemporary farming methods [49,67]. It also hampers the adoption and integration of digital agricultural solutions [1]. In Kenya, Ghana, Malawi, Uganda, Zimbabwe, and South Africa, inadequate digital platforms to connect food system actors, such as farmers with markets, financial services, and other agricultural stakeholders, limit efficiency and transparency in the food system [46,47,55,72]. Improving internet connectivity, as detailed in the theoretical framework, can eventually improve food systems in SSA.

Infrastructural deficiencies lead to increased food losses and waste. Poor food storage and transportation infrastructure significantly contribute to the high levels of post-harvest losses, reducing the amount of food available and increasing food prices. Inadequate transport networks also prevent food system actors, especially smallholder farmers in remote areas, from accessing profitable markets, limiting their income and incentives for increased production [64]. Increased transportation and storage costs due to infrastructural shortages are often passed on to consumers, making food less affordable [1]. Lack of reliable irrigation, energy for mechanisation, and modern technologies hinders the overall efficiency of the food system. Reduced food availability, higher prices, and limited access to a variety of nutritious foods exacerbate food insecurity and malnutrition across the continent [1]. Addressing the infrastructural challenges in African food systems requires substantial and sustained investment from governments,

the private sector, and development partners [73]. It is posited that by addressing these infrastructural bottlenecks, African food systems actors can realise change as espoused in the ToC and unlock the potential of their food systems, boost food security, improve livelihoods for farmers, and foster sustainable economic development [62].

5.2. Resource Inadequacy

The review also revealed that resource challenges, worsened by political instability outside the continent, threaten African food systems significantly, impeding the continent's capacity to attain food security and sustainable development [5]. Internal factors such as unsustainable agricultural practices, deforestation, and overgrazing also contribute to extensive land degradation, affecting about 65% of Africa's cultivated land [74]. This results in soil erosion, nutrient exhaustion, and reduced agricultural productivity [75], threatening the livelihoods of over 70% of the African population that depends on the land for food and income [11]. Water shortage is also a growing concern in SSA, with two-thirds of the continent classified as arid or semi-arid [71]. Climate change, population growth, and poor water management worsen this issue, leading to droughts, low agricultural yields, and increased competition for water resources [72]. It is predicted that by 2025, nearly 230 million Africans will face water scarcity [76,77].

Climate change is also a major driver of food insecurity in SSA, leading to unpredictable weather patterns, extreme events, such as droughts, storms, and floods, and increased temperatures [64,78]. These disruptions affect traditional farming systems, lower crop yields, and increase the incidence of pests and diseases, further straining agricultural production [61]. For instance, climate change in the Horn of Africa in countries such as Somalia, has devastated agriculture and triggered a severe food crisis [75]. Climate change-associated events also disrupt food storage, processing, and transportation [66].

The review recommends that addressing these resource challenges requires a multi-faceted approach, which involves sustainable land and water management practices, climate-resilient agricultural activities, investments in infrastructure (including digital infrastructure), and the adoption of policies that promote equitable access to resources and markets [1,75]. It is suggested that governments, international organisations, and local communities work together to build resilient and sustainable food systems that can ensure food security for all Africans [67]. Initiatives like the African Fertiliser and Soil Health Action Plan (2024–2034) and investments in climate-smart agriculture are vital steps towards transforming SSA food systems and ensuring a food-secure future for the continent [11,79]. Implementing these recommendations is anticipated to bring about change as espoused in the ToC.

5.3. Social Challenges

The review shows that social challenges substantially impact the functionality and resilience of SSA food systems. The social challenges identified in the review are multi-faceted, encompassing economic, political, and cultural dimensions. These challenges affect food production, distribution, access, and consumption. Africa's poverty rates are reported as very high [1]. High poverty and income inequality levels limit access to nutritious food for a significant portion of the African population [1]. Due to poverty, many people in SSA are unable to afford a healthy diet, highlighting the deep-rooted socio-economic inequalities that hamper food security efforts [76]. Even when food is available, many Africans cannot afford it, leading to food insecurity [74,78]. For example, in South Africa, about 20% of the population is food insecure due to high poverty levels, income inequality, and unemployment [64]. In Kenya, about 25.4% of the population is multidimensionally poor. This includes 13,754 people in 2022. Furthermore, 26.4% of the population is exposed to multidimensional poverty, which is 14,325 thousand people in 2022 [80]. In Zimbabwe, in 2023, 35% of the population, or 5.6 million, lived in extreme poverty [78]. Beyond food availability, access to nutritious food and adequate health services is important. Issues like a lack of knowledge about nutritional food benefits and combinations, and insufficient health services contribute to malnutrition [77,80]. Unsafe food practices and inadequate food safety standards also pose health risks [71].

