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A framework for researching African food systems

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The structure and functioning of current African food systems, together with unfavourable terms of trade and climate change impacts, pose significant challenges to achieving sustainability and more equitable outcomes. A contextually grounded evidence base is essential to identify feasible and resilient transformation pathways. Global food systems research has focused on industrialised food systems, with less attention given to Africa and to other differently structured systems. A framework for food systems analysis in Africa is needed to guide analysis and promote transformation while ensuring equitable opportunities for vulnerable communities amidst diverse cultural contexts. The Food Systems Research Network for Africa (FSNet-Africa) project developed a tailored analytical framework aimed at enabling holistic African food systems analysis. A co-production, iterative approach that built on existing models, the research of twenty early career scholars, and feedback from African scholars culminated in the development of the FSNet-Africa Food Systems Framework presented here. The process has demonstrated the effectiveness of a co-creation approach in developing applicable conceptual models for African food systems research. The Framework describes, from the lens of African food systems, a set of food systems drivers, the food system itself, and food system outcomes. Applications of the framework in research, teaching and policy spheres has demonstrated its wide relevance and applicability to addressing complex issues across the African food system.

KEYWORDS

transformation, African food systems, systems analysis, just transitions, research frameworks

1 Introduction

Food systems are integral to the achievement of many of the sustainable development goals (SDGs). Although only SDG 2 (No Hunger) addresses a direct food system outcome, goals relating to health, inclusion, responsible consumption, reduced inequality and the elimination of poverty, the environment and partnerships are all related to an efficient, sustainable and just food system. Food systems contribute to producing livelihood opportunities that are inclusive and equitable and can operate in a restorative manner concerning biodiversity and natural resources. Finally, food systems are central in addressing climate change and can provide increased resilience and adaptability to risks and shocks at multiple scales.

The multiple and interconnected linkages in food systems underscore the imperative to conceptualise and understand them further through research. Applying a systems approach to analysing food production, distribution, and consumption has a long history. An early example is Steinhart and Steinhart's (1974) analysis of the energy usage of the United States food system. Most studies focus on analyses that examine the value chains in the system as the link between supply (production) and demand (consumption) (Reardon, 2015). Demand-oriented approaches are common and focus on consumer behaviour, access to and affordability of food, and healthy and nutritious diets. These studies emphasise the nature of the food environment as an important factor shaping options and preferences. System-wide approaches are less common and are concerned with achieving responsive, adaptive food systems through improved governance to overcome trade-offs and leverage synergies (Brouwer et al., 2020).

Recently, food systems analyses have become widespread (Béné et al., 2019), with the 2021 UN Food Systems Summit demonstrating the extent of interest. One reason for this is that the approach provides deeper, more comprehensive, and actionable insights into complex global development challenges compared to focusing only on agriculture or nutrition. By understanding the interconnections within the food system, policymakers, researchers, and practitioners can develop strategies for more equitable, sustainable, and resilient food systems (Béné et al., 2019; Global Panel on Agriculture and Food Systems for Nutrition, 2025).

1.1 Food systems analysis in Africa

Historically, global food systems research has focused on industrialised food systems, with less attention given to Africa and other differently structured systems in which pre-existing ways of production, distribution and consumption were reshaped by colonialism and post-independence structural adjustment (McMichael, 2013). Much of the research in Africa has focused on agricultural production rather than the entire food system [FAO (Food Agriculture Organization), 2020a,b]. Limited resources have impacted the quantity and depth of food systems research, and the lack of reliable and complete data (Béné et al., 2019) has made it challenging to build a robust and evidence-based understanding of African food systems across diverse regions and cultures (Ingram, 2011).

Addressing food system challenges and promoting transformation in Africa is a pressing priority (Nature Food, 2023). According to recent estimates, one in five Africans experienced hunger in 2023, and hunger is increasing [FAO (Food and Agriculture Organization), IFAD (International Fund for Agricultural Development), UNICEF, WFP (World Food Programme), and WHO (World Health Organization), 2024]. With population projections predicting that 25% of people will live in Africa by 2050 [UN ECA (United Nations Economic Commission for Africa), 2024], the importance of African food systems and their resilience is further underscored.

But there is no single African food system. With over 2,000 languages, 3,000 ethnic groups, 54 countries, and 10 major agro-ecological zones, the continent contains a diversity of food cultures and food environments [Shoup, 2011; Duru, 2020; FAO (Food and Agriculture Organization) IIASA (International Institute for Applied Systems Analysis), 2024]. At the same time, African food systems are part of a global network shaped by the biosphere, political economy, and cultural globalisation (Inglis, 2009; Bernstein, 2016).

Several factors argue in favour of exploring the notion of a single conceptual framework to guide analysis of African food systems. The continent has a shared history of colonisation, underdevelopment, and limited inclusion in the world food system. There is an element of commonality in the investments, collaborations, and regulations carried out through pan-African governance, including institutional structures such as the African Union and increasing integration of countries that is recognized by recent initiatives such as the Africa Continental Free Trade Agreement. There is a shared vision of the challenges and opportunities which face its governments and citizens and how to address these, as captured by Agenda 2063, the "One Africa Voice" initiative, and the Comprehensive African Agricultural Development Programme (CAADP) (African Union, 2023), articulated at the CAADP Kampala Summit, "Africa's agricultural renaissance" where the 10-Year CAADP Strategy and Action Plan (2026–2035) was endorsed.

There are also characteristics of African food systems that distinguish them from industrialised systems. They have been shaped by the legacy of colonisation, in ways that continue to distinguish them from those of other world regions, creating spatially uneven agrarian structures and enduring inequalities in access to land (Cooper, 2019). These historical legacies have produced hybrid governance structures, spatial disparities in production potential, and a fragmented institutional landscape that remain evident in contemporary African food systems (Guyer, 2019; Ayeb and Bush, 2019).

Further, across the continent, land and livestock are not just economic assets but serve as crucial elements of identity, social status, and cultural heritage (Chigbu, 2013; Guyer, 2019; Zeleza, 1994). Women and youth are central to the functioning of African food systems, yet they face structural constraints that inhibit their full and equitable participation. Women contribute disproportionately to food production, processing, marketing, and household nutrition, yet are routinely excluded from decision-making, land ownership, credit access, and extension services (Doss et al., 2018). In both Francophone and Anglophone contexts, women are overrepresented in informal low-return parts of the food system and underrepresented in higher-value chains (Botreau and Cohen, 2020). These dynamics reflect entrenched gender norms and institutional barriers, which not only reproduce inequality but also reduce system-wide productivity.

Unlike many OECD countries, where food systems are capital-intensive and ageing, or Asian countries where food systems have experienced rapid intensification, and are also ageing, the exclusion of youth is a problematic and specific issue in Africa. With 60% of the continent's population under the age of 25, Africa has a demographic advantage that could be harnessed for agricultural innovation and food system transformation (Rocca and Schultes, 2020; Ahmed et al., 2016). However, young people often struggle to enter agricultural value chains due to a lack of access to land,

finance, and market infrastructure, as well as perceptions that farming is unprofitable or socially undesirable (Mkandawire et al., 2021).

