ReSAKSS
Regional Strategic Analysis and Knowledge Support System
by AKADEMIYA2063

Annual Trends and Outlook Report 2023

AFRICAN FOOD SYSTEMS TRANSFORMATION AND THE POST-MALABO AGENDA

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Established in 2006 under the Comprehensive Africa Agriculture Development Programme (CAADP), the Regional Strategic Analysis and Knowledge Support System (ReSAKSS) supports efforts to promote evidence- and outcome-based policy planning and implementation. In particular, ReSAKSS provides data and related analytical and knowledge products to facilitate CAADP benchmarking, review, and mutual learning processes. AKADEMIYA2063 leads the work of ReSAKSS in partnership with the African Union Commission, the African Union Development Agency-NEPAD (AUDA-NEPAD), and leading regional economic communities (RECs). AKADEMIYA2063's mission is to provide data, policy analysis, and capacity strengthening support to enable African Union (AU) Member States to achieve economic transformation and shared prosperity in support of AU's Agenda 2063.

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Abbreviations

AATS	Africa Agriculture Transformation Scorecard
AfCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AIH	Africa Information Highway
AIP	Affordable Input Program
AME	adult male equivalent
ASF	animal-source foods
ATOR	Annual Trends and Outlook Report
ATVET4W	agricultural technical vocational education and training for women
AU	African Union
AUC	African Union Commission
AUDA-NEPAD	African Union Development Agency-New Partnership for Africa's Development
BMGF	Bill and Melinda Gates Foundation
BR	Biennial Review
CAADP	Comprehensive Africa Agriculture Development Programme
CEN-SAD	Community of Sahel-Saharan States
CGE	computable general equilibrium
COMESA	Common Market for Eastern and Southern Africa
CSO	civil society organization
DHS	demographic and health surveys
EAC	East African Community
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
f-RESUS	forensic framework for resilience and sustainability
FAO	Food and Agriculture Organization of the United Nations
FAOSTAT	FAO Statistical Database

FBD	foodborne disease
FDI	foreign direct investment
FEWS-NET	Famine Early Warning Systems Network
FS-ROAS	Food System Rapid Overview Assessment using Scenarios
FSSA	Food Safety Strategy for Africa
FTF	Feed the Future
GAAP2	Gender, Agriculture, and Assets Project, Phase 2
GDP	gross domestic product
GHG	greenhouse gas
GPS	Global Positioning System
ICT	information and communication technology
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGAD	Intergovernmental Authority on Development
ILO	International Labour Organization
JP RWEE	UN Joint Programme on Rural Women's Economic Empowerment
JSR	Joint Sector Review
LSMS	Living Standards Measurement Study
LST	land surface temperature
MI	market inclusion
ML	machine learning
NAIP	national agriculture investment plan
NAP	National Adaptation Plan
NCD	noncommunicable disease
NDC	Nationally Determined Contribution
NDVI	Normalized Difference Vegetation Index
NGO	nongovernmental organization

Abbreviations *Continued*

NHA	nutrient household adequacy
NMA	nutrient market adequacy
NPCA	NEPAD Planning and Coordinating Agency
NSO	National Statistics Office
NPA	nutrient production adequacy
PPP	purchasing power parity
R&D	research and development
REC	regional economic community
ReSAKSS	Regional Strategic Analysis and Knowledge Support System
RF	results framework
SADC	Southern African Development Community
SDGs	Sustainable Development Goals
SEM	structural equation modeling
SME	small and mid-size enterprise
SPARS	Strategic Plan for Agricultural and Rural Statistics
SPS	sanitary and phytosanitary
SSA	Africa south of the Sahara
STI	science, technology, and innovation
TFP	total factor productivity
UMA	Union du Maghreb Arabe
UN	United Nations
UNFSS	United Nations Food Systems Summit
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WASH	water, sanitation, and hygiene
WDI	World Bank World Development Indicators
WEAI	Women's Empowerment in Agriculture Index
WFP	World Food Programme
WHO	World Health Organization

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Foreword

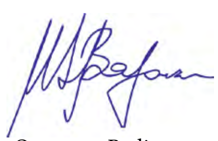
Twenty years ago in 2003, African leaders launched the Comprehensive Africa Agriculture Development Programme (CAADP) as a shared continentwide framework for agricultural development. With its emphasis on evidence-based planning, inclusive policy processes, and mutual accountability in support of agriculture-led growth, CAADP has helped to galvanize broad recognition of the importance of agriculture for Africa's development goals and the need for multistakeholder partnerships to advance progress. With the 2014 Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods, African leaders reaffirmed their commitment to the CAADP principles and values and expanded the CAADP agenda to encompass goals in the areas of poverty, hunger, trade, and resilience, among others. The Malabo Declaration also called for a continentwide Biennial Review of progress toward the commitments of the Declaration.

With the approach of 2025, the endline for the Malabo Declaration commitments, African leaders are about to embark on the process of designing the post-Malabo Declaration agenda for CAADP implementation. Africa is in a remarkably different position today from that of 2003 and even from that of 2014. Since the early 2000s, Africa has made tremendous progress compared to the decade before CAADP in terms of economic and agricultural growth: Africa has had the world's fastest agricultural growth rate since 2000, and GDP has more than doubled. In addition, the prevalence of poverty has dropped by around one-third, and child malnutrition has declined steadily. However, progress has slowed since the mid-2010s, with decelerating economic growth and a worrying rise in the prevalence of undernourishment. The COVID-19 crisis in 2020 and the impacts of the Russia-Ukraine war in 2022 demonstrated the vulnerability of the continent to international health and commodity market shocks. The most recent Biennial Review report, released in early 2022, showed that the continent is not on track to achieving the Malabo Declaration commitments. It has become increasingly clear that Africa must urgently reinvigorate progress to avoid losing the ground gained since 2003.

Another change that has occurred since the establishment of CAADP is the rapidly growing understanding of the importance of applying a food systems lens to development questions—that is, using a holistic perspective that considers the range of interlinked actors and activities constituting the food system. Africa engaged extensively with the United Nations Food Systems Summit of 2021, and the majority of African countries developed national pathways to food systems transformation which are currently being implemented. With the Malabo Declaration, African leaders already envisioned a food systems approach, looking beyond agricultural production to emphasize actions and goals along the agrifood value chain. The post-Malabo agenda for CAADP implementation must further deepen the focus to respond to emerging issues and meet the needs of sustainable food systems transformation in a context of accelerating climate change and multifaceted stressors and shocks.

The 2023 Annual Trends and Outlook Report (ATOR) aims to provide knowledge and evidence in support of the design of a robust and comprehensive post-Malabo agenda. The report looks back on implementation of the Malabo Declaration and assesses the current status on CAADP indicators; examines key food systems components and cross-cutting issues; presents methodologies for comprehensive assessments of food systems; and provides recommendations for the design of the post-Malabo agenda. The report emphasizes the importance of research and innovation as well as data and analysis to inform food systems transformation strategies.

Despite the impressive progress since 2003, Africa in 2023 faces both persistent and new challenges. The next phase of CAADP implementation must build on the successes of the past and help Africa to recapture its growth momentum to accelerate progress toward its goals. It is our hope that the 2023 ATOR will contribute to the development of a robust agenda that will provide a framework for sustainable food systems transformation for years to come.



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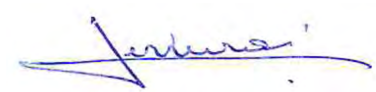

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Executive Summary

The Comprehensive Africa Agriculture Development Programme (CAADP) was launched in 2003 as a shared continentwide framework for agriculture-led growth and development. The CAADP agenda was broadened and reinvigorated in 2014 with the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods, under which African leaders recommitted to the CAADP goals and principles and extended the agenda to encompass new commitments in areas including poverty, hunger, trade, resilience, and mutual accountability, with targets to be achieved by 2025. In 2023, after two decades of CAADP implementation, Africa's leaders are beginning to envision the next phase of CAADP after the end of the Malabo Declaration commitment period.

The continental and global context today is markedly different from those in which the earlier phases of CAADP implementation were designed. Africa has made substantial progress since the launch of CAADP in terms of economic and agricultural growth and poverty and hunger reduction, but a recent deceleration of progress combined with the devastating impacts of global shocks have created an urgent need to recapture momentum and accelerate Africa's progress toward meeting its goals. In addition, awareness of the interconnected nature of food systems has increased in Africa and across the globe. Africa engaged closely with the 2021 United Nations Food Systems Summit (UNFSS), including by developing the Africa Common Position on Food Systems at the continental level and establishing country-level pathways for food systems transformation. The increasing complexity of Africa's food systems has made the need to craft development strategies through a food systems lens all the more relevant.