Land tenure challenges have been observed as another challenge in SSA. A substantial percentage of

African rural land is undocumented, making it susceptible to land grabbing and expropriation [81]. Weak land governance and corruption worsen this issue [82]. Women, who constitute a substantial share of the agricultural labour force (60–80%), often have insecure or limited land rights because of customary laws, hindering their productivity [79]. Gender inequality also affects the operation of food systems in SSA. In SSA, women play a crucial role in food systems, in farming, food processing, and food preparation in households [77], yet they face systemic barriers in accessing vital resources, such as land, credit, and technology [83]. In South Africa, this inequality is leading to lower productivity, particularly on women-managed farms and enterprises compared to farms run by men [79]. Reducing the gender gap in agriculture could boost the economy and reduce food insecurity in SSA [75]. South Africa is among the countries focusing on improving food production and access through deliberately targeting women, particularly through its land reform programme [79].

Conflict and Instability have also been identified as barriers to food system development in SSA [75,76]. Violent conflicts and insecurity, local or international, disturb food systems activities, displace farming communities, and exacerbate food insecurity [5]. Countries experiencing conflict often become food insecure and prone to hunger. For instance, many people facing severe food insecurity in SSA reside in conflict-affected countries [76,80]. Over 25 million people in Sudan and 27.7 million in the Democratic Republic of Congo face severe food insecurity due to ongoing conflicts [77].

Addressing these social barriers needs integrated and inclusive political and private sector strategies that consider the diverse needs and contexts across SSA. Consolidating land rights, promoting gender equality, infrastructural development, fostering peace and stability, and implementing climate-smart agricultural practices are vital steps towards transforming SSA food systems and achieving food security for all.

5.4. Institutional Mismanagement and Corruption

The review shows that institutional mismanagement and corruption have deep and harmful impacts on SSA food systems, undermining food security, impeding agricultural development, and perpetuating poverty in many countries [75,76,83]. These issues manifest in various forms across the food value chain, from policy formulation to distribution and consumption. In Zimbabwe, Kenya, and South Africa, natural resource mismanagement has resulted in poorly designed or ineffectively executed food system policies [49,67,71,79]. Mismanagement in these countries include a lack of coherent plans, inconsistent implementation, and a failure to prioritise the needs of food system actors [9]. For instance, in Zimbabwe and South Africa, subsidies meant to support smallholder farmers were poorly targeted or incompetently distributed, failing to attain their intended impact on productivity [79].

The review also shows that deficiencies in governance structures and the rule of law generate an environment where mismanagement can flourish. This includes a lack of transparency and accountability in public institutions, which discourages investment and sustainable agricultural practices [74]. Mismanagement in African institutions is also contributing to underinvestment in critical infrastructure, such as transportation networks, storage facilities, and irrigation systems [84,85]. This leads to high post-harvest losses, limits market access for farmers, and increases the cost of food for consumers [81]. For instance, in 2024, significant food losses continue to plague SSA, impacting food security and economic development. Nearly a third (30%) of harvested food in SSA is lost before it reaches consumers [82]. This food loss and wastage is attributed to diverse factors, including poor infrastructure, post-harvest handling practices, and climate change. Likewise, insufficient extension and research support hamper the integration of modern technologies into food system operations, undermining overall efficiency [83]. Mismanaged institutions are unable to allocate resources effectively to the food systems sector. This can involve underfunding agricultural research and development, neglecting the needs of small-scale actors in favour of large-scale operations, or misdirecting funds intended for agricultural development towards non-food priorities [70].

Corruption is also another challenge in SSA food systems. Corruption is resulting in the misuse, stealing,

and illicit diversion of funds and resources meant for the food systems sector [9]. In countries like Zimbabwe and Kenya, this includes the stealing agricultural inputs like fertilisers and seeds, stealing funds from food systems development projects, and manipulating procurement processes for personal gain [83,86]. Corrupt practices like bribery and extortion along transport corridors and ports of entry increase food costs and reduce farm-gate prices, thus discouraging production [74]. High corruption levels also discourage domestic and foreign investment in the food systems sector. The lack of investment delays the modernisation and expansion of agricultural production [75,82]. Corruption also erodes trust in public institutions and worsens social inequalities [77,87]. When resources are misappropriated and policies are manipulated for personal gain, it compromises the capacity of the government to provide vital services and support to its citizens, especially the most vulnerable, who are mostly affected by food insecurity. Corruption also severely undermines the effectiveness of food aid programmes [80,88]. Instances of public officials diverting food aid for personal gain have been documented in countries such as Malawi, Zimbabwe, and Uganda [51,77,89], meaning that assistance may not reach those in need. Examples of corruption in African Food Systems include corrupt officials conniving with powerful individuals to acquire land illegally, often displacing farmers and undermining their livelihoods [90]. It also includes bribery at checkpoints, with truck drivers transporting food facing demands for bribes at roadblocks, leading to increased transport costs and food spoilage [91].