African food systems also differ significantly in their post-independence integration into global markets and their technological dependencies. Many countries remain exporters of raw agricultural commodities, such as cocoa, coffee, cotton, and cashew nuts, while relying on imports for processed foods, agricultural inputs, and farm machinery (Poulton et al., 2006; Bernstein, 2016). This is reinforced by unequal terms of trade and tariff structures that favour producers in the Global North (Clapp et al., 2022). African producers, lacking the subsidies and infrastructure available in Europe or the Americas, often struggle to compete, while capturing a minimal share of the value generated in agri-food chains.

Food value chains across Africa are also typically shorter, less integrated, and less regulated than in industrialised regions, relying heavily on smallholders, open-air markets, and informal retailers (Reardon et al., 2019). Value chains reflect a lower level of processing, fewer intermediaries and more direct transactions between producers and consumers [AGRA (Alliance for a Green Revolution in Africa), 2022]. Technologically, African agriculture remains under-mechanised and heavily reliant on imported inputs. African farmers on average have ten times fewer mechanised tools per hectare than their counterparts in Asia [ECA (UN Economic Commission for Africa), AUC (African Union Commission), AfDB (African Development Bank), and UNDP, 2021]. The Green Revolution, which reshaped food systems in Asia and Latin America, had limited impact in Africa due to ecological diversity, policy misalignment, and weak public investment (Jayne et al., 2010). Agricultural research and development remains externalised, with limited locally adapted innovation (Ayeb and Bush, 2019).

Food system transformation in Africa is already underway and is likely to take a different path from others (Global Panel on Agriculture and Food Systems for Nutrition, 2025). Driven by rapid urbanisation, shifting diets, and structural changes in value chains, informal and formal markets are expanding, especially in urban areas, while midstream actors such as processors and logistics providers are becoming more prominent. Policies aligned with CAADP and national development strategies have promoted value chain development, while digital innovations are improving access to inputs, finance, and market information. In 2023, 40 countries were on track to recommitting to the principles of CAADP to invest at least 10% of national budgets in agriculture, with an aim to achieve 6% economic growth. Other indicators suggested that several countries were also making progress in enhancing resilience to climate variability and strengthening mutual accountability for actions and results (African Union, 2023). Achievements in the past two decades of the CAADP process have led to renewed commitment in the form of the Kampala CAADP Declaration on Building Resilient and Sustainable Agrifood Systems in Africa (African Union, 2024a, 2023). The new agenda for the next decade sets ambitious targets related to agrifood growth and trade, inclusion and equity, and resilience and climate action. At the same time, civil society movements, including agroecology and food sovereignty advocates, are challenging dominant models of industrial intensification, calling for more inclusive and sustainable approaches. Land reforms and tenure formalisation efforts, though uneven, are also reshaping production systems.

African food system actors are likely to deepen their focus on climate resilience, with greater adoption of diversified cropping systems, drought-tolerant varieties, and sustainable intensification strategies. Changes to the food environment such as the expansion of supermarkets and greater integration into global markets also pose risks (Reardon et al., 2003; Minot, 2011). These effects may disproportionately impact smallholders, women, and youth, while increasing dependence on imported technologies. Growing awareness of these risks is evident among African governments, civil society groups, agroecology networks such as Alliance for Food Sovereignty in Africa (AFSA), and farmer associations in countries like Kenya and Ghana [AFSA (Alliance for Food Sovereignty in Africa), 2021; Beuchelt and Badstue, 2013]. The Africa Union, for example, hosted the Africa Fertiliser and Soil Health Summit in 2024, which is intended to culminate in a Declaration (African Union, 2024a,b). Some government agencies and researchers are also re-evaluating input-intensive models, advocating for sustainable, locally adapted alternatives that prioritise resilience and equity [HLPE (High Level Panel of Experts), 2019].

An analytical framework is needed to provide a heuristic that enables scholars, policy makers and practitioners to assess the trade-offs implied by policies and practices that seek to address these options with the intention of improving food system outcomes. This paper describes the preparation and application of such a framework that is both globally comparable, yet contextually nuanced enough, to account for the unique aspects of African food systems.

2 Developing a framework for understanding African food systems

2.1 An initial conceptualisation

In 2021, the University of Pretoria and the University of the Western Cape agreed to collaborate in the preparation of a tailored analytical framework for the Food Systems Research Network for Africa (FSNet-Africa) project. The FSNet-Africa project sought to strengthen food systems analytical capabilities in Africa through a structured programme of research leadership development. An important objective was to translate evidence generated from research findings into implementable policy solutions and practical interventions to support attaining the SDGs.

At the outset of preparing the FSNet-Africa food systems framework (the Framework) it was recognized that several analytical frameworks are also available for the analysis of food systems (Sobal et al., 1998; GLOPAN (Global Panel on Agriculture and Food Systems for Nutrition), 2016; HLPE (High-Level Panel of Experts), 2017; FAO (Food Agriculture Organization), 2018; Van Berkum et al., 2018; IFPRI (International Food Policy Research Institute), 2020). In general, these propose similar dimensions:

- They identify external drivers of food system change;

- They describe the components of the system, including the institutions, actors, and activities in food supply chains and the food environment;
- They recognise a set of food system outcomes;
- They encourage the development of policy levers that seek to improve both food system outcomes and its resilience.

The Framework was adapted from Brunori et al. (2015) TRANSMANGO that extends the well-known High-Level Panel of Experts framework [HLPE (High-Level Panel of Experts), 2017]. It adopts a socio-economic systems approach to African food systems that is underpinned by a scoping of the relevant literature concerning the challenges and knowledge gaps facing African food systems.

The resulting initial Framework (referred to in this paper as Framework v1) presented a conceptual overview of the components of, and linkages within, food systems, identifying the different levels at which food systems operate and how they transform (Bayat et al., 2023).

2.2 Applying the framework to expand the evidence base

The Framework v1 was conceptualised as a tool to guide the research of a cohort of twenty early career scholars recruited by FSNet-Africa for a structured 2-year capacity-building programme. Each scholar applied the Framework v1 to design their research project. The scholars were drawn from diverse disciplines in the natural and social sciences and from six African countries (South Africa, Zambia, Kenya, Tanzania, Malawi and Ghana). Many of the early career researchers have published their research work that was guided by the Framework (e.g., Anim-Jnr et al., 2023; Dorvlo et al., 2023; Kwapong et al., 2024; Lungu et al., 2024).

Framework v1 also guided the preparation of the South Africa Rapid Food System Assessment for the UN Food Summit [FAO (Food and Agriculture Organization), EU (European Union), CIRAD, and CoE-FS (DSI-NRF Centre of Excellence in Food Security), 2022].

2.3 Refining the framework

By applying Framework v1 to diverse projects in various disciplines and geographic contexts, the 20 early career FSNet-Africa scholars were able to provide feedback on its applicability and recommendations on how it could be adapted or extended. Feedback was obtained through a facilitated feedback session during a workshop with the 20 scholars with the focus on collaboratively refining the framework for improved applicability to African food systems research. The workshop was held after they had practically applied the Framework to their own research and thus could identify gaps, ambiguities and instances of redundancy. The feedback provided by the fellows was captured during the workshop, incorporated into the Framework, and based on the analysis of the senior researchers in the team, accepted as initial adaptations to the Framework.

