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Sustainable food systems transformation: Are we attempting to eat the elephant in one piece?

Significance:

In this Commentary, we critically examine the concept of sustainable food systems transformation, with a particular focus on the complexities, potential ripple effects, and real-world practical implications of pursuing such a transition. Drawing on the metaphor of 'eating an elephant' as a representation of undertaking a monumental yet feasible task, the Commentary highlights that while transformation is a viable vision, it is often non-linear, intricate, multidimensional and inherently complex. The discussion traces the evolution of the sustainable food systems concept, interrogates the underlying implicit assumptions, identifies key drivers of change, and explores the operational challenges encountered in practice. Furthermore, it delineates strategic priorities necessary for the effective implementation of sustainable food systems transformation. By situating these issues within a broader contextual framework, we aim to inform and guide future scholarly and policy-oriented engagements on this topical and global issue.

Context

The current agri-food systems are not sustainable; they need to be transformed with major changes needed in production, distribution and consumption (dietary shifts).[1] Sustainable food systems transformation has become an issue of global priority given persistent food insecurity, malnutrition, environmental degradation and rural poverty. Africa faces diverse and complex transformation challenges in the context of climate change, food waste and loss, changes in consumer demand, and cultural change, accelerated by a growing population projected to be 2.5 billion by 2050.[2] The growing need for sustainable food systems transformation calls for clarity of the concept itself, understanding the current issues and challenges of making it operational, ensuring that there is common understanding on the nature of the transformation, what it entails and a buy-in from all stakeholders on the need for the transformation, and the steps needed to realise the transformation, particularly in an African context. If the current agri-food systems are maintained, it will become increasingly difficult or even impossible to achieve the United Nations' Sustainable Development Goals (SDGs).

Continuing population and consumption growth will mean the global demand for food will increase for at least another 40 years.[3] Many international organisations, such as the United Nations Food and Agriculture Organization (FAO) have provided such projections. The challenge ahead is finding ways and means to sustainably meet this growing food demand. Based on empirical evidence, various sustainable agricultural production practices (climate-smart agriculture, precision agriculture, agroecology, agroforestry, regenerative agriculture, organic farming, etc.) have been recommended, presenting the analogy of an elephant that is not consumable all at once. The uptake of these sustainable agricultural practices has not been as widespread as one would have expected. Even though there are a variety of contextual reasons for this in the literature, one challenge that complicates uptake across the board is the public versus private costs/benefits of adopting these practices, *meaning* that there are public benefits that farmers do not fully capture and there are costs (direct and/or opportunity costs) that only farmers incur. Market incentives do not reward sustainable production practices or sustainable consumption behaviour. Said differently, the costs of sustainability are paid by the consumer/producer while everyone enjoys the benefits. This mismatch is an inherent challenge and is responsible for the poverty of adopting sustainable agricultural practices. Because of the complexity and multidimensionality of the food system concept, a multifaceted, multistakeholder, multisectoral, transdisciplinary and global strategy is needed to ensure sustainable food systems transformation. Because of the complexities of food systems, changes at one level may have undesirable effects at other levels, or may lead to leakage effects and spillovers.[1]

Food systems are both contributors to and victims of climate change. Food systems create about 37% of total emissions through different agricultural practices, such as livestock farming, crop production and value addition. These activities also lead to deforestation, plastic use and increased carbon emissions.[4] Reducing greenhouse gas emissions in food systems will enhance the system's resilience. Similarly, strategies to reduce food waste and loss throughout the food supply chain will significantly contribute to emission reduction, strengthening the system's resilience. Understanding the 'food loss and waste – food security' nexus contributes to understanding the challenges posed by the continuous and unsustainable practices of agri-food systems and supply chains. This would call for ensuring the sustainability of different components of the food system: primary food production, processing, packaging, distribution, retailing, consumption and disposal.

While there are benefits to sustainable supply chains, a number of operational issues remain. How feasible are such practices for small farmers operating in a fragile environment? What are the costs and benefits (to consumers, producers, and other actors along the value chain)? Are consumers willing and able to pay marginally more? What does this mean for poor smallholder farmers in terms of income, food security and livelihood? How do we incentivise the required behavioural changes? This short article outlines the genesis of the sustainable food systems concept, the implicit assumptions made, the drivers of sustainable food systems transformation, the operational challenges, and the priorities identified to implement sustainable food systems transformation.