The post-Malabo agenda will thus need to help Africa return to a rapid growth path while accounting for current challenges and uncertainties across the food system. Just as the original CAADP agenda and the Malabo Declaration were informed by data and knowledge, the design of the post-Malabo agenda must be guided by timely, high-quality evidence on key development issues facing the continent today. The goal of the 2023 Annual Trends and Outlook Report (ATOR) is to provide a range of evidence on key issues in food systems transformation to aid policymakers in designing a robust and comprehensive post-Malabo agenda. The ATOR looks back on the successes and lessons learned from CAADP implementation to date, discusses the current status of CAADP indicators, introduces methodologies and tools for food systems assessments, provides detailed evidence on key food systems components and cross-cutting issues, and offers recommendations to guide the design of the post-Malabo agenda.

Stocktaking on the CAADP/Malabo Agenda

A review of the evolution in the CAADP Results Framework indicators since the 2003 launch of CAADP demonstrates the scale of the progress achieved on multiple fronts. Gross domestic product has nearly doubled, poverty rates have declined by around one-third, and child malnutrition has declined steadily. Government agricultural investments have increased and agricultural output has grown rapidly, driven in part by increases in land and labor productivity. Africa has also made significant and concrete efforts to adhere to the CAADP values of evidence-based policymaking and inclusive design and review processes, and the vast majority of African countries are participating in the continentwide Biennial Review of progress called for in the Malabo Declaration. However, there is also significant cause for concern about Africa's development trajectory. Robust progress in economic growth and poverty reduction have decelerated since the mid-2010s, and progress in reducing the prevalence of undernourishment reversed. Despite increases in agricultural expenditures and growth, the original CAADP targets of a 10 percent public agricultural expenditure share and a 6 percent annual agricultural growth rate have not been achieved at the continental level. The most recent Biennial Review report of 2022 showed that Africa is also off-track to achieve the additional Malabo Declaration commitments.

An empirical estimation of the relationships between CAADP Biennial Review indicators suggests that committing to and implementing CAADP principles and values positively influences development outcomes in some cases, but also highlights unexpected results or lack of impacts in other cases. The design of the post-Malabo agenda should be informed by a detailed examination of the theory of change underpinning CAADP as well as further analysis of the relationships between CAADP indicators. This will require greater investments in data covering the entire food system to guide strategy design and assess the translation of strategies to action.

Methodologies and Tools for Food Systems Assessments

Food systems are inherently complex and dynamic, constituting a wide range of actors and activities spanning agricultural production, processing, distribution, consumption, and disposal, as well as the linkages and dependencies between activities and the broader environmental and social context. Food systems policies must take into account synergies and trade-offs between outcomes in different food systems components, and should be grounded in detailed understanding of food system characteristics, structure, drivers and challenges. The 2023 ATOR offers several approaches to food systems assessments which can be used to meet different analytical needs.

First, food systems diagnostics is an approach that examines the components and interdependencies within a food system, describing dynamics and highlighting strengths, weaknesses, and challenges. It can play an important role in guiding food systems transformation strategies, benchmarking and tracking changes in food systems, and identifying drivers of transformation. The approach is based on the identification and categorization of indicators capturing food systems activities; qualitative discussions with local stakeholders on food systems characteristics, drivers, and challenges; and assessment of current food systems policy coverage and policy gaps. It is carried out as an iterative process involving an inclusive group of food systems stakeholders. The assessment provides a detailed view of the food systems landscape and can serve as a backdrop to identify the types of policies needed to advance goals and the potential constraints and synergies that policy design should consider.

While food systems diagnostic analysis offers a comprehensive overview of current food system components, drivers and gaps, some purposes may require a more forward-looking approach to assess the expected outcomes of alternative interventions. This can be carried out through a proposed forensic framework for resilience and sustainability, which allows the estimation of future evolution of food system indicators. The framework combines a focus on both resilience and sustainability, two interlinked and interdependent concepts that show important synergies. Decision-makers can use the framework to select outcome indicators of interest and assess the impacts of food system drivers on outcomes using machine learning models. The approach allows for analysis of potential scenarios and the identification of trade-offs between different outcomes.

Key Issues in Food Systems Transformation

Health, Nutrition, and Food Safety

A central goal of any food system is to ensure adequate and healthy diets for all in a sustainable manner. Meeting this goal requires concerted efforts both at the level of broad policy frameworks and of targeted interventions to address local, context-specific food security and nutrition challenges. Given the intersections of national, continental, and global policy frameworks around food systems transformation, accelerating progress toward nutrition goals and other food systems commitments requires attention to policy coherence, or ensuring that policies and actions avoid undermining the goals of other policies and take advantage of potential synergies. The ATOR assesses the alignment of the commitments for food systems transformation actions made by African countries as part of the UNFSS with the seven food systems priority policy actions proposed by the World Health Organization (WHO) to improve nutrition, as well as their alignment with selected CAADP Biennial Review performance categories. The UNFSS commitments are partially aligned with both frameworks, with a higher degree of alignment with the Biennial Review than with the WHO priority policy actions. The design of the post-Malabo agenda should consider placing greater emphasis on actions to improve the food environment to promote healthy and nutritious diets as expressed in the WHO priority policy actions.

At a more granular level, food systems transformation efforts should take nutrition into account at every stage from production through consumption. Africa faces widespread and severe micronutrient deficiencies that have serious impacts on health and well-being. By examining the adequacy of production, market supply and consumption of a range of nutrients in two case study countries, the ATOR demonstrates that nutrient adequacy gaps differ between and within countries, and by food system component—for example, the adequacy of nutrient production tends to exceed the adequacy of consumption, indicating loss of nutrients along the food value chain. Comparing adequacy levels in different food system segments can offer an indication of where nutrients are entering or leaving a food system and what types of interventions can be considered to improve nutrition. Strategies to increase the adequacy of nutrients at the production level include selecting crops based on their potential to fill key nutrient gaps as well as biofortification to enhance the nutrient content of crops. Strategies to increase nutrient adequacy at the market level include trade policies designed to facilitate imports of nutrient-rich crops, more efficient food supply chains to prevent food and nutrient loss, and industrial fortification to add nutrients to food products during processing. At the consumption level, households' intake of nutrients can be improved by increasing financial access to food through income transfers or targeted price subsidies, as well as other interventions to increase physical access to markets.

Another key facet of improving food security and nutrition is ensuring greater food safety. With a disproportionately high burden of foodborne diseases, Africa faces growing food safety risks and urgent needs to strengthen food safety systems. The rapidly increasing complexity of Africa's food value chains and greater consumption of perishable foods are leading to growing food safety challenges that outpace the development of capacity to address them. African leaders are working at multiple scales to improve food safety systems, including through the recent development of the African Union Sanitary and Phytosanitary Policy Framework and the Food Safety Strategy for Africa as well as other continental and regional frameworks and initiatives. Further efforts are required to address key gaps in Africa's food safety system, including the ability to generate high-quality evidence to inform risk-based safety assessments and capacity to implement food safety control systems. Africa's approach to food safety should evolve to incorporate a model of governance based on shared responsibilities, where partnerships and collaboration contribute to increasing food safety; greater investments in the generation, dissemination, and use of food safety data; a shift in the focus of food safety efforts from formal export trade only to domestic markets and informal food sectors; and improvements in human capacities and in sustainable funding for food safety efforts.

Climate Change Adaptation and Bioeconomy Adoption

Climate change is rapidly altering the context within which Africa's food systems operate. Long-term changes in temperature and precipitation combined with increased frequency of drought, flood, and other extreme weather events will require adjustments in agricultural production as well as activities in other food systems components. Thus, efforts to advance food systems transformation must take into account the needs of food systems actors to adapt to the changing climate. While climate change is expected to have strong negative impacts on agriculture by reducing crop yields, intersectoral linkages will lead to broader economic growth declines and increases in poverty. Large-scale implementation of adaptive responses—i.e., climate-smart agriculture practices such as soil and water conservation and adoption of improved crop varieties—have the potential to counteract the negative effects of climate change on agricultural production and prevent broader economic impacts. However, achieving the required level of adoption will require extensive investments as well as interventions to increase producers' adaptive capacity, for example by boosting human capital and building asset bases, with targeted outreach for female-headed households who may be less able to adopt adaptive practices and technologies. These efforts must be informed by a detailed understanding of local patterns of exposure and vulnerability, which differ not only between but within countries.