After the conclusion of the FSNet-Africa fellowship programme, a purposively selected group of researchers (which included senior scholars and early career researchers) who were familiar with and had applied the Framework to their research, participated in an intensive week-long workshop to develop a synthesis of findings from the work of the 20 FSNet-Africa early career scholars. During this workshop, a further round of feedback and deliberations on the Framework resulted in the framework presented in this paper.

The relevance of the Framework for expanding the evidence base related to African food systems was tested through multi-disciplinary application and an iterative process of knowledge co-production. The process has highlighted the value of a co-creation approach to developing conceptual models for research to ensure their applicability and a common interpretation.

3 The FSNet-Africa food systems framework

The Framework (Figure 1) comprises three interconnected aspects—food systems drivers, the food system itself, and food system outcomes. The aspects (and their respective components) are connected by feedback and feed-forward loops that mitigate or amplify changes to conserve or disrupt the system's resilience. Thus, the Framework depicts a "*complex, heterogeneous and circular system replete with linear as well as non-linear feedbacks*" characterized by multi-causality "*resulting from multiple interactions among interdependent components*." (Béné et al., 2019, p. 152).

3.1 Food systems drivers

Béné et al.'s (2019) systematic literature review on food systems identified 155 proposed drivers of change. In addition to the impracticality of this large number of drivers, the authors point out the limited usefulness of food system drivers that lack clear definitions and conceptual precision. They propose that for "*…a specific process to be considered as a driver, the effect of this process needs to be continuous over a certain period of time so that it effectively alters or influences the system durably and consistently*" (Béné et al., 2019, p. 150). This definition allows processes (drivers) to be both exogenous (emanating from outside the food system) and endogenous (emanating from within the system).

The Framework, while seeking to ensure conceptual clarity in defining the drivers included, emphasizes drivers that are external to the food system. This formulation is consistent with the socio-ecological systems approach (Ostrom, 2009; Nassl and Löffler, 2015).

The Framework defines these drivers of food system change as consistent, long-running processes that may be social, economic or environmental (Tscherning et al., 2012). They apply pressure to the system that results in durable changes and, in turn, result in modifications to the food system outcomes (either favourably or adversely). Drivers of food systems can be intended/deliberate or unintended/accidental, and changes can result from the combination of two or more distinct drivers. Moreover, drivers may

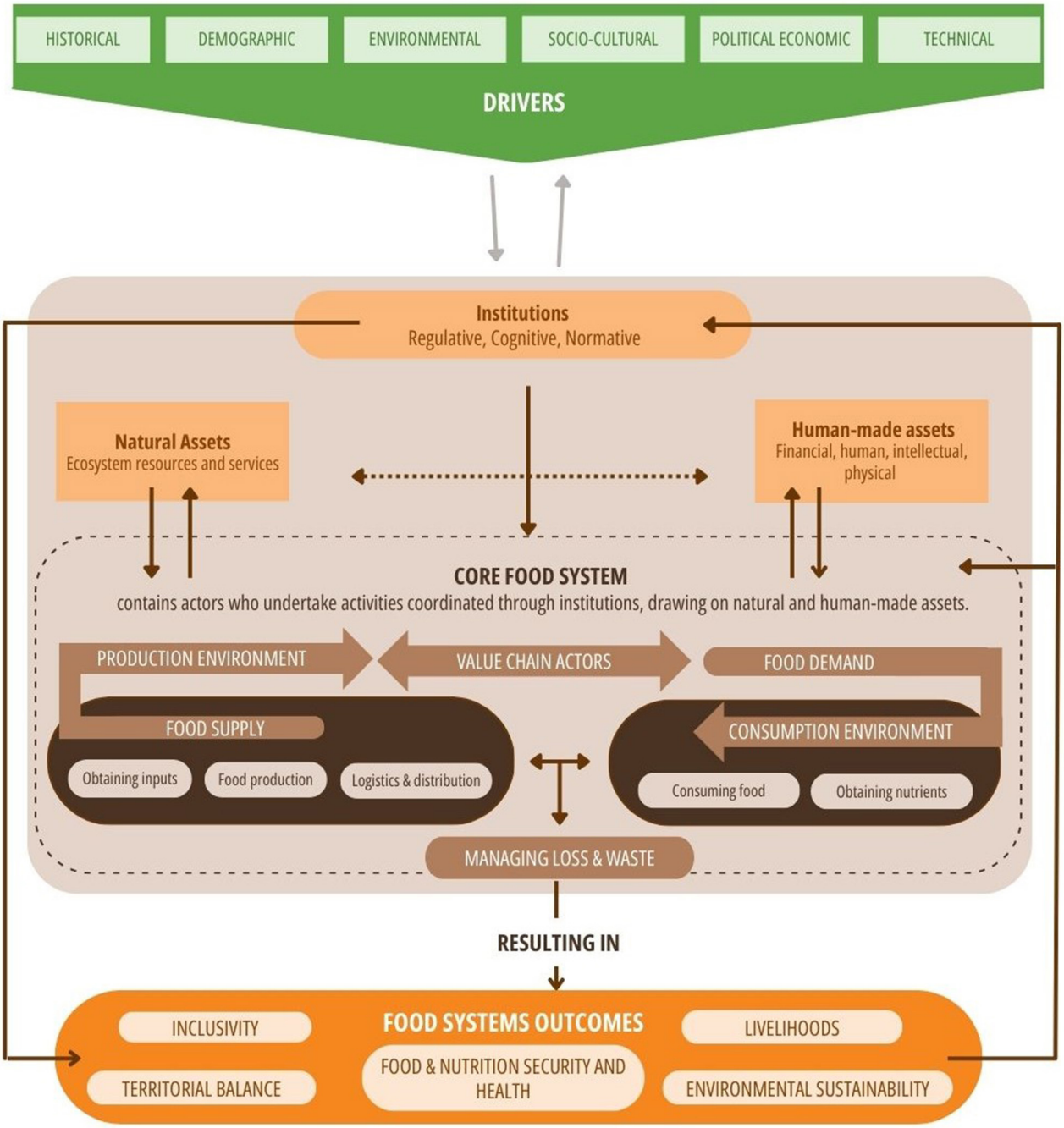

FIGURE 1
FSNet-Africa food systems framework.

produce incremental change along a predictable pathway or may result in transformation: structural shifts with uncertainty about the pathway and consequences (Borel-Saladin and Turok, 2013).

Béné et al. (2019) reduced their extended inventory of possible drivers to a list of 12 that they argue meet the criteria of (1) being processes, (2) continuously exert an influence on the food system over a period of time, and (3) alter the food system durably and consistently. The Framework includes six food systems drivers: historical, demographic, environmental, sociocultural, political-economic and technical, and thus collapses and groups some of the drivers identified by Béné et al. (2019) while adding elements of relevance to the African context.