The genesis of the concept of sustainable food systems in the context of Africa

The roots of sustainable food systems can be traced back to the environmental movements of the 1970s, owing to the poverty of conventional food production and consumption practices. The publication of *The Limits to Growth* (1972) underscored the potential dangers of over-exploitation and over-dependence on natural resources, which sparked a broader conversation about how nature-dependent industries were degrading natural capital.[5] 'The Green Revolution' (1940s–1960s) also sparked debates about intensive agriculture's long-term environmental, economic and social consequences. In Africa, much of the debate was about why the Asian green revolution did not happen there.

From the 1980s to the 1990s, the dominant discourse in the developing world was on food security and agricultural productivity, with heavy emphasis on increasing yields, extension services, agricultural technology and managing land degradation. Population growth, famines, rural poverty and food insecurity mainly drove this. The concept of sustainability began to gain more currency, particularly following the Brundtland Report (1987), which highlighted the interconnectedness of environmental, economic and social dimensions of sustainable development. During this time, food security gained prominence, with the FAO articulating the different dimensions of the concept.[6] The discussion shifted to multisectoral solutions when the sustainable food systems lens first appeared in African regional initiatives like the Comprehensive African Agricultural Development Programme (CAADP) in the early 2000s. Global agendas also started to shape local food policies. The current discussion is on the resilience and sustainability (and lack thereof) of local food systems, following the COVID-19 pandemic, climate disasters, the war in Ukraine, and current policies of the Trump administration.

In essence, the phrase 'food systems' has become prominent in recognition of the complexity and multidimensionality of food and its actors/value-adding actions. This shift has occurred due to the recognition that food security is only one outcome among other outcomes in a bigger and more complex food system. A food system encompasses a range of actors and their interlinked value-adding activities (noted above) that originate from agriculture, forestry or fisheries and parts of the broader economic, societal and natural environments in which they are embedded.[7] The food system consists of complex sub-systems such as a farming system, an input supply system, an agribusiness value chain system, a transport system and a waste management system. It interacts with other systems, including the energy, information, trade, water and health systems. This means a structural change in the food system might originate from a change in another system or vice versa. For example, a policy promoting more biofuel in the energy system will significantly impact the food system, or an ICT policy in a country will affect the food system. A policy on water use efficiency will have a significant impact on the food system. Such interactions and ripple effects demonstrate the need for a holistic approach.

It has become necessary to recognise the complexity of food systems beyond food and agriculture, integrating all the above actors and actions holistically. As a result, sustainable food systems emerged as an interdisciplinary field that combines ecological, social and economic dimensions.[8] The Rio+20 summit in 2012 reaffirmed the importance of sustainable agriculture and food systems. More recently, many of the Sustainable Development Goals have explicitly incorporated the need for sustainable food systems. Having gone through these different phases, sustainable food systems have now been at the centre of global policy discussions.[9] The food system approach not only helps to engender discussion of adaptation options across the complete set of food system activities, but also provides a framework for systematic analysis of synergies and trade-offs balanced across a range of societal goals.[10] The synergies and trade-offs arise because food systems are integrated and dynamic networks with knock-on effects that link food production, processing, distribution, consumption and waste management.[11]

A sustainable food system is meant to ensure that the foundations for ensuring food security and nutrition do not occur at the expense of the welfare of future generations. The SDGs are centred on a sustainable food system. To eradicate hunger, attain food security, and enhance nutrition by 2030, the SDGs demand significant changes in agriculture and food systems. Accordingly, to achieve the SDGs, the global food system must be redesigned to be more resilient, environmentally sustainable, more productive, inclusive, and capable of providing wholesome diets to everyone, both now and for future generations.[7] This daunting task demands systems thinking and perspectives to address the local, national, regional and global challenges.

Assumptions of food systems transformation

Food systems transformation sounds neutral or positive, but it actually rests on a lot of implicit assumptions regarding the required change, particularly its feasibility and practicality. By definition, food systems transformation implies that the system needs to change. Why does it need to be transformed? Does the transformation entail the same thing for the different elements of the system? How would we account for the heterogeneity? Who are the agents of change? What is the change theory? Are all the actors actively pursuing the transformation? Are there missing links in the system? Who is responsible for any missing links in the system? Who deals with the knock-on or ripple effects and synergies? Who deals with trade-offs? Where is the clearing house? All these questions have implicit assumptions behind them. Addressing these questions will shed light on the implicit assumptions.