Climate-smart agriculture practices are part of a broader approach termed bioeconomy—a model that applies science, technology, and innovation for sustainable production and value addition based on biological resources. Greater bioeconomy adoption has the potential to facilitate climate change adaptation and drive broader improvements in environmental sustainability, food and nutrition security, and economic growth. A wide range of bioeconomy practices and innovations are already taking place in Africa, and several countries and regions have committed to further advancing bioeconomy by establishing stand-alone bioeconomy plans. However, numerous gaps remain, including uneven adoption of bioeconomy approaches throughout the continent, underinvestment in research and development, and a lack of education and training opportunities to build human capacities in bioeconomy. The development of a continentwide bioeconomy strategy could help to harmonize and build synergies among national and regional efforts to enhance the contribution of bioeconomy to overall food systems transformation. Such a strategy would require detailed assessment of the current status of bioeconomy across the continent as well as an inclusive design process that invites the contributions of all food systems stakeholders.

Gender Equality and Women's Empowerment

While the relationship between food systems transformation and women's empowerment is complex, there is evidence that women's empowerment and gender equality have positive impacts on a number of desirable food systems outcomes, including child nutrition, household food security, and agricultural production and productivity. In contrast, the impacts of food systems transformation on women's empowerment and gender equality are not straightforward. Food systems transformation is generally expected to benefit food systems actors, but in some cases there is potential to deepen existing patterns of inequality. For example, efforts to increase value addition could exacerbate intrahousehold inequalities between men and women in contexts where men have control over lucrative value chain activities. It is therefore important to better understand the linkages between empowerment, equality, and food systems transformation activities in order to avoid unintended impacts and craft effective gender-transformative food systems policies. Among other considerations, efforts to enhance women's empowerment and promote gender equality should examine potential impacts on women's workload, and should involve both men and women in shifting gender norms. Greater investments in gender-related data are important to inform policies and strategies for equitable food systems transformation.

Data, Technology, and Innovation

An important theme across the report is the vital need for knowledge and evidence to guide food systems policy design, implementation, and assessment. The generation of knowledge and evidence ultimately relies on the availability of timely, relevant, and high-quality data. Limited investments in data capacities have led to significant gaps in the availability of data to support food systems policymaking in Africa, including data quality challenges, inadequate data maintenance and dissemination, and lack of coverage of key food systems components and issues such as food processing, transportation, and distribution; food waste and loss; and diet quality. Current initiatives to increase the quality and coverage of data on Africa's food systems are having an impact, but further efforts are required to increase investments in data capacities and tools, improve coordination between data generators and users, and raise funding allocations for data collection. Additionally, there is need for an exercise, potentially led and coordinated at the continental level, to define a common set of indicators to track and measure food systems activities and drivers.

Another key cross-cutting area in food systems policy is the need for science, technology, and innovation to fuel productivity growth. Africa's rapid agricultural growth during the past twenty years has been largely driven by the expansion of farmland, but sustaining increased output into the future will require technological advances allowing farmers to produce more with the same or fewer resources. At the agricultural production level, technological advances tend to be context-specific, such as the development of new crop varieties suited to local conditions, and thus require significant investments in research and development at the national level. For other food systems components such as processing and distribution, technologies may be transferrable from abroad, and governments can facilitate technological exchange by putting in place policies to promote foreign direct investment. Governments should also encourage greater private sector research and development by reducing restrictions on market participation and protecting intellectual property rights. Finally, farmers and other food systems actors may need support to adopt productivity-enhancing technologies, including efforts to strengthen capacities, provide risk management tools, and increase access to financial services.

Concluding Remarks

Africa's food systems face a multitude of constraints, challenges, and risks. Efforts are needed to raise productivity throughout the food value chain while increasing environmental sustainability and promoting healthy, safe, and nutritious diets. In a context of increased shocks from climate change, conflict, global trade disruptions, and other sources, the sustainability and resilience of food systems must be a key goal of food systems transformation efforts. The post-Malabo agenda for CAADP implementation will need to draw upon knowledge and evidence in order to successfully guide food systems transformation policy planning and implementation. The 2023 ATOR strives to provide evidence to inform the design of the post-Malabo agenda by assessing the status of CAADP implementation, exploring strategic issues related to food systems transformation, and proposing methodologies and approaches to better understand food systems challenges and drivers. The report calls for a strong focus on enhancing innovation throughout Africa's food systems as well as sustained investments in generating the data required to inform evidence-based food systems transformation policy.

CHAPTER 1

Introduction

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Augustin Wambo Yamdjeu

Overview

This year marks 20 years of implementing the Comprehensive Africa Agriculture Development Programme (CAADP), which was launched with the Maputo Declaration in 2003. With CAADP, African leaders committed to promoting agricultural growth as a key catalyst of broader economic development. After the first decade of CAADP implementation, characterized by strong agricultural and economic growth across the continent, the CAADP agenda was broadened under the 2014 Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods. The Malabo Declaration reaffirmed the commitments of African heads of state to the original CAADP targets of achieving a 6 percent agricultural growth rate and a 10 percent agricultural expenditure share, while adding further commitments to be achieved by 2025 in areas including nutrition, poverty, resilience, and trade.

With 2025 approaching, the African Union, regional economic communities, and countries are embarking on the process of designing the next phase of CAADP implementation. The post-Malabo agenda will need to build on the significant successes of CAADP in the past 20 years while learning from mistakes and failures. Moreover, the next CAADP cycle must expand to focus on additional key areas that have emerged in the past decade. In particular, the importance of applying a food systems lens to policy has been widely acknowledged; this involves taking into account the wide range of actors and activities involved in the production, distribution, and consumption of food and the interlinkages among them. Through CAADP, as reinforced under the Malabo Declaration, African leaders already envisioned a food systems approach to trigger an agricultural-led economic transformation across the continent. Extensive reflection in the years following the Malabo Declaration has helped to clarify continental priorities for food systems transformation and brought to light additional strategic areas that should be addressed through food systems transformation efforts. The development of the post-Malabo agenda is therefore an opportunity to deepen the focus on food systems and further strengthen CAADP implementation to promote sustainable food systems transformation.

The main objective of the 2023 Annual Trends and Outlook Report (ATOR) is to generate evidence on the implementation of the CAADP/Malabo agenda and thus contribute to the design of the post-Malabo phase of CAADP implementation. The remainder of this introductory chapter briefly reviews the current state of the food systems transformation agenda in Africa before highlighting the ATOR's 12 substantive chapters.

Advancing Transformation of Africa's Food Systems

Food systems can be broadly defined as encompassing the group of actors and activities involved in the production, processing, distribution, consumption, and disposal of food, as well as the surrounding environment (von Braun et al. 2021). Food systems transformation refers to changes in food systems toward desirable outcomes; it generally encompasses movement toward food systems that are productive, resilient, and environmentally sustainable; support remunerative livelihoods; and provide healthy diets for all.

Africa's food systems face threats from several fronts that will only intensify in the future and thus need to be addressed as a matter of strategic priority. The COVID-19 pandemic, the Russia-Ukraine war, and resulting global commodity market disruptions, as well as extreme weather events linked to a deepening climate crisis, are all indicative of shocks and stressors that put significant pressures on global and African food systems (Badiane and von Braun 2022). In addition to long-term dynamics such as demographic changes, urbanization, and a continentwide nutrition transition, these shocks represent a complex web of challenges to African food systems. When left unmitigated, the likely effects of shocks and stressors on agricultural yields and productivity, infrastructure, broader economic growth, and community livelihoods risk unraveling the progress made in improving food security and nutrition and alleviating poverty.

Food systems challenges cannot be addressed in isolation, but require coordinated actions to remove constraints on multiple fronts. For example, efforts to increase farm productivity may not result in improved incomes for farmers or increased availability of food in domestic markets if transport infrastructure is inadequate to bring harvests to markets. Investments in irrigation or mechanized processing equipment may not improve productivity if energy supplies are unreliable. Increased supply of nutrient-dense foods may not improve nutrition if consumers cannot access them due to lack of financial resources or physical access to markets, or if they choose not to due to preferences or lack of knowledge. Because of the interlinked nature of such challenges, a food systems approach that considers the entire constellation of actors and activities and the interactions among them is essential to advancing development goals.

In 2021, the United Nations Food Systems Summit (UNFSS) focused attention on the importance of applying a food systems lens to development efforts. Africa participated enthusiastically in the UNFSS, holding numerous regional and thematic dialogues to garner experiences and ideas from across the continent on challenges facing its food systems and potential solutions. Going into the UNFSS, the African Union Commission (AUC) and African Union Development Agency-New Partnership for Africa's Development (AUDA-NEPAD) developed the Africa Common Position on Food Systems after extensive stakeholder consultations. The Common Position highlights key action areas involving national, regional, and continental interventions with necessary thematic and sector coherence, alignment, and interdependences (AUC and AUDA-NEPAD 2021). It also underscores the urgent need to pursue sustainability and resilience as a means of achieving food systems transformation by catalyzing rapid expansion in agricultural and food productivity and production, boosting investment financing for Africa's food systems transformation agenda, ensuring access to safe and nutritious food for all, and strengthening and harnessing Africa's growing local food markets. Africa also engaged with the UNFSS at the country level, with a majority of countries developing national pathways documents that outline priorities, actions, and commitments for food systems transformation.