3.1.1 Historical drivers

Food systems across Africa have been shaped by the continent's history, from pre-colonial traditions through colonialism and the processes of democratization and engagement with the global

economy during a period of neo-liberal policy (Hannaford, 2023). Each historical stage, along with its associated political, economic, and social drivers, has resulted in lasting changes in African countries' production and consumption environments. These historical trajectories still influence what food is produced and consumed, where it is produced, by whom, and for whose economic benefit. They have also shaped the productivity of food production systems and the extent to which value chains have developed and matured (Bjornlund et al., 2020).

While the specific ways in which history has shaped food systems vary across countries, a shared factor is the broad legacy of colonialism in most countries, and the subsequent cycles of liberation, conflict, and structural change.

3.1.2 Demographic drivers

Demographic drivers such as population size, urbanization, age structure, and migration patterns are particularly critical in shaping African food systems. These factors influence the amount of food required to ensure food and nutrition security, the structure of agricultural markets, and the types of food produced as consumer preferences evolve. Africa's population dynamics will significantly shape not only the continent's food systems in the coming decades, but also global economic, environmental, and social trends.

In 2023, Africa's population stood at approximately 1.4 billion [UN DESA (United Nations Department of Economic and Social Affairs), Population Division, 2024]. By 2050, Africa's population is projected to reach 2.5 billion [UN ECA (United Nations Economic Commission for Africa), 2024]. Rapid urbanization, a key feature of Africa's demographic transition, is expected to continue, with over 50% of the population living in urban areas by mid-century [OECD (Organization for Economic Cooperation and Development) and SWAC (Sahel and West Africa Club), 2020]. This shift has already begun influencing food consumption habits, with urban populations increasingly relying on processed and convenience foods. In addition to urbanization, Africa's diverse settlement patterns—spanning megacities, suburban, township, informal, and both dense and sparsely settled rural areas—affect food access, production, and market connectivity (De Bruin et al., 2021). At the same time, migration flows of some 21 million people within the continent influences preferences, provides opportunities for trade, and presents new challenges [UN IOM (United Nations International Organisation for Migration), 2024].

Africa's youthful population is distinctive, with around 60% of the continent's inhabitants younger than 25 (Rocca and Schultes, 2020). If well-managed through strategic investments in education, employment, and agriculture, this youthful population could deliver a demographic dividend, driving economic growth and food system transformation (Ahmed et al., 2016) through transformation of human-made assets.

3.1.3 Environmental drivers

The environment is a critical driver of food systems because it directly influences the availability of natural assets such as water, soil, and biodiversity, all of which are essential for food production. Environmental changes are already placing African food systems under significant stress (Pereira et al., 2020), and this pressure will increase in the future [IPCC (Intergovernmental Panel on Climate Change), 2023]. The sustainability and resilience of these systems will depend on effectively managing environmental challenges, particularly in the face of growing threats from climate change, resource depletion, and ecosystem degradation.

Although Africa is one of the lowest contributors to global greenhouse gas emissions, the continent has already experienced significant losses and damages attributable to human-induced climate change. Rising temperatures, increased frequency of heatwaves, and reductions in arable land is negatively affecting crop yields. At the same time, climate change is exacerbating health issues such as undernutrition, heat stress, and vector-borne diseases. Localized challenges, such as prolonged droughts in the Sahel, tropicalisation in East Africa, and rising sea levels in coastal regions, further stress food systems. Global warming between 1.5 and 2°C is projected to result in widespread and severe consequences, including reduced agricultural productivity, economic stagnation, rising inequality, and biodiversity loss [IPCC (Intergovernmental Panel on Climate Change), 2023].

3.1.4 Political-economic drivers

The inclusion of political-economic drivers in the Framework acknowledges the interaction of power and the operation of markets, and how this influences food systems and the provisioning of food (Fine, 1994). This driver refers to economic macro-drivers influencing the global food system, as well as to the microeconomics of food production, processing and distribution (Jayne et al., 2014). As Béné (2022) observes, the trade-offs between competing goals take place in the face of divided interests and unequal power dynamics. The decisions of all stakeholders, including governments, and researchers are influenced by these dynamics.

Political-economic drivers impact multiple aspects of the food system through changes to human-made assets and institutions, including food prices, availability, the length of supply chains and access to markets. They exert an influence on African food systems through the size and nature of markets; the availability and terms of financial resources required for private and public investment; the quantity and quality of the livelihoods that are produced by the food system; and availability of social protection and other components of the social wage (Niño-Zarazúa et al., 2012; Mogues, 2015; Greenberg, 2017). In the case of micro-drivers, enterprises in many African countries face limited or missing markets, especially in terms of finance, insurance, and inputs. This influences the operation of value chains and can exacerbate the impact of power inequalities (Poulton et al., 2006).

The increasing prosperity of parts of Africa's population is a key political-economic driver. The rise in the average per capita incomes of many countries previously classified as low-income means that more countries are now considered middle-income. Income growth has coincided with improvements in the business environments of many countries, improvements in physical infrastructure, a reduction in political risk, and the introduction of new technologies, particularly mobile phone penetration. An important consequence of this is changing consumer preferences with increased consumption of convenience food and animal protein (Sans and Combris, 2015; Komarek et al., 2021).

3.1.5 Technical drivers

Technical drivers are factors that trigger significant changes in the technological landscape, impacting food value chains and food production environments. These drivers include disruptive innovations such as precision agriculture, material advancements like biodegradable packaging, process innovations such as blockchain for traceability, and regulatory shifts that promote sustainable practices. As technology advances, food system enterprises must adapt to emerging and changing demands.

Digitally enabled agricultural transformation could lead to meaningful livelihood improvements for smallholder farmers (Tsan et al., 2019). However, technological adoption faces unique challenges, such as limited infrastructure in both urban and rural areas, uneven internet access, and high costs of advanced technologies. These factors can create a preference for low-cost, sustainable solutions that can overcome barriers to entry. For example, the proliferation of mobile technologies has been a significant shift in Africa over the past decades, providing farmers access to market information, weather forecasts, and financial services (Baumüller, 2018). At the same time, the growing digital divide between Africa and regions with rapidly advancing technologies poses a challenge to the continent's ability to transform its food systems (Revenko and Revenko, 2022). Addressing this divide will ensure that technological advancements can drive equitable and sustainable growth in Africa's food systems.

3.1.6 Socio-cultural drivers

Food systems in Africa are shaped by a variety of socio-cultural drivers, deeply intertwined with the continent's history, economic structures, and social transformations. Traditional food cultures and indigenous knowledge systems significantly shape the production environment through farming techniques and crop varieties, and the consumption environment through food preservation methods and dietary preferences (Scoones and Thompson, 2011). For instance, certain crops are valued for their nutritional value and medicinal properties, and some foods are consumed or avoided depending on cultural or life-stage considerations (Chakona and Shackleton, 2019).

In many African societies, women are the primary food producers, responsible for farming, food preparation, and household nutrition. Despite their central role, women often face significant barriers to accessing critical resources like land, credit, and technology. These gendered dynamics influence decisions about crop selection, food purchasing, and nutritional priorities within households, which in turn impact food and nutrition security (Meinzen-Dick et al., 2014; Njuki et al., 2016) and food system resilience.