6. Discussion: Leveraging FinTech Solutions

The review generally shows that SSA food systems are facing enormous challenges. While several strategies have been proposed to deal with the challenges, this article explores the diagnostic potential of Fintech solutions to generate efficient, resilient, and sustainable food systems through mobilising resources and connecting food system activities and programmes as espoused in the ToC (see **Figure 1**). FinTech solutions offer advanced ways to address various challenges faced within SSA food systems, from farmers to consumers.

6.1. Enhancing Efficiency

With most SSA food system actors facing acute financial exclusion [65], FinTech solutions can enhance food systems by enabling digital lending and financing that can boost resources and smooth activities and programmes of different categories of food system actors, particularly smallholder farmers who make up the majority of farmers in SSA. FinTech platforms could revolutionise credit access for smallholder farmers and agricultural businesses facing financial challenges in SSA. By leveraging data analytics, mobile technology, and other credit scoring methods, FinTech platforms can evaluate creditworthiness faster and more effectively than traditional financial institutions, thus expediting change in food systems [92]. This can allow food system actors like farmers to access vital financing for resources such as inputs, equipment, and working capital, boosting productivity and efficiency. For instance, cotton marketing agencies in Zimbabwe, such as Parrogate and Gargill, use data gathered during farmer onboarding and farm mapping to determine credit amounts [13]. However, some farmers avoid engaging these marketing agencies due to the exploitative nature of their services [13]. Therefore, regulatory frameworks that guide how marketing and fintech agencies engage farmers and other actors are needed. For instance, in South Africa, agricultural joint ventures and partnerships with farmers are overseen by the Department of Agriculture, Land Reform and Rural Development.

FinTech solutions also generate the emergence of digital marketplaces from which food system programmes and activities can benefit. Mobile-based platforms connect food system actors, improving general efficiency. Mobile-based platforms can connect farmers directly with processors, retailers, and consumers, eliminating intermediaries and reducing transaction costs. These marketplaces are reputable for improving price transparency, providing access to broader markets, and enabling more efficient supply chains [93]. Examples include GeoFarmer in Kenya, which facilitates two-way data flow to support co-innovation in agricultural

projects, the M-Kulima in Tanzania, which allows farmers to list produce and connect with buyers, FarmSpace in South Africa, which provides farmers with the latest agricultural news, trends, and practices, and the ITIKI Plus in Kenya, Mozambique, and South Africa, which integrates indigenous knowledge with scientific agro-climate decision support for farmers.

Through FinTech, digital payment systems can facilitate transactions. Digital payment solutions can be used to streamline transactions across the SSA food system chain, making payments faster, cheaper, and more secure. This will reduce the risks associated with cash transactions and promote financial inclusion for food system actors, thus leading to sustainable food system transformation. With faster payments, actors such as farmers can buy inputs in time. Digital payments will also reduce the delays associated with using intermediaries in payments. In addition, it can also help reduce corruption as food system actors can easily transact among themselves with minimal interruption by third parties. For instance, Njogo et al.[94] found that although the rise of digital payment had exposed customers in West Africa to risks such as internet fraudsters and incomplete transactions, among others, the use of Automatic Teller Machines has been a deterrent to corruption levels in several countries in the region. Birigozzi et al.[95] also posit that digital payment systems can reduce government corruption by providing a more transparent and traceable record of financial and resource transactions, making it harder for officials to skim funds or engage in bribery. However, these scholars also argue that digital payments alone may not be a complete solution, as other factors like policy reforms and socio-political change also play a critical role, as shown in the theoretical framework. Therefore, improving digital platforms for food system actors can potentially improve SSA food systems. However, in countries like Zimbabwe, policy inconsistencies tend to deter fintech agencies, such that even where farmers would accept them, the services are simply not available. This is another challenge impeding sustainable change in the country's food system.

FinTech companies can also utilise data analytics, artificial intelligence, and the internet to provide food system actors with real-time information on weather patterns, soil health, market prices, processing and storage conditions, and food transportation routes. This allows for more informed decision-making about production, processing, storage, and transportation, leading to increased efficiency and reduced waste in food systems.

FinTech also enables supply chain optimisation. Technologies such as blockchain can increase transparency and traceability in food supply chains, reducing wastefulness and ensuring food safety. By tracking food products from farm to consumer, stakeholders can detect and address issues such as waste and contamination more effectively.