The momentum created by the UNFSS has begun to drive action to achieve food systems transformation goals throughout Africa. However, a few critical hurdles are yet to be overcome, including the challenge of generating evidence to support the design of policies and interventions for food systems transformation. Operationalizing the national pathways after the summit has also proved difficult. During preparations for the UNFSS+2 Stocktaking Moment in 2023, representatives from African countries identified several obstacles to implementing national pathways, including recent overlapping health, climate, and conflict-related shocks affecting food systems; high inflation, which has lowered access to agricultural inputs as well as healthy food; lack of financial resources; and technical capacity constraints (UN Food Systems Coordination Hub 2023). Other challenges include a lack of clarity on the division of responsibility for food systems transformation within governments, as well as insufficient coordination (Morrison 2022).

Informing the Development of the Post-Malabo Agenda

Addressing the challenges to achieving Africa's food system goals requires evidence to inform policy choices and the design of implementation plans. Knowledge and analysis has been an important factor for CAADP in successfully informing the development of its agenda, as well as its implementation at the regional and country levels. In the early years of implementation, African centers of expertise, known as Pillar Institutions, provided knowledge support related to sustainable land and water management, market access, food supply and hunger, and agricultural research. The Regional Strategic Analysis and Knowledge Support System (ReSAKSS) was established in 2006 to provide data and evidence in support of CAADP implementation, as well as strengthening evidence-based policymaking systems. African universities, think tanks, and research organizations also contribute to generating and analyzing evidence to guide implementation. The post-Malabo agenda should continue to emphasize the strong role of locally relevant evidence to strengthen the development of broad strategies, as well as the design of detailed implementation plans and investments.

The goal of this report is to begin the process of consolidating evidence and knowledge to guide the design of a robust and comprehensive post-Malabo agenda for continued food systems transformation in Africa. The report chapters (1) assess the current status of food systems, explore methodological issues, and review the alignment of food system commitments with other global goals, and (2) provide detailed assessments of key food systems components and cross-cutting issues, and offer recommendations for their coverage in the post-Malabo agenda.

The report begins with a detailed examination of performance under the Malabo Declaration. In chapter 2, Ulimwengu, Tefera, and Wambo Yamdjeu analyze Africa's performance in the last three Biennial Reviews (BR) and assess the efforts still needed to meet the Malabo Declaration goals and targets by 2025. In addition to descriptive analysis, the study uses structural equation modeling to empirically assess the causal relationships hypothesized in the Malabo theory of change. Although CAADP aims to help African countries reach a higher path of economic growth through agriculture-led development, the chapter shows that the goals of CAADP have not yet been met. The authors argue that the lack of progress in achieving CAADP/Malabo targets is a complex issue that encompasses numerous factors including policy and institutional failures. They emphasize the importance of quality data to help translate the CAADP/Malabo agenda from policy to effective action and stress that success requires the involvement of private sector players, international partners, and local communities in addition to governments.

The complex nature of food systems, with their multiple interlinked activities and actors, can pose challenges for designing and implementing food systems policies because of the potential synergies and trade-offs between food system components. In chapter 3, Matchaya and Guthiga demonstrate the potential role of food system diagnostics to inform policy options for guiding food systems transformation. Food system diagnostics is an analytical approach to assess the various components and interdependencies within a food system, describing dynamics and highlighting strengths, weaknesses, and challenges. It allows stakeholders to identify food systems policy gaps, determine achievable targets, promote sustainable agricultural practices, and explore existing opportunities for food systems transformation. The authors carry out food system diagnostic analysis for Malawi, providing a detailed assessment of the current status of major food system components and identifying gaps in food system policy coverage. The chapter highlights the importance of robust stakeholder involvement in any food system diagnostic analysis as an iterative, collaborative process.

In addition to the outputs of the 2021 UNFSS, several other global and continental frameworks have been developed to achieve sustainable and healthy food systems, including the seven food systems priority policy actions proposed by the World Health Organization (WHO) to improve the ability of food systems to ensure good nutrition. The complexity of the food systems transformation agenda means that it is important to evaluate the degree to which different commitments and frameworks reinforce each other. In chapter 4, Nanema, Amevinya, and Laar assess the alignment of Africa's UNFSS commitments with the seven WHO food systems priority policy actions as well as selected CAADP BR performance categories. They find that national and continental UNFSS commitments are only partially aligned with the frameworks examined, and that alignment of UNFSS commitments with BR performance categories is higher than their alignment with the WHO policy actions. The UNFSS commitments place significant emphasis on combating hunger and food security through sustainable increases in production, as well as building resilience to shocks and stressors. In addition to these essential areas, more attention should be paid to the areas included in the WHO priority policy actions, which aim to improve the food environment to promote healthy diets.

Africa's nutrition challenges are multifaceted. In addition to persistent undernourishment and growing issues of overweight and obesity, micronutrient deficiencies, also known as "hidden hunger," are widespread. In chapter 5, Ulimwengu, Magne Domgho, and Collins make the case for nutrition-smart food systems that deliver not only sufficient quantities of food, but sufficient quality to address micronutrient deficiencies. Using the cases of Senegal and Rwanda, the authors estimate and map three types of nutrient adequacy: nutrient production adequacy, nutrient market adequacy, and nutrient household adequacy. Differences in adequacy patterns at different stages provide insight into potential areas of loss or gain of nutrients within the food system. The analysis also demonstrates the varying patterns of adequacy within countries and between different nutrients, highlighting the need for context-specific solutions to improve nutrition.

Food safety is a key component of food and nutrition security. Africa suffers from a disproportionate burden of foodborne diseases, which are associated with increasing health and economic repercussions. In chapter 6, Ayalew, Kareem, and Grace review the current food safety landscape in Africa, discussing available evidence on the burden of unsafe foods, identifying key challenges to improving food safety, and reviewing continentwide initiatives to strengthen food safety systems. They call for a paradigm shift in food safety governance in Africa, with emphasis on food safety as a shared responsibility, greater prioritization of domestic food safety needs, sustained funding to strengthen food safety systems and capacities, and investments in quality data on food safety. The authors make recommendations for the post-Malabo agenda to adequately capture and measure food safety systems and health outcomes.

The importance of resilience, or the ability to withstand and recover from stressors and shocks, was recognized in the Malabo Declaration, which included a commitment to increasing the resilience of livelihoods and production systems to climate variability and other risks. The years since the Malabo Declaration have underlined the importance of strengthening the resilience of households, communities, and food systems to a wide range of shocks. Efforts to boost resilience require an understanding of its current status and drivers, but measuring resilience poses significant methodological challenges.[1] In chapter 7, Agyemang and colleagues argue that the resilience of food systems should be assessed in combination with sustainability due to the interlinked nature of these two concepts. They develop an analytical framework to assess food system resilience and sustainability at multiple scales, and carry out a case study assessment of continental and regional food systems. The authors also propose a digital decision-support system to allow decision-makers to carry out such assessments and simulate the impacts of different interventions to advance food systems transformation.

Climate change poses major risks to food systems transformation, and climate shocks and related extreme weather are major contributors to food insecurity in Africa. Chapter 8, by Wouterse and colleagues, examines the climate-food security nexus with a focus on incorporating climate risk and adaptation solutions in food systems transformation efforts. The chapter explores the components of climate risk in selected African countries as well as the economic implications of climate change and the potential impacts of climate-adaptive agricultural production strategies. The authors propose a typology for microregion climate risk to improve the targeting of adaptation interventions. The chapter finds that climate-smart agricultural practices have the potential to lessen the negative economic impacts of climate change, but that countries' adaptive capacities need to be strengthened to ensure continued uptake of relevant technologies and practices. Due to differences in risk patterns between countries, adaptation strategies must be tailored to local contexts.

Women in Africa often face disproportionate challenges in accessing resources, which reduces individual welfare as well as broader productivity and efficiency. The relationship between food systems transformation and gender equality is complex. In chapter 9, Quisumbing and colleagues explore the potential contribution of food systems transformation to increased gender equality and women's empowerment, as well as the potential for equality and empowerment to help accelerate food systems transformation. The chapter finds evidence that women's empowerment and gender parity can have positive impacts on several key food systems transformation outcomes, while the changes created by this transformation can have both positive and negative impacts on equality and women's empowerment. Gender-transformative interventions must be grounded in an understanding of context-specific factors, which requires collecting gender-related data on the costs and benefits of changes in food systems for both men and women.