3.2 The food system

The components of the food system in the Framework include institutions, natural assets, human-made assets, and the core food system. The latter contains the production environment, the consumption environment and the value chains that connect them, and all activities for managing loss and waste.

3.2.1 Institutions

Institutions are social structures that provide meaning and stability to social life, guiding behaviour and choices by developing, embedding and adapting rules, norms and values (Hallett and Ventresca, 2006). Institutions need to be backed by power and resources to be effective. Institutions can guide human behaviour by wielding this power to provide incentives, restrictions, and rewards.

In Framework v1, institutions were grouped into three pillars: regulative, normative and cognitive. This conceptualization is the same as the TRANSMANGO framework (Brunori et al., 2015), and institutions have remained a component of the Framework throughout its revisions.

Regulative institutions are *"the rules of the game and consist of written and unwritten codes with enforcement mechanisms"* (Scott, 2008). These institutions include organizations that engage in rule-setting, monitoring, and sanctioning or rewarding, and the means to enforce these (Douglass-North, 1990). The regulator element encompasses constitutions, legislative acts, by-laws, policies and programmes, directives and regulations. They may be global, such as those of the World Trade Organisation; regional, such as CAADP; national and sub-national, such as the zoning and advertising regulations adopted by municipal governments. In some instances, these institutions may be legally sanctioned, but they can also be self-regulating or voluntary (Brunori et al., 2015).

Cognitive institutions are akin to Veblen's (1919) "*settled habits of thought,*" dealing with how actors understand and make sense of their environment. They are the deeply embedded formal and informal rules that people internalize and that shape their paradigms and worldviews (Friel, 2017).

Normative institutions are *"norms and values that structure choices, emphasizing how things should be done and defining legitimate means to accomplish them"* (Friel, 2017). In food systems, norms and beliefs inform values that point towards what is preferred or desirable or norms concerning actions. They shape the roles played by different actors and how these roles are carried out. They confer rights and responsibilities as well as privileges and obligations. Normative institutions play a key role in African food systems. For example, in many parts of Africa, land and livestock continue to play multiple roles possessing both economic and normative value (Morris, 2000; Meinzen-Dick and Mwangi, 2009).

Gender norms are another important case, shaping expectations about how persons of different genders are expected to behave—dictating, for example, what is appropriate for men and women to do in terms of producing, cooking and eating food. Normative institutions also influence children's socialization regarding food behaviours based on gender (Polar et al., 2021; Ramirez-Santos et al., 2023). Within food systems, gender is a socio-cultural driver, with patriarchy being a normative institution, and gendered inequalities an outcome.

There is an important distinction between cognitive and normative institutions; the former shapes how we think and interpret the world, while the latter guides our actions by establishing rules and expectations. Both play a role in shaping behaviour and societal structures from different perspectives. They are related in that once a particular belief or value is widely accepted within a society (cognitive institution), it can lead to establishing norms and rules that dictate appropriate behaviour (normative institutions). In this way, normative institutions draw

upon cognitive frameworks to define what is considered acceptable or expected.

In African food systems, coordination of actors is rarely driven by a single institutional logic, whether that of markets or government. Rather, it emerges from the interplay of formal state policies, customary norms, and market practices. For example, in land governance, formal titling systems coexist with customary tenure regimes, requiring farmers, traders, and governments to navigate hybrid institutional arrangements that influence access and investment decisions. Similarly, food safety standards in informal markets often rely less on state regulation than on reputational norms and shared understandings among traders and consumers. In urban food retail, informal vendors operate within contested spaces where municipal by-laws, collective organising, and social legitimacy interact to structure what is permissible. In these contexts, institutions coordinate activity by harmonising expectations, reducing conflict, and enabling cooperation, even in the absence of strong enforcement.

3.2.2 Natural assets

The TRANSMANGO framework (Brunori et al., 2015) described natural assets as encompassing the provision of ecosystem resources and services as identified by the Millennium Ecosystem Assessment, namely provisioning, regulating, and supporting services [MEA (Millenium Ecosystem Assessment), 2004]. The provisioning assets provide the food system with products from the ecosystem, such as fuel, food and fibre, fresh water, genetic resources and other renewable and non-renewable resources. These are frequently required as inputs to activities performed by actors. Natural assets are also regulators of processes within the food system—for example, they help maintain air quality, regulate climate, and receive and decompose waste. The supporting assets include, but are not limited to, the production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and habitat provisioning (Brunori et al., 2015).

Natural assets interact with the core food system (through actors and the activities they undertake) and are impacted by the influence of drivers. Natural assets can be exploited by actors and activities in the food system or maintained sustainably. Changes in drivers can influence the creation or destruction of natural assets (Brunori et al., 2015).

3.2.3 Human-made assets

The TRANSMANGO framework (Brunori et al., 2015) describes human-made assets as those providing *"actors with resources and services that influence the functioning of the food system"*. The conceptualization is similar to Common and Stagl (2005), with human-made assets covering five typologies: physical, human, intellectual, social (including cultural) and financial assets. Physical assets are the components (e.g., tools, machinery, roads, dams, storage facilities, energy generation, etc.) that provide the infrastructure for activities in the food system. Human assets are learned knowledge and skills within individuals that influence the productivity of the food system (including through the supply of labour). Intellectual assets are built upon knowledge and skills that are not embodied in individuals but are available to actors (e.g., books, articles, magazines, websites, etc.). The functioning of the food system, especially related to consumption, is also conditioned by social assets. These are linked with the coordination of food system activities and tightly bound to human values and behaviour, as well as other human institutions and patterns of social, economic and political organization. Financial assets encompass everything that relates to financial resources and services.

The Framework adopted the construct of assets—natural and human-made—after considering other framings (Scoones, 1998; Steffen et al., 2020). Feedback from scholars confirmed the ease with which these constructs (natural and human-made assets) can be understood and applied within multidisciplinary teams.

3.2.4 The core food system

The HLPE's notion of food production and consumption environments [HLPE (High-Level Panel of Experts), 2017] was adopted in the Framework to draw attention to sociocultural practices and the specific attributes of territories and places. The components of the core food system in the Framework include the food production environment, the food consumption environment, the value chains that connect these, and the losses and waste that occur because of activities within the system.

3.2.4.1 The food production environment

Four key activities were identified on the *production side* of Framework v1—input and output markets, production and processing, logistics and distribution, and innovation and branding. These differed slightly from the TRANSMANGO framework to better align with recent agri-food value chain analysis (Barrett et al., 2022).

In the Framework, the terminology of food production activities as the component of the system responsible for food supply was reintroduced with activities specified: providing inputs, producing food, and logistics and distribution. Feedback that informed this, particularly from practitioners, was that excluding production terminology did not immediately make agriculture's role evident in the system. Obtaining inputs includes all activities linked to the input industry, such as procuring raw materials required for producing food. Food production involves diverse activities, from growing plants and producing livestock to collecting foods from the environment (e.g., wild food, fishing). Distributing food (and inputs) includes all activities and logistics that reduce the distance between the input industry and farmers, and between farmers and consumers.