The need for transformation emanates from the need to integrate sustainability and ensure the resilience of the system. As noted above, current food systems are major contributors to environmental degradation. They often fail to ensure equitable access to nutritious food. Many food production practices are economically unsustainable for smallholder farmers and vulnerable groups. These are the justifications for the transformation. The ultimate goal of the transformation is to build food systems that are environmentally sustainable, economically viable, nutritionally adequate and socially inclusive.

Sustainable production, strategies to reduce food waste and loss, equitable distribution and access to healthy food, healthy consumption, inclusive governance, and policy and investment shifts are the key pathways to the transformation agenda.

Food systems transformation makes an implicit assumption about the nature of the different parts. It is assumed that the whole is the sum of homogeneous parts. That assumption simplifies the complexity of the problem and the solution. The transformation agenda calls for different adjustments as it relates to the different heterogeneous elements of the system. The agents of the change are the actors in each element of the system.

The other implicit assumption is that there are no missing links, and there are actors to take care of any existing missing links. If there are knock-on or ripple effects, synergies or trade-offs, the system has to develop mechanisms that can account for such impacts and ensure a sustainable food transformation.

The theory of change behind the idea of 'sustainable food systems transformation' refers to a structured framework that outlines how and why a transition from current food systems to more sustainable ones will lead to desired long-term outcomes like environmental sustainability, food security and social equity. Policy and regulation, innovation and technological change, behavioural change and collaboration (multistakeholder partnerships) are the levers of change. Stakeholders should be willing and able to collaborate across sectors. Political buy-in has to be there, and financial resources have to be mobilised. There has to be enough public awareness and incentive to change behaviours and norms. For the system to be transformed, given the diversity of motives and incentives for the stakeholders in the system, all actors have to be actively pursuing the transformation.

In the context of sustainable food systems, a clearing house refers to a central platform or mechanism that collects, organises and disseminates knowledge, data, tools, best practices and resources to support the transformation of food systems toward sustainability. The purposes of the clearing house in the context of sustainable food systems include knowledge sharing, coordination among the sectors/stakeholders/actors, capacity building, evidence-based policy support, and monitoring and evaluation.

Most actors/stakeholders want transformation, although some groups may prefer incremental change or the status quo as some transformative processes may exacerbate inequalities.[12] Transformative processes that worsen inequalities undermine the diversity and complexity of the system, characterised by different levels of inequalities. Many marginalised groups, such as smallholders, Indigenous people, the disabled and women, have historically been sidelined in food system reforms.[13]

Another implied assumption of food systems transformation is that this change will be driven by technological innovation[14], yet there are a number of food systems transformation drivers. This assumption underestimates the social, political and ecological dimensions that cannot be addressed by technology alone. These assumptions behind food systems transformation are crucial to avoid unrealistic solutions, recognise trade-offs, and ensure inclusivity, preventing shallow reforms that disregard root causes and better aligning strategies with local realities.

The impacts/outcomes expected from sustainable food systems transformation include reduced environmental impacts of food systems, improved food and nutrition security, greater resilience to climate change, and enhanced livelihoods and equity, especially for women and smallholders. Sustainable food systems transformation requires an understanding of the drivers of food systems transformation, to which we now turn.

Drivers of food systems transformation in an African context

Food systems now require transformation in the face of climate change, evolving cultures and technological advancements to meet the transforming demands arising from a growing population. Given the preceding implicit assumptions and the challenges thereof, how can food systems transformation be achieved? The key is to consider the transformation process as a journey and the outcome as a continuum. Given the interconnectedness of dimensions linked to food systems, one important change that needs to occur is the functionality of different systems with one another. This entails the purge of fragmentation, a common challenge in policy formulation and implementation. Both inaction and fragmentation are critical challenges.

The transformative changes being called for in a global food system in crisis cannot – and ultimately will not – be achieved without intense scrutiny of the challenges and changes in the underlying political economies that drive today's food systems.[15] The key drivers of food systems transformation can be summarised as follows.

Climate change and environmental degradation

Africa is among the most vulnerable continents to climate change, despite contributing the least to its causes. Rising temperatures, erratic rainfall and extreme weather events are already undermining crop yields, livestock productivity and ecosystem services.[16] Land degradation, biodiversity loss and water pollution further constrain food system resilience. These environmental pressures necessitate adaptive and transformative responses, including shifts toward agroecological practices, climate-smart agriculture and nature-based solutions.[17] Climate risk is thus both a disruptor and a driver for sustainability-oriented transformation.