Bioeconomy is an approach that applies science, technology, and innovation for sustainable production and value addition based on biological resources. Improved bioeconomy adoption can contribute to environmental sustainability, food and nutrition security, energy security, economic growth, and social welfare. In chapter 10, Aidoo and colleagues explore Africa's bioeconomy landscape and future prospects. The chapter examines the current status of bioeconomy adoption in different components of food systems, highlighting gaps and potential actions; reviews bioeconomy policies, strategies, and regional commitments; and provides recommendations for the design and implementation of an Africa-wide bioeconomy strategy. Successfully developing a robust strategy will require further diagnostic work to assess national and regional bioeconomy potential across the continent, as well the establishment of an inclusive design process that allows farmers, youth, civil

1 Chapters 10 and 11 of the 2021 ATOR, *Building Resilient African Food Systems after COVID-19* (Ulimwengu, Constas, and Ubalijoro 2021), also explored methodologies and frameworks for measuring resilience. See Constas, Wohlgemuth, and Ulimwengu (2021) and d'Errico, Jumbe, and Constas (2021).

society organizations, the private sector, and other stakeholders to have a voice in identifying opportunities for bioeconomy adoption.

Efforts to accelerate food systems transformation require timely, high-quality, and reliable data that span the entire food system to guide the design of strategies and programs and enable monitoring, review, and mutual accountability processes. In chapter 11, Matchaya, Makombe, and Mihaylova review data needs and efforts to increase data availability, highlight key data gaps, and provide recommendations for addressing challenges and harnessing opportunities to improve data for decision-making in food systems transformation. The analysis shows that despite efforts to improve data availability and accessibility, numerous challenges persist, including poor data quality related to limited investments in data systems and capacities, as well as gaps in coverage of key areas. Notable data gaps include food processing and packaging; food retailing, distribution, and transportation; food waste and loss; and diet quality and nutrient content. The chapter calls for improved coordination between and among data generators and users as well as greater investments in data systems and capacities.

Increasing agricultural production and productivity is a key goal of the CAADP and Malabo agendas, and an important driver of overall food systems transformation. In chapter 12, Fuglie discusses the role of agricultural productivity growth, key components of and constraints to growth, and opportunities for increasing productivity growth in Africa. The chapter reviews the key role of technological innovation and of agricultural research and development (R&D) systems in particular. The author makes recommendations to strengthen agricultural R&D systems, improve the level and efficiency of agricultural R&D investments, and promote the adoption of productivity-enhancing technologies by farmers. In addition to bolstering public R&D systems, the chapter suggests measures that governments can take to encourage private sector innovation to enhance the contribution of the private sector to productivity growth.

In addition to providing evidence on featured issues relevant to the CAADP agenda, the ATOR also serves as the official monitoring and evaluation report for CAADP. Chapter 13, by Collins, Tefera, and Wambo Yamdjeu, reviews progress in CAADP implementation as well as the status of countries, regions, and the continent as a whole with respect to the indicators of the CAADP Results Framework. The chapter shows that Africa has made significant progress over the past two decades of CAADP implementation, with increases in incomes and agricultural productivity and decreases in hunger and poverty. However, the relatively rapid and robust progress during the early CAADP years slowed during the second decade of CAADP implementation, and the COVID-19 pandemic and Russia-Ukraine war have further exacerbated remaining challenges. The authors emphasize the need to build on the strengths of CAADP implementation while finding innovative ways to address continuing and new challenges in the post-Malabo agenda.

The 2023 ATOR strives to assess the current state of Africa's food systems, explore strategic issues related to food systems transformation, and reflect on necessary methodologies and approaches to provide a better understanding of key challenges and necessary actions to accelerate transformation. The transformation of African food systems in the post-Malabo era requires a concerted effort that encompasses policy reforms, investment in technology and innovation, commitment to nutrition and food safety, gender equity, and climate resilience strategies. This transformative journey must be underpinned by robust, evidence-based policies, driven by the collective effort of governments, the private sector, and civil societies, and guided by the principles of inclusivity, sustainability, and resilience. The path ahead is challenging, but with strategic collaboration and persistent effort, the vision of a transformed, robust, and sustainable African food system is within reach.

CHAPTER 2

Seven Years of Implementation of the Malabo Declaration: Making Sense of the Malabo Theory of Change

John M. Ulimwengu, Wondwosen Tefera, and
Augustin Wambo Yamdjeu

Introduction

Adopted by the African Union heads of state and government in 2014, the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods provides the direction for agricultural growth and transformation on the continent. One of the seven commitments of the Malabo Declaration is the pledge by African heads of state and government to hold themselves accountable for actions and results against targets set out in the declaration. The commitment to mutual accountability is operationalized through a continentwide Biennial Review (BR) to monitor and report on progress made in achieving all the Malabo Declaration goals and targets.[1]

The African Union Commission (AUC) and the African Union Development Agency–New Partnership for Africa's Development (AUDA-NEPAD), in collaboration with the regional economic communities (RECs) and with technical assistance from several partners,[2] are leading the BR process. They are spearheading the development of several components:

1. Technical guidelines that profile indicators utilized for assessing the progress made in achieving the seven Malabo commitments.
2. A country performance reporting template, tailored to each country, which serves as a structured tool for collecting data and presenting updates on country progress.
3. A technical note on the scorecard presenting the methodology adopted to benchmark and evaluate country progress toward meeting the Malabo commitments and targets. This note distinguishes between "on-track" and "not-on-track" progress statuses for each Malabo commitment and also computes an aggregate score reflecting the nation's overall compliance with all the specified targets.
4. An e-Biennial Review (eBR) platform, which serves as an interactive repository for BR data. This comprehensive tool streamlines the collection, analysis, storage, accessibility, and reporting of data at various levels, from individual countries to regional and continental perspectives.

The first BR process, report, and Africa Agriculture Transformation Scorecard (AATS)[3] spotlighted lessons and challenges that offered room for improvement in upcoming BRs. For instance, the process faced delays in starting, exclusion of important stakeholders from review and dialogue, limited awareness of the BR process in some countries, and insufficient technical and financial resources. These challenges extended to organizing workshops for validating data before sending them to RECs. The assessment also highlighted data-related issues and capacity constraints that many African nations encounter. Specifically, the report pointed out problems such as low data quality, missing information, unclear indicators, and data not available in required formats.

The absence of data posed a significant hurdle, as countries submitted reports with gaps in observations for various BR indicators. Moreover, countries struggled with inadequate technical skills for data collection, monitoring and evaluation, and analysis, along with ineffective protocols for sharing data among different government ministries. The report also acknowledged limitations in the BR performance scorecard methodology, particularly in choosing suitable indicator weights and assigning a zero score due to missing data from reporting countries.

The purpose of this chapter is to analyze Africa's performance in the last three BRs, examine the degree to which Africa is on track, and assess the efforts still needed to meet the Malabo goals and targets by 2025. The chapter uses structural equation modeling (SEM) with BR data to empirically assess the causal relationships hypothesized in the Malabo theory of change. Specifically, the analysis examines the relationships between the countries' implementation

1 The seven Malabo Declaration commitments are (1) recommitting to the principles and values of the Comprehensive Africa Agriculture Development Programme (CAADP) process, (2) enhancing investment finance in agriculture, (3) ending hunger in Africa by 2025, (4) reducing poverty by half by 2025 through inclusive agricultural growth and transformation, (5) boosting intra-African trade in agricultural commodities and services, (6) enhancing resilience of livelihoods and production systems to climate variability and other related risks, and (7) strengthening mutual accountability for actions and results.

2 The technical partners include the Regional Strategic Analysis and Knowledge Support System (ReSAKSS), the Alliance for a Green Revolution in Africa, and the Food and Agriculture Organization of the United Nations.

3 The AATS is a tool that helps summarize countries' performance on the BR indicators and track their progress on the Malabo commitments. For each country, the AATS highlights five indicators with strong performance and five areas that the country should pay greater attention to.

of Comprehensive Africa Agriculture Development Programme (CAADP) principles and values, policy outcomes, and development outcomes measured by the BR data. In addition, the chapter aims to inform the post-Malabo agenda with forward-looking analysis and recommendations.

The chapter is organized as follows: the following section outlines and discusses the BR process and trends in BR performance over the three BR cycles. This is followed by a discussion on the conceptual framework, estimation, and analysis of findings. The last section provides conclusions and recommendations.

Context

Since the inaugural report, a series of events have been organized at the national, regional, and continental levels to assess achievements, challenges, and lessons derived from the BR process. These gatherings have also deliberated on continual enhancements, particularly concerning the process itself, relevant indicators, data quality, methodologies, and technical guidelines.