Many African food production systems remain characterised by a lack of human-made assets through small-scale operations that rely on rain-fed farming practices, with little use of external inputs such as improved seeds, breeds and fertilisers, and limited mechanisation for preparing the land, harvesting and threshing (Jayne et al., 2019). Of concern is the limited change in access to technology and mechanisation. African farmers have ten times fewer mechanised tools per farm area than farmers in other developing regions, and access is not growing as quickly as in other regions [ECA (UN Economic Commission for Africa), AUC (African Union Commission), AfDB (African Development Bank), and UNDP, 2021]. However, current trends indicate a move towards capital-intensive, industrialised and highly concentrated commercial farming and the consolidation of farmlands, which has resulted in smallholder farmers becoming landless and resorting

to poorly remunerated, insecure work on commercial farms or migrating to urban centres in search of economic opportunities [FAO (Food Agriculture Organization), 2016].

3.2.4.2 Value chains

Value chains link food production activities with the food consumption environment, encompassing all activities along the so-called farm-to-fork. The concept of value chains is useful for analysis as a value chain approach considers all activities and services that contribute towards moving products or services from their conception to their end use, identifying the relative benefit that accrues in each node along the chain. This type of analysis seeks to trace the patterns of value creation and the linkages between geographically dispersed economic activities and actors (Gereffi and Fernandez-Stark, 2016). Value chain analysis should reveal the power dynamics between nodes in the chain, exposing the feedback and feed-forward loops to the political-economic drivers of the food system.

The value chains in African food systems demonstrate considerable diversity. Tight and loose value chains can be identified, with the former based on formal contracts and the latter on informal exchange agreements between buyers and sellers. Many African food value chains are characterized by fragmentation, informality, and reliance on smallholder farmers, but they are also increasingly influenced by urbanization and growing consumer demand for processed foods, and by financialisaton (Reardon et al., 2019; Tschirley et al., 2010; Isakson, 2017).

3.2.4.3 The food consumption environment

Following Brunori et al. (2015), two activities were initially identified on the *consumption side* (consuming food and obtaining nutrients), but were then replaced with "food environments" as a concept representative of the activities in this component of the food system. Swinburn et al. (2013, p. 12) define the food environment as the "…*collective physical, economic, policy and sociocultural surroundings, opportunities and conditions that influence people's food and beverage choices and nutritional status*". Following the feedback sessions, the descriptive elements of consuming food and obtaining nutrients were reintroduced into the Framework to improve conceptual interpretation of the diagram by non-experts.

The African consumption environment is changing. Projections show that African food markets are expected to grow six fold by 2025, with most of the expansion driven by urban demand for processed staples (Malabo Montpellier Panel, 2018). The implications of economic growth, urbanization, and rising incomes are complex as they relate to food consumption. One aspect that is well documented is the increasing consumption of animal proteins, a decline of starchy staples, and greater dietary diversity (Bennett, 1941). Urban consumers are more likely to prefer convenience foods that require less preparation time and increase their consumption of caloric sweeteners. Finally, 70% of African urban households purchase from vendors in the informal economy, and a significant share of this expenditure is on prepared food. Some of this food is minimally processed, but increasingly includes unhealthy processed foods with high trans- and saturated fat, sugar, and salt content (Frayne et al., 2010; Battersby and McLachlan, 2013).

3.2.4.4 Food loss and waste

From initial production to household consumption, food is lost or wasted throughout the supply chain. Food loss is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers. Food waste refers to the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food service providers and consumers [FAO (Food Agriculture Organization), 2019]. The decrease (from food loss or waste) may be accidental or intentional, leading to less food available.

The TRANSMANGO framework (Brunori et al., 2015) identifies the food losses and waste actors generate through-out the food chain. However, they further their definition of loss and waste in the food system by adding other losses and waste (e.g., of inputs to production, packaging) and other activities such as recycling waste and disposing of waste to the environment. Framework v1 incorporated the concepts of food loss and waste and the final Framework is explicit about food loss and waste as per the initial conceptualization but does not adopt the broader definition.

Food loss and waste in Africa is a critical issue. Approximately one-third of all food produced on the continent is lost or wasted, primarily due to inadequate infrastructure, poor storage facilities, and inefficient supply chains [FAO (Food and Agriculture Organization), 2014]. Rural farmers often struggle with access to markets and modern technology, leading to significant post-harvest losses [FAO (Food Agriculture Organization), 2019]. Additionally, urban areas contribute to food waste through consumer behaviour and inadequate waste management systems. Addressing food loss and waste in Africa is essential for improving food availability and enhancing livelihoods and mitigating the environmental impacts associated with food production (Totobesola et al., 2022).

3.3 Food systems outcomes

The food system produces outcomes (results or consequences) that influence food system components and drivers with or without some time delay.

A review of the literature identified that although the classification of food systems outcomes varies from author to author, the outcome categories can generally be assigned to four broad groups: food and nutrition security (or health pillar) and the three pillars of sustainability, namely environmental, social and economic (Stefanovic et al., 2020).

The TRANSMANGO Framework (Brunori et al., 2015) included three outcomes—food and nutrition security, environmental sustainability and socio-economic welfare (including income, employment, wealth). Framework v1 made use of a recent Organisation for Economic Cooperation and Development [OECD (Organization for Economic Cooperation and Development), 2021] publication that provides useful insight into the outcomes of food systems. The report stressed that the food system impacts three conditions that are essential for human existence—food and nutrition security, livelihoods, and environmental sustainability. These are presented as a triple challenge since pursuing these goals can result in multipliers, trade-offs and externalities.

Framework v1 also argued that addressing territorial balance should be an additional outcome (David-Benz et al., 2022). Territorial balance refers to achieving greater equity in the resilience, diversity, and transformation of the other food system outcomes between regions. To achieve this governance may need to be polycentric where there are multiple interacting governing bodies who can make and enforce rules within a specific policy arena and geography (Schoon and Cox, 2018).

Five outcomes were included in the Framework which are deeply interconnected, influencing and shaping one another in various ways.

3.3.1 Food and nutrition security

Food and nutrition security has been the most studied food systems outcome until recently. Food security is defined as a situation "*when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary and food preferences for an active and healthy life*" (FAO (Food and Agriculture Organization), 1996). The definition addresses four pillars of food security—physical availability of food, access to food (physical and economic), food utilization and stability of the food supply (FAO (Food and Agriculture Organization), 2008). However, since stability is interlinked with availability and access, sometimes the stability pillar is left out (Charlton, 2016). Recently added internationally accepted dimensions include agency and sustainability (Clapp et al., 2022). Going beyond this, nutritional security considers the consistent and equitable access to healthy, safe, affordable foods that are essential to optimal health and wellbeing (Ingram, 2020).