Demographic change and urbanisation

Africa's rapidly growing and urbanising population, projected to reach 2.5 billion by 2050, has significant implications for food systems. Urbanisation is reshaping food demand, driving shifts toward more processed, convenient and diverse diets.[18] This creates new opportunities for agri-food value chains, but also increases pressure on rural producers, infrastructure and natural resources. Urban growth also alters labour markets and land use, weakening traditional food systems while strengthening connections to globalised supply chains. The 'youth bulge' offers potential for innovation and entrepreneurship, but youth engagement remains constrained by structural barriers such as land access and financial exclusion.[19] Youth mindset, attitude towards farming, and entrepreneurial challenges are also hurdles in agricultural succession planning.

Technological innovation and digitalisation

Digital technologies are transforming agricultural extension, market access, financial services and data management. ICTs have the capacity to change consumer preferences. Social media can drive the globalisation process, resulting in more homogeneity; and the digital divide among the different elements of the food system will affect the transformation process. Mobile platforms and precision agriculture tools offer new avenues for increasing productivity and improving decision-making.[20] However, access and benefits remain uneven due to digital divides related to gender, geography and education. Innovation ecosystems, consisting of research institutions, start-ups and government programmes, can drive locally relevant solutions, particularly when co-produced with communities.[21] The integration of Indigenous knowledge and low-cost innovations also plays a crucial role in context-appropriate transformation.

Social movements and changing food narratives

Consumer preferences, civil society activism and farmer movements are increasingly shaping African food systems. Calls for food sovereignty, agroecology and nutrition-sensitive agriculture reflect broader struggles over land rights, equity and ecological sustainability.[22] Social narratives that portray food as a public good, as opposed to a commodity, are helping to reimagine food systems around values of social justice, human rights and well-being. These narratives challenge dominant paradigms and promote locally embedded alternatives.

Policy and governance reform

Institutional and governance arrangements shape the direction and inclusivity of food systems transformation. Decentralisation, participatory policy processes and multistakeholder platforms have emerged as key mechanisms for enabling systemic change.[23] However, as noted above, many African countries face governance challenges, including fragmented policies, limited coordination and weak implementation capacity. International frameworks such as the United Nations Food Systems Summit and Agenda 2063 provide normative direction, but require strong local adaptation and ownership to be effective.[13]

Economic liberalisation and market integration

Trade liberalisation, structural adjustment and regional integration (e.g. the African Continental Free Trade Area) have altered the structure of African food systems. These shifts have expanded access to markets and inputs, but also increased vulnerability to global price volatility and corporate concentration.[24] While commercialisation offers income opportunities, it often benefits larger and more connected actors, exacerbating inequality and marginalising smallholders. Effective transformation requires inclusive value chain development and policies that balance efficiency with equity.[25]

Food systems transformation in Africa is being driven by intersecting demographic, environmental, technological, economic and socio-political forces. While these drivers present significant challenges, they also offer entry points for more just, resilient and sustainable food futures. The success of such transformation depends on inclusive governance, systems thinking, and the capacity to navigate trade-offs and synergies in a rapidly changing world. The next section synthesises the challenges of operationalising the transformation of food systems, taking into account the implicit assumptions and the drivers.

Challenges in operationalising sustainable food systems transformation

Operationalising the concept of sustainable food systems entails translating a broad and complex idea into practical, disaggregated and actionable strategies. The key challenges are given below.

Complexity and interconnectedness

Balancing the trade-offs or ripple effects between environmental sustainability (e.g. reducing greenhouse gas emissions), economic profitability and social equity (e.g. food accessibility and affordability) remains a key challenge. Our capacity to nurture resilient food systems within global environmental change, and understand their drivers and

the determinants of livelihood outcomes and trade-offs is severely constrained. Eriksen[11] developed a framework that could be employed to build a database of typologies of food system interactions, functional for different management or analytical purposes. Fassio and Chirilli[26] suggest a framework for analysing food and agriculture systems that can provide a holistic assessment of the impacts, actions and outcomes achieved by these systems.

Accounting for contextual variability

The other challenge is adapting sustainable food systems to diverse local contexts, in which socio-economic, political and environmental conditions differ. This is especially the case for the African smallholder sector, which is characterised by the heterogeneity of the products and diversity of the socio-economic and agroecological systems.