In essence, the BR process serves as a vehicle to implement the CAADP/Malabo theory of change, striving to drive agricultural transformation and enhance food security and nutrition throughout Africa. Our understanding of the CAADP/Malabo theory of change, as outlined in Benin, Ulimwengu, and Tefera (2018), revolves around four key pillars:

1. Increasing investment in agriculture: This pillar emphasizes the need for African governments to allocate a significant portion of their national budgets to agriculture and ensure targeted investments in key areas such as irrigation, infrastructure, research, and extension services.
2. Ending hunger and achieving food security: The overall goal of the program is to enhance productivity and production in agriculture to improve food availability; promote market access; and support smallholder farmers, particularly women and youth, in adopting sustainable agricultural practices.
3. Promoting agricultural research, technology, and innovation: This pillar focuses on strengthening agricultural research and development systems; promoting the use of modern technologies; and fostering innovation to improve productivity, enhance resilience to climate change, and address challenges in the agricultural sector.
4. Enhancing resilience and agricultural sustainability: The theory of change emphasizes building resilience in agricultural systems, promoting sustainable resource management, and adopting climate-smart agricultural practices to mitigate the effects of climate change and ensure long-term agricultural sustainability.

Evaluating the implementation of CAADP/Malabo requires the consideration of various aspects such as policy reforms, investment, progress toward targets, and impact on agricultural development. The AUC, AUDA-NEPAD, and other stakeholders have been actively engaged in supporting countries in their efforts to develop and implement appropriate policies. However, the level of policy implementation varies across countries. Some countries have made significant progress in reforming policies, such as aligning their national agriculture investment plans with CAADP principles. Some have faced challenges in implementation due to limited capacity and resources, while others still have not done enough to embrace CAADP. For example, CAADP has been advocating for increased public and private investment in agriculture, suggesting the target of allocating at least 10 percent of national budget expenditures to the sector. However, here again, progress in investment varies among countries, with some making significant strides while others struggle to meet the target. Limited public funding, competing priorities, and challenges in attracting private sector investment remain key barriers to achieving the investment goals.

The Malabo Declaration also sets targets for development outcomes in various areas, including agricultural productivity, access to markets, food security, and resilience. Assessing progress toward these targets requires a country-specific analysis. Overall, as with policy reformation and investment goals, progress has been mixed. Some countries have made significant progress in certain areas, such as increasing agricultural productivity or enhancing resilience, while facing challenges in other areas, such as reducing postharvest losses or achieving food security targets.

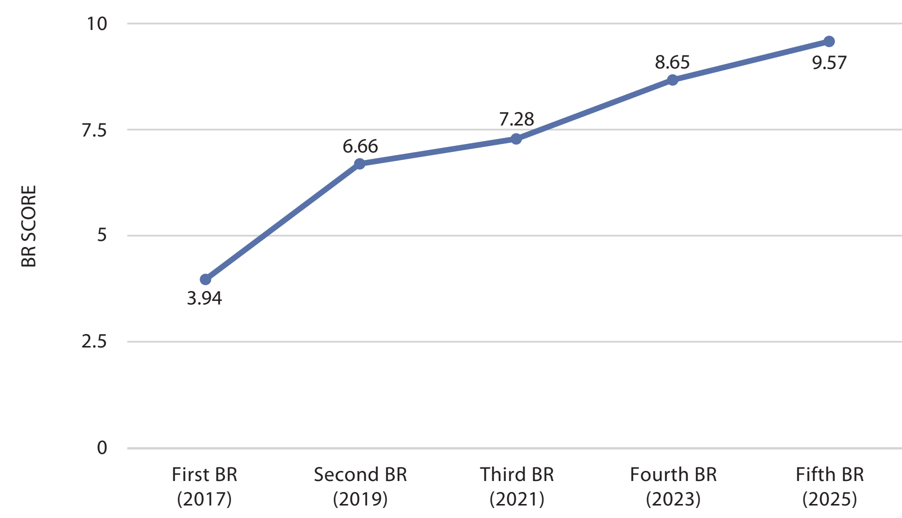
In order to assess country performance in implementing the declaration, the AUC released the first, second, and third BR reports in 2018, 2020, and 2022, respectively, along with the corresponding AATS.

During each BR reporting cycle, the AATS is compared with the BR benchmark score, the minimum score required in that particular year for a country to be considered on track to achieving the Malabo target by 2025. During the inaugural (2017) BR, the benchmark score was 3.94 out of 10. As Figure 2.1 shows, by design, the minimum score increased to 6.66 points during the second (2019) BR and further to 7.28 in the third (2021) BR cycle. The minimum score needed for a country to be on track to achieve the Malabo targets for the next successive BRs are 8.65 and 9.57 for the 2023 (fourth BR) and 2025 (fifth BR), respectively (AUC 2020). This means that Africa as a whole needs to experience continuous and progressive improvement to be on track in meeting the Malabo goals and targets.

The number of countries that drafted, validated, and submitted BR reports to their respective RECs increased from 47 in the first BR to 49 in the second BR and 51 in the third BR cycle, showing that more and more countries are being involved in the BR process. The performance observed in the three BRs, however, indicates that Africa has remained off track with regard to meeting the Malabo goals and targets by 2025. In the first (2017) BR, the AATS stood at 3.6 out of 10, below the 3.94 minimum required to be on track. In the second (2019) BR, the continent improved its score by about 12 percent, to 4.03, but remained off track since it was below the benchmark of 6.66 set for the second BR cycle. In the third (2021) BR cycle, the AATS reached 4.32, increasing by 7.2 percent over the second BR, but the continent again remained far off track, as it was below the 7.28 benchmark (Figure 2.2).

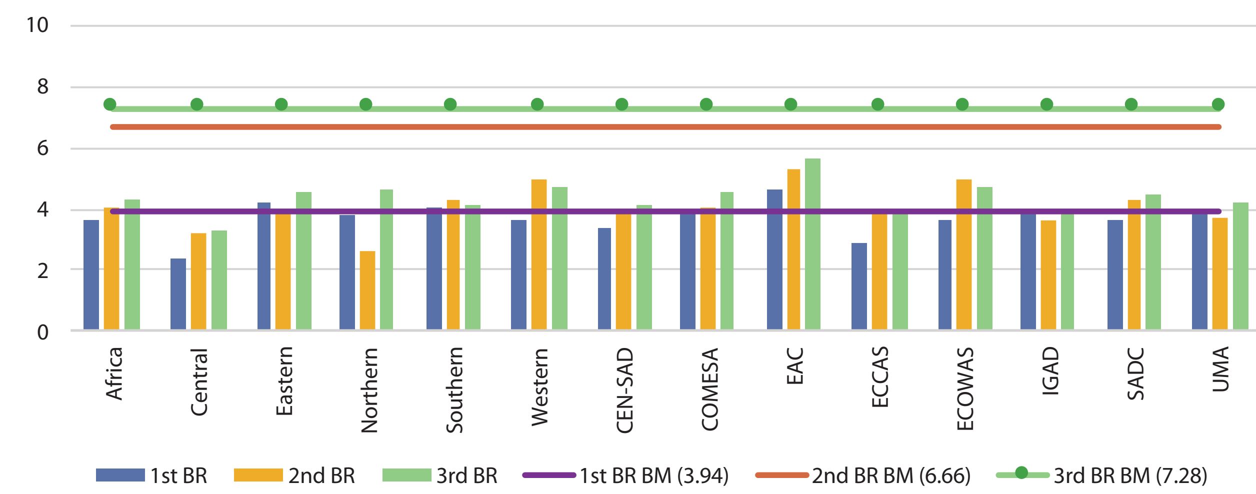
The trend shows that progress in implementing the goals and targets has continued to slow for Africa as a whole. A similar trend was observed for most of the geographic regions and RECs. A few subgroups were on track during the first BR cycle, including eastern Africa, the Common Market for Eastern and Southern Africa (COMESA), the East African Community (EAC), and the Union du Maghreb Arab (UMA). In the second and third BR cycles, however, none of the geographic regions and RECs were

FIGURE 2.1—BR BENCHMARK (MINIMUM SCORES BY BR CYCLE)



Source: Authors' calculations based on AUC (2020, 2022).
Note: BR = Biennial Review.

FIGURE 2.2—AFRICA AGRICULTURE TRANSFORMATION SCORE AND BR BENCHMARKS (BY BR CYCLE)



Source: Authors' calculations based on AUC (2018, 2020, and 2022).
Note: BM = benchmark; BR = Biennial Review; CEN-SAD = Community of Sahel-Saharan States; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SADC = Southern African Development Community; UMA = Union du Maghreb Arabe.

able to reach the benchmark scores for meeting the Malabo goals and targets. Relatively higher scores were recorded during the second and third BR cycles by a few subgroups, including western Africa, EAC, and the Economic Community of West African States (ECOWAS).