6.2. Building Resilience

FinTech solutions facilitate digital insurance. For instance, agri-FinTech provides tailored insurance products like index-based insurance that can protect food system actors against various shocks, such as droughts and floods[96]. These solutions often utilise weather data and remote sensing to automatically trigger payouts, offering timely financial support to food system actors, enhancing their resilience. In East Africa, Acre Africa links farmers to weather-indexed insurance plans with payouts *via* mobile money.

FinTech platforms can also enable food system actors to access diversified income sources, such as through involvement in carbon credit schemes or access to new value chains[84]. For farmers, this will reduce reliance on single crops and enhance the ability of food system actors to withstand economic and environmental shocks.

Access to information and advisory services is also easier with FinTech. Mobile platforms and digital tools provide food system actors access critical information on best practices, effective management, and market trends[48]. This empowers them to adopt more resilient practices and adapt to changing conditions. For instance, DigiFarm uses drones in Kenya to provide farmers with information about land topography and guide pest and fertiliser application, thus boosting productivity.

6.3. Fostering Sustainability

Some FinTech solutions incentivise adopting environmentally friendly food system practices by connect-

ing access to credit or insurance to sustainable practices. For instance, FinTech platforms may offer better terms to farmers adopting conservation agriculture, agroforestry, or food processors practising responsible food waste.

FinTech also facilitates food waste reduction. Efficient supply chains enabled by FinTech, such as digital marketplaces and improved logistics, can reduce post-harvest losses and food waste, contributing to more sustainable food systems for the SSA population. In addition, data-driven insights provided by FinTech can help stakeholders optimise resource use and minimise their environmental impact. Furthermore, FinTech can also play a vital role in unlocking green finance for sustainable agriculture by linking environmentally mindful investors with farmers and agri-businesses employing sustainable practices.

6.4. Challenges and Opportunities

Notwithstanding the enormous potential of FinTech in transforming African food systems, several challenges must be addressed. This includes ensuring that food system actors, particularly smallholder farmers who comprise most SSA farmers[9], have the essential digital literacy and access to digital infrastructure (internet, mobile phones) to adopt FinTech solutions. Poor infrastructure, especially reliable internet connectivity and electricity, can hinder the deployment and effectiveness of digital solutions, and therefore needs to be prioritised. Increasing internet connectivity, as detailed in the theoretical framework, and promoting the use of digital platforms can improve access to information, markets, and financial services for food system actors.

There are also trust and awareness issues that may impede the adoption of FinTech solutions. Building trust in digital platforms and raising awareness about the benefits of FinTech solutions among actors, particularly smallholder farmers and others, is essential. In addition, supportive policies and regulations are required to foster innovation in Agri-FinTech while shielding consumers and ensuring fair competition. Further, while FinTech can promote financial inclusion, efforts are needed to ensure that solutions are accessible and affordable, especially for smallholder farmers and women who usually face challenges in accessing loans and credit from financial institutions[92].

Notwithstanding the identified challenges, the opportunities for leveraging FinTech to build efficient, resilient, and sustainable food systems in SSA are significant. By addressing the current gaps and fostering collaboration among governments, the private sector, and development organisations, FinTech can play a transformative role in ensuring food security and promoting sustainable development across the region.

7. Conclusion

The article identified the challenges of SSA food systems and through the ToC, explored how FinTech can be leveraged to address the identified challenges. Drawing from several examples across Africa, the article demonstrated how FinTech solutions have the potential to improve efficiency, resilience, and the sustainability of SSA food systems. It argues that since the leading food system actors in SSA are smallholder farmers, who make up the majority of all farmers, improving their access to fintech can improve their activities. A ToC espouses that once the activities of a particular programme or programmes are integrated, such programmes stand a good chance to flourish. This article concludes that adopting a ToC can therefore, help improve African food systems, and possibly improve infrastructure.

The review showed that Africa has limited food processing plants, making food system activities concentrated at the bottom level of the food system chain, characterised by low profitability. This affects the possibility of actors adopting FinTech. Therefore, financial exclusion is the leading cause of financial exclusion by SSA food system actors and limited adoption of FinTech solutions. In addition to infrastructural roll out, stakeholders must address trust and awareness issues, promote financial inclusion, and adopt supportive policies and regulations that foster innovation in Agri-FinTech while shielding consumers and ensuring fair competition. Future research can explore how funds can be mobilised to support FinTech access, adoption, and integration by SSA food system actors, particularly farmers. Adopting these strategies can lead to the required sustainable change of

African food systems.

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Conflicts of Interest

The authors disclosed no conflict of interest.

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