Institutional/policy barriers and market failures

Existing policies and entrenched institutional structures often favour conventional food systems and create incentives for unsustainable practices (e.g. input subsidies). Policy frameworks are fragmented and lack cross-sectoral coordination.[3] There is no mechanism in place to account for the discrepancy between private and public costs/benefits of adopting sustainable production, processing, packaging, distribution, consumption, waste disposal and recycling.

Consumer behaviour and demand

Poor consumer demand for food is hardly shaped by sustainability considerations. Changing consumers' behaviour and increasing their demand for sustainable, healthy foods is a challenge if consumers have to pay the extra cost when food becomes expensive because it has accounted for environmental sustainability, or it has internalised the environmental costs of food production.

Climate change and environmental stress

While sustainable food systems are often proposed as solutions to mitigate climate change, the need for adaptation to these changes further complicates their implementation.[9] A dual imperative of mitigation and adaptation is created through sustainable food systems practices, resulting in tensions both in policy and practice. Practices aimed at reducing emissions, such as reduced livestock production, may not align with adaptive strategies required for food security in climate-stressed communities that are dependent on mixed farming practices.

Data and monitoring challenges

Robust data collection systems are often absent in low-income and rural areas, making it challenging to assess progress or make evidence-based decisions. Monitoring and evaluating the sustainability of food systems is a difficult task. Developing countries face capacity constraints when developing comprehensive metrics and data systems. Given the multifaceted and multidimensional nature of sustainable food system indicators, the lack of standardised definitions and measurement methods poses challenges for cross-study comparisons, monitoring and promoting food systems, and policy implementation.[27]

Future research directions in sustainable food systems

The future of sustainable food systems will require innovative research to address the issues enumerated above and emerging challenges, and to test new solutions. Future research in sustainable food systems must move from narrow technical fixes toward systemic, political and justice-centred approaches that recognise diversity, vulnerability and complexity.

Agroecology

There is a tremendous knowledge gap on what it takes to optimise agroecological practices and their scalability, and to evaluate their impact on productivity, climate resilience and ecosystem services.

Sustainable food consumption and dietary shifts

The 'how' of changing consumer behaviour and promoting healthy and sustainable diets will remain a key area of focus for future research. In this regard, there is a need to explore strategies for promoting healthy and culturally acceptable, sustainable diets that reduce environmental footprints. There is a need to understand the impact of sustainable food systems on public health in terms of providing nutritious, culturally appropriate and affordable food. The challenge, however, is that sustainable food consumption could be a luxury for many poor consumers.[28]

Digital agriculture and precision technologies

Another area of research is the application of digital technologies, including precision agriculture, big data analytics and remote sensing, to optimise resource use, improve productivity and account for the environmental impact of agriculture. Big data is expected to greatly impact smart farming, creating unprecedented decision-making capabilities along the whole supply chain and changing role players.[29]

Circular food systems

The potential of circular food systems that minimise waste, reduce reliance on virgin resources (reused, recycled or repurposed), and support sustainable food production and consumption practices has not yet been fully explored. Future research should explore the 'food loss and waste–food security' nexus through evidence-based and scenario analyses, informing stakeholders about nexus interactions and highlighting synergies between different resource uses in a circular and green economy perspective.[30]

Concluding remarks

The design and evaluation of policies that support sustainable food production and consumption is complex in theory and practice. This means that the elephant is not consumable in one goal, nor can sustainable food systems be considered unidimensional. That is why food systems transformation must be viewed as a journey, not a destination. From this perspective, sustainability is not a fixed or static state but an ongoing process of learning, negotiation, and consensus-building, thereby encouraging systems thinking.[31] This entails regular identification of food systems vulnerability spots, adaptation and intervention areas in different food system activities, to improve food security, livelihood and environmental outcomes. Viewing sustainability as a fixed destination implies that there is an ideal end-state – a point at which food systems are fully aligned with environmental integrity, social equity and economic viability. Framing the vision as a journey is useful in setting targets, benchmarks and indicators (e.g. SDG 2: Zero Hunger), which are essential for accountability and international cooperation. Framing it as a destination may obscure the dynamic and contested nature of food systems, oversimplifying the complexity of local realities, trade-offs and power asymmetries.[10,11] Imagining sustainability and sustainable food systems as a journey and the outcome as a continuum enables us to realise that food systems are constantly evolving, shaped by changing ecological conditions, social demands and political contexts.

Declarations

We have no competing interests to declare. We have no AI or LLM use to declare. Both authors read and approved the final manuscript.

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