In this chapter, using data from the first three BR cycles (2017, 2019, and 2021), we provide a comprehensive assessment of the BR thematic areas and indicators and their interrelationships that builds on the agenda's own theory of change, as developed by Benin, Ulimwengu, and Tefera (2018).

Conceptual Framework and Methods

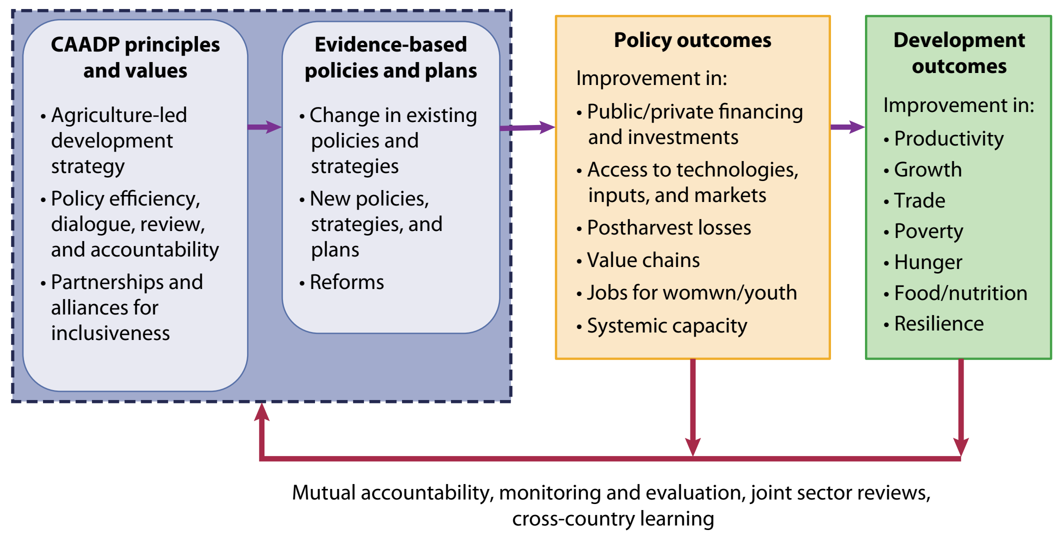
Impact Pathway of the Malabo Declaration and Empirical Framework

The CAADP/Malabo theory of change builds on the work developed by Benin, Ulimwengu, and Tefera (2018), which outlines the fundamental hypothesis for recommitting to the CAADP process. The hypothesis is that committing to mutual accountability for results and actions in CAADP brings added benefit by reforming evidence-based planning and implementation, rooted in the principles of country ownership and inclusiveness. The theory of change can be generalized by the impact pathway shown in Figure 2.3.[4] Committing to the CAADP principles and values is expected to improve the policymaking process and to safeguard the design and implementation of good policies, which in turn is expected to lead to desirable policy outcomes. These outcomes include an increase in the amount and quality of public and private investments, increased access to technologies and markets, a reduction in postharvest losses, increased employment for women and youth along key value chains, and increased systemic capacity for planning and implementation. The policy outcomes in turn are expected to contribute to better development outcomes—to raise productivity, accelerate growth, increase trade, reduce poverty and hunger, increase food and nutrition security, and enhance resilience to climate variability.

As shown in Figure 2.3, the notion of committing to mutual accountability for results and actions is better reflected in the feedback linkages associated with monitoring and evaluation, joint sector reviews, and cross-country learning, among others, to improve the policymaking process and the design and implementation of evidence-based policies and plans. This reflects the dynamism in the implementation process, and the form of mutual accountability may be described as collaborative, as opposed to representative or corporate (Steer, Wathne, and Driscoll 2008).

In this chapter, we aim to empirically assess the existence and strength of causal relationships between the different elements of the Malabo Declaration impact pathway illustrated in Figure 2.3. To do this, we use structural equation

FIGURE 2.3—MALABO DECLARATION IMPACT PATHWAY



Source: Authors' calculations based on AUC (2018, 2020, and 2022).

Note: BM = benchmark; BR = Biennial Review; CEN-SAD = Community of Sahel-Saharan States; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SADC = Southern African Development Community; UMA = Union du Maghreb Arabe.

4 This impact pathway underlies the CAADP Monitoring and Evaluation Framework (Benin, Johnson, and Omilola 2010), the CAADP Mutual Accountability Framework (Oruko et al. 2011), the CAADP Results Framework (AU-NEPAD 2015a), and the Implementation Strategy and Roadmap to Achieve the 2025 Vision on CAADP (AU-NEPAD 2015b).

modeling (SEM), a powerful multivariate analysis technique that is widely used in social sciences research. It integrates aspects of several other statistical techniques, including factor analysis, multiple regression, and simultaneous equation modeling. It is particularly suited to testing complex relationships involving multiple causes and multiple outcomes. Theoretical and empirical advantages of SEM include that it (1) allows complex relationship testing, (2) models measurement error and allows for the inclusion of confounding variables, (3) enables the analysis of latent variables, (4) enables theory development and tests the plausibility of a hypothesized model, (5) can conduct multigroup comparisons, (6) allows the estimation of models with nonlinear relationships, and (7) can be used with secondary data sources.

While SEM has many advantages, it also has certain limitations, such as complexity in interpretation and dependence on model specification. In this paper we build the SEM based on the BR's own theory of change, and results are interpreted accordingly. In the analysis section we discuss the estimation strategy to account for SEM limitations.

Data

The CAADP Malabo BR reports and the corresponding databases released by the AUC in 2018, 2020, and 2022 are the sources for the data used in this chapter. The BR database covers indicators related to the CAADP process, investment in agriculture, poverty, hunger, agricultural trade within Africa, resilience, and mutual accountability. During the inaugural BR reporting period, seven thematic areas were disaggregated into 23 performance categories, which were further divided into 43 indicators. Following the second BR, four more indicators on food safety and food security were added under thematic area 3 (ending hunger). This increased the number of performance categories to 24 and the total number of indicators to 47 (Table 2.1).

Appendix Table A2.1 presents the seven thematic areas, all 24 performance categories, and the 47 indicators and their position in the impact pathway. Some of the indicators were incorporated after the second BR. These are performance category 3.6 (food safety) and some indicators under thematic area 3: the prevalence of moderate and severe food insecurity in the population (I3.5vii), Food Safety Systems Index (I3.6i), Food Safety Health Index (I3.6ii), and Food Safety Trade Index (I3.6iii).

Reporting on the BR indicators requires a wide range of parameters across African food systems. In the first (2017) BR, a total of 166 parameters were required to report on the 43 BR indicators, and this increased by 60 percent, to 266, during the second BR. Countries were advised to report on disaggregated data following the introduction of the eBR,[5] which was the main reason behind the increase in the number of parameters (Benin et al. 2020). Furthermore, the introduction of four more indicators during the 2019 BR necessitated the addition of several new parameters. In the third (2021) BR cycle, the required number of parameters to report on the 47 indicators further increased, to 334, representing a change of 25.6 percent from the second (2019) BR. Parameters needed in thematic area 3 (ending hunger) and to some extent in thematic area 4 (halving

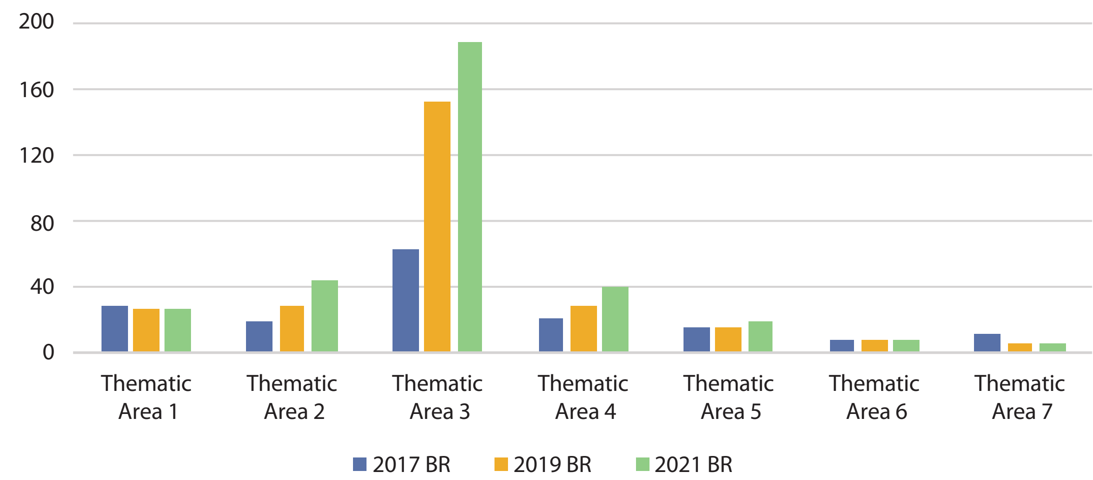
TABLE 2.1—NUMBER OF MALABO BR PERFORMANCE CATEGORIES AND INDICATORS

Thematic area		Number of: Performance categories			Number of: Indicators		
		First BR	Second BR	Third BR	First BR	Second BR	Third BR
TA1:	Recommitting to CAADP process	3	3	3	3	3	3
TA2:	Enhancing investment finance in agriculture	4	4	4	6	6	6
TA3:	Ending hunger by 2025	5	6	6	17	21	21
TA4:	Halving poverty through agriculture by 2025	4	4	4	8	8	8
TA5:	Boosting intra-African trade in agriculture commodities and services	2	2	2	3	3	3
TA6:	Enhancing resilience to climate variability	2	2	2	3	3	3
TA7:	Mutual accountability for actions and results	3	3	3	3	3	3
	Total	23	24	24	43	47	47