In Africa, food security remains a critical concern, with (as noted earlier), one in five Africans experiencing hunger in 2023, and hunger remaining on the rise on the continent [FAO (Food and Agriculture Organization), IFAD (International Fund for Agricultural Development), UNICEF, WFP (World Food Programme), and WHO (World Health Organization), 2024]. At the same time, the nutritional needs of the population in Africa are not being met equitably, leading to significant health challenges. There are indications of a triple burden of malnutrition (over-nutrition, under-nutrition, and micronutrient deficiencies) in an increasing number of countries, and especially in the North African region (Abrahams et al., 2011). In Africa, 28% of the adult population were overweight in 2016 and 11% were obese [WHO (World Health Organization), 2021].

The African Prosperity Report links the rise of an African middle class to expanded opportunities in the fast-food industry (Legatum Institute, 2016). A consequence of this expansion is the heightened risk of diet-related non-communicable disease (NCDs). Globally, diabetes accounts for the second largest share of the global burden of diet- and nutrition-related NCDs after ischaemic heart disease. This is set to increase [Wild et al., 2004; IDF (International Diabetes Federation), 2015]. This increase in diabetes is occurring in Africa. In 2000, an estimated 14 million African adults aged 20–79 had diabetes, representing a regional prevalence of 2.1–6.7%. This is projected to reach 18.6% in 2030, an increase of 162% and the second greatest increase after the Middle East (Wild et al., 2004). Similar trends have been found with respect to other NCDs, with, for example, the prevalence of cardiovascular disease increasing in Africa (Opie and Mayosi, 2005).

Food safety is also an issue and linked to health. Africa has the highest per capita prevalence of foodborne illnesses in the world, leading to over 137,000 deaths and 91 million acute illnesses in 2015 [GFSP (Global Food Safety Partnership), 2019]. Aflatoxins are a further food safety threat to Africa's food system (Chauhan, 2017). Of concern is that children are at particular risk of foodborne diarrhoeal diseases. This is a risk factor for the achievement of balanced diets, especially affecting children and women during pregnancy (Chambers and von Medeazza, 2014). Addressing these nutrition and health concerns through the food system is a clear clarion call on the continent.

3.3.2 Livelihoods

Livelihoods was an outcome included in all three versions of The Framework, and it is broadly aligned to the socio-economic outcome in the TRANSMANGO framework.

Food system livelihoods are essential for most African economies providing income and employment. Through agriculture, food processing, distribution, and retail, food systems offer both formal and informal economic opportunities that support household resilience, poverty reduction, and broader social wellbeing. Improving African food systems through better infrastructure, technology, and sustainability practices can enhance livelihoods but can also present risks, especially for vulnerable groups.

More than 60% of the population in sub-Saharan Africa is engaged in agriculture, either directly (as smallholder farmers) or indirectly (in associated industries such as food processing, input supply, and transportation). Urbanization and the demand for processed foods are also creating new jobs in food manufacturing, packaging, and retailing [FAO (Food Agriculture Organization), 2017]. In many African food systems, informal markets and street vending are key sources of income for low-income households, particularly for women. Small-scale traders, vendors, and food processors play a critical role in ensuring food availability and affordability, especially in urban areas [IFAD (International Fund for Agricultural Development), 2016].

As the debate shifts from agriculture increasing crop yields as a pathway out of poverty for small-holder farmers in Africa towards the opportunities in value addition and services across the entire value chain (Gassner et al., 2019), a focus on food systems analysis and interventions becomes increasingly important to realise the potential of the system for improving livelihoods.

3.3.3 Environmental sustainability

Environmental sustainability was an outcome included in all three versions of the Framework. While the environment as a driver of food systems highlights the role that natural resources and climate play in shaping agriculture and food availability, environmental sustainability as an outcome looks at how food systems can be managed to ensure long-term ecological health, addressing the environmental impacts of food production and consumption to create a more balanced and resilient system. As an outcome, environmental sustainability speaks to the proactive,

deliberate strategies to manage and reduce the environmental impacts of food production, processing, and distribution.

Approaches such as climate-smart agriculture, regenerative agriculture, agroecology and a shift towards increasing utilisation of African indigenous and traditional crops are increasingly recognised as relevant solutions for ensuring sustainable and resilient food production and food security [HLPE (High Level Panel of Experts), 2019].

3.3.4 Territorial balance

Territorial balance was an outcome included in all versions of the Framework, although the first version used the terminology territorial balance and equity.

African food systems are characterized by distinct territorial imbalances that are apparent between regions, countries and within countries. Many of these form part of the legacy of colonialism (Roessler et al., 2020). In some cases, colonial land acquisition led to the relocation of indigenous populations into marginal "communal areas" where the climate and soils are not conducive to agriculture. Settler farmers occupied the best agricultural lands, which they devoted to cash cropping, horticulture, dairy and cattle farming, leading to the domination of agriculture in the economy. These areas also benefitted from infrastructural investment including roads and irrigation. Despite almost 70 years since decolonization, many countries in Africa continue to have islands of prosperity co-existing with marginalized areas.

Differences in under-5 child mortality (U5MR) can serve as a proxy for this spatial inequality and in an analysis of 35 countries Li et al. (2019) show considerable variation in the trends and levels of subnational U5MR across Africa. Satellite imagery of night-time light is another proxy, and Falchetta et al. (2020) report similar patterns of inequality.

Both the literature (David-Benz et al., 2022) and the feedback from the FSNet-Africa scholars agree that territorial balance should remain as an outcome in the Framework.

3.3.5 Inclusivity

Gender, as an aspect of socio-cultural drivers, shapes the roles, access, decision-making, and market participation within food systems, directly influencing food production, distribution, and consumption patterns. As a normative institution, gender reinforces societal expectations and rules regarding the roles of men and women in food systems, maintaining traditional hierarchies. As an outcome, food systems often reproduce gender inequalities in terms of economic status, nutrition, and empowerment, reinforcing existing gender norms and disparities. In these ways, gender is both a cause and consequence of the way food systems function in Africa, with implications for inequality, health, and economic opportunities across societies.

Resources and influence in value chains and food environments are unequally distributed across the food system. In general, women and youth throughout the continent face unequal economic outcomes in Africa's food systems. These constraints significantly impede their productivity and overall contributions (Doss et al., 2018). Women involved in agriculture and food production are often paid less than men for the same work. Women often have less access to lucrative markets and commercial opportunities, as men tend to dominate higher-value market chains. This limits women's income potential and economic empowerment (Botreau and Cohen, 2020).

In many cultures, women and girls eat last and least, particularly in food-insecure households. As a result, many women in African countries experience high levels of food insecurity, anaemia and nutrient deficiencies. Since women play a key role in children's nutrition, these gendered imbalances result in high levels of malnutrition and stunting amongst children, and in worst cases leads to high child mortality rates [UNICEF (United Nations Children's Fund), 2023].

The operation of food systems can reinforce these trends but can also present opportunities to address gender and generation inequalities (Mkandawire et al., 2021). Thus, researcher feedback proposed that gender and generation (im)balance be included as a separate outcome.

The final FSNet-Africa Framework (Figure 1) adopted the notion of inclusivity to encompass gender and generational aspects, and to acknowledge the need for a food system that ensures equitable participation and benefits for all stakeholders, particularly marginalized and vulnerable groups (for example persons living with disabilities, the elderly, farm workers, and nomadic pastoralists among others).

3.4 Feedback/feed-forward loops

Feedback loops in a food system refer to the mechanisms that allow the system to respond to disturbances or changes to maintain its health and functionality. These loops can be positive or negative. Positive feedback loops amplify or exacerbate changes within the system. For example, in the context of food systems, a positive feedback loop might involve increased food prices leading to more land conversion for agriculture, which in turn exacerbates environmental degradation. Negative feedback loops counteract changes. A negative feedback loop might involve regulatory measures that respond to overfishing by setting catch limits, which helps protect fish populations and maintain ecological balance. Both positive and negative feedback loops can either reinforce positive trends or lead to undesirable outcomes (Sundkvist et al., 2005).

Feed-forward loops are proactive mechanisms that anticipate system disturbances and allow for mitigating responses before these disturbances take effect (Lundberg and Johansson, 2015). In the context of food systems, feed-forward loops include early warning systems, scenario planning, and activities in the research and innovation ecosystem. For example, early warning systems monitor environmental conditions, market trends, or resource availability to predict potential disruptions to food production or distribution. This can include monitoring weather patterns to anticipate droughts and plan for water resource management. An example is the Famine Early Warning Systems Network (FEWS NET) that has been assessed to have achieved 84% accuracy over the decade from 2009 to 2020 (Backer and Billing, 2021).

By incorporating such feed-forward loops into food systems analysis, policymakers can make informed choices to mitigate potential risks and enhance the system's adaptability. This proactive approach helps ensure the long-term sustainability and resilience of food systems in the face of evolving challenges. Feedback and feed-forward loops permit responses to system disturbance to modify the system and so maintain the system's health and function (Casti and Fath, 2008).

Understanding the interrelationships in the system creates a framework within which trade-offs can be researched, understood and responded to. An example is urbanisation. Urbanisation in Africa is creating new jobs in food manufacturing, packaging and retailing. In many African food systems, informal markets and street vending are key sources of income for low-income households, particularly for women. Small-scale traders, vendors, and food processors play a critical role in ensuring food availability and affordability, especially in urban areas. The increasing urban demand tends towards processed foods that are linked to a rise in obesity, as well as non-communicable diseases. This is a negative trade-off for positive economic outcomes. Food safety in informal markets is often compromised due to limited infrastructure, lack of regulation, and poor hygiene practices posing risks for contamination and foodborne illnesses. This example demonstrates the value of an African framework for examining complexity to inform research, development and policy making.

4 Discussion

The evidence base related to African food systems remains underdeveloped, creating a critical gap in the region's ability to address food security and sustainability challenges. The Framework was developed as a tool for African food systems analysis to help identify key research gaps, highlight leverage points for transformative change, and address persistent food system failures. The Framework is distinct from other existing food system frameworks in its incorporation of historical drivers, its emphasis on inclusivity as an explicit food system outcome, and by highlighting the role of institutions and their diversity. While not necessarily uniquely African, the Framework has proven highly relevant and adaptable for identifying commonalities and specific challenges across East, West, and Southern Africa. In particular, opportunities related to indigenous crops and consequently indigenous knowledge and the importance of preserving and amplifying this knowledge were identified. Similarly, the framework has assisted the 20 FSNet-Africa scholars in unpacking the important and on-going role of small-scale farmers within the food system, particularly in mitigating climate change. The framework has also helped to better understand how to reshape consumer demand for healthier, safer and more affordable food that is environmentally friendly, and helped unpack challenges and opportunities related to governance within the African food system.

The Framework is intended as a heuristic model that enables analysts, educators, and policymakers to assess system dynamics and identify entry points for change. It provides a tool for facilitating cross-disciplinary collaboration and consensus-building among scholars. Its adaptability has been demonstrated through its application to a wide range of research areas, from plant and livestock science to gender studies and food system economics. This flexibility underscores its applicability to real-world problem-solving in diverse contexts. For example, the Framework has been applied by Anim-Jnr et al. (2023) to examine the potential of agroecology for sustainable small ruminant production in low- and middle-income African countries. Dorvlo et al. (2023) examined the pathways and interactions for integrating mechanisation into sustainable rice production in Ghana. Lungu et al. (2024) used the Framework to understand the potential of Moringa oleifera as a sustainable broiler feed additive in South Africa, while Kwapong et al. (2024) examined farmer's experiences with climate-smart agricultural practices. The Framework has been effectively utilised as a tool for teaching, analysis, and policy advocacy. It has been used to train and inform the research work of students at the Lilongwe University of Agriculture and Natural Resources in Malawi. It has also been applied to develop a doctoral level programme that will be offered by the Africa-Europe Cluster of Research Excellence in Sustainable Food Systems (CoRE-SFS). The framework has also been applied to identify evidence gaps within the context of gender and food systems. A literature analysis conducted by Mkandawire et al. (2024) revealed that while women's financing and entrepreneurship emerged as key gender policy priority, this area remains significantly under-researched. This application demonstrates the framework's utility in highlighting critical knowledge gaps, informing future research agendas, and providing a basis for aligning research efforts with policy priorities.

Beyond academia, the Framework has proven valuable for policy analysis due to its ease of understanding. It has been presented to policymakers and used to explore the potential impacts of emerging policies on food systems. For example, an ongoing study is applying the Framework to assess the effects of a net-zero emissions policy on food security and livelihoods, demonstrating its capacity to evaluate trade-offs and synergies in policy development. Given the shift towards a food systems approach in the new 10-year agenda outlined in the Kampala CAADP Declaration, the Framework offers a timely and practical tool for guiding policy and decision-making. It can support governments in conceptualising the complexity of food systems by providing a structured lens through which to understand the various elements and interdependencies. The Framework can be used to assess the potential trade-offs and synergies associated with specific policy decisions. It can facilitate the identification of gaps and opportunities for greater coherence through a systematic analysis of existing policies and the range of stakeholders engaged across different components of the food system.

While the framework incorporates context-specific nuances relevant to African food systems, it is primarily informed by the experiences and expertise of the 20 researchers involved in the FSNet-Africa project. As such, it does not claim to capture the full spectrum of issues shaping African food systems—for instance, emerging debates around the mega farm agenda or the impacts of migration and globalisation, which continue to exert significant pressure on the continent's agrifood landscapes. These limitations do not diminish the framework's utility. Rather, it should be viewed as a dynamic and adaptable tool—one that can be refined and expanded to suit the specific contexts and objectives of its application. In conclusion, the Framework has been

tested and applied across multiple domains, making it a versatile tool for both research, teaching and policy analysis. Its utility in unpacking complex issues and contributing to sustainable food system transformations positions it as a critical asset for advancing African food systems research and policy.

Author contributions

JM: Conceptualization, Writing – original draft, Writing – review & editing. FS: Conceptualization, Funding acquisition, Writing – review & editing. CQ: Conceptualization, Funding acquisition, Writing – review & editing. MM-C: Conceptualization, Funding acquisition, Visualization, Writing – original draft, Writing – review & editing. EM: Conceptualization, Writing – review & editing. AD: Conceptualization, Funding acquisition, Writing – review & editing.

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Conflict of interest

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