Source: AUC (2018, 2020, and 2022).
Note: BR = Biennial Review; CAADP = Comprehensive Africa Agriculture Development Programme; TA = thematic area.

5 The eBR is an interactive web-based data platform tool developed by ReSAKSS.

FIGURE 2.4—NUMBER OF PARAMETERS REQUIRED (BY THEMATIC AREA AND BR CYCLE)



Source: Authors' consolidation based on AUC (2018, 2020, and 2022).
Note: BR = Biennial Review.

poverty) were further disaggregated during the third BR exercise. In addition, two indicators in thematic area 2 (investment in agriculture) that were silent in the previous BR cycles were included in the analysis during the 2021 BR cycle and therefore further contributed to the increase in the number of parameters.

In general, the parameters required for thematic area 3 (ending hunger) remained the highest during the three BR cycles and showed significant increase during the last two BRs (Figure 2.4). In the third BR cycle, close to 60 percent of the total parameters required on the BR report were related to thematic area 3. The number of parameters for thematic areas 1, 2, 4, 5, 6, and 7 combined was less than that of thematic area 3 alone. However, compared to the first (2017) BR, the number of parameters in the subsequent two BRs decreased for thematic area 1 (recommitment to CAADP) and thematic area 7 (mutual accountability). This is because the parameters required for computing the indicators for the two thematic areas were simplified (Benin et al. 2020).

The number of countries that participated in the BR and submitted data represents the maximum number of observations expected for each indicator in each BR cycle. Thus, the maximum number of observations in the first, second, and third BRs was 47, 49, and 51, respectively. As Appendix Table A2.2 shows, data were missing for many of the indicators, although the magnitude of the deficiency differed by indicator as well as by BR cycle. Data loss was more notable in some indicators, including I3.3, I3.5v, I4.1iv, and I3.6iii. The number of countries with missing observations showed a declining trend from the first BR cycle to the third (Appendix Table A2.2).

Critical Analysis

Indicators on Recommitting to CAADP Process and Mutual Accountability for Actions and Results

Progress in thematic area 1—recommitting to the CAADP process: The Malabo commitment to the CAADP process (thematic area 1) is composed of three performance categories, each with one performance indicator. *Country CAADP process* is the first performance category (PC1.1), and the indicator is the *CAADP Process Completion Index* (I1.1), with a milestone of 100 percent since 2018. Countries are required to report a total of seven parameters on this indicator. These parameters measure the existence and implementation of a Malabo-compliant national agriculture investment plan.

The indicator is computed by taking a simple average of the seven parameters. The progress for the continent shows continuous improvement in indicator I1.1 during the three BR cycles, increasing from 63.2 percent to 81 percent between the first and the third BRs (Figure 2.5A). Looking at geographic regions, a pattern similar to the continent as a whole holds for the northern and southern Africa regions. For the central and western regions, the CAADP Process Completion Index recorded in the third BR was higher than the result in the first BR but lower than what was recorded in the second BR period. For eastern Africa, a decline was observed during the second BR but the figure later improved during the third BR period. Overall, eastern Africa had the highest CAADP Process Completion Index score during the first BR, while western

Africa recorded the highest score during the second and third cycles.

Establishing CAADP-based cooperation, partnership, and alliance is the second performance category (PC1.2) under thematic area 1. The indicator associated is *the existence of, and quality of, a multisectoral and multistakeholder coordination body* (I1.2). The target for this indicator has been set at 100 percent since 2018. Five parameters, which measure how broad, inclusive, participatory, and open the coordination mechanism is, are used to report on the indicator (see AUC 2021).

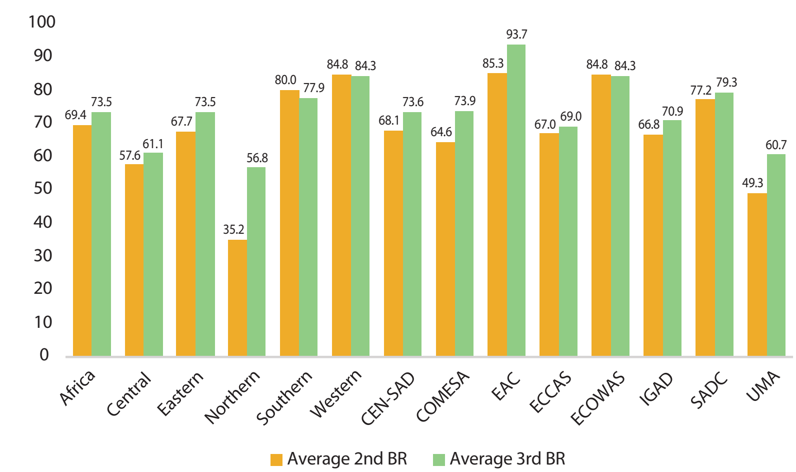
For Africa as a whole, the indicator improved significantly during the second BR, with a 72.3 percent increase compared to the performance recorded during the first BR (that is, from 47.5 percent to 82.3 percent). During the third BR, however, the result declined to 75.5 percent. This was due primarily to a decline in the scores for Mauritius and Somalia, from 8.4 and 6.4, respectively, to 0 (as the countries did not participate in the third BR), as well as a significant reduction in the score for Benin and Niger. A similar pattern is observed for the central, southern, and western Africa regions. The performance for eastern Africa remained almost unchanged in the third BR, while it marginally improved for northern Africa (Figure 2.5B).

The third performance category under thematic area 1 is *establishing CAADP-based policy and institutional review, setting, and support* (PC1.3). The indicator for this is the *existence and adequacy of evidence-based*

BOX 2.1—PROPORTION OF BR PARAMETERS REPORTED

Africa, as well as most of the subgroupings, showed a higher rate of data reporting during the 2021 BR when compared with the 2019 BR performance. For Africa as a whole, of the total required parameters, the data reported increased from 69.4 percent to 73.5 percent (Figure B2.1). That is, during the second BR cycle, 69.4 percent of the total 266 data parameters were reported. In the third BR, 73.5 percent of the 334 parameters were reported for Africa as a whole. At the regional level, the result is similar except for a few groupings. Southern Africa, western Africa, and ECOWAS are the only subgroups that showed a decline in the data reporting rate during the 2021 BR, when compared with the 2019 BR, albeit marginally. These data need to be unpacked by thematic area and country to identify the main contributors behind the reductions observed in the data reporting rate by these groups during the 2021 BR. At the same time, these groups already have a higher reporting rate, at about 80 percent or more. EAC is the only subgroup that recorded a data reporting rate of more than 90 percent during the third (2021) BR.

FIGURE B2.1—DATA REPORTING RATE (PERCENTAGE)



Source: Authors' consolidation based on AUC (2018, 2020, and 2022).
Note: BR = Biennial Review.

Northern Africa and UMA recorded notable increases in their data reporting rates, of more than 10 percentage points. The finding shows that despite improved data reporting rates, there is still a need to do more and better to further improve the data reporting performance. For Africa as a whole, for example, more than a quarter of the required data parameters are not yet being reported.

Source: Authors' calculations based on AUC (2018, 2020, and 2022).
Note: BR = Biennial Review; CEN-SAD = Community of Sahel-Saharan States; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SADC = Southern African Development Community; UMA = Union du Maghreb Arabe.

policies, supportive institutions, and corresponding human resources (I1.3), with a target of 100 percent since 2018. The three parameters associated with this indicator measure the extent to which policies are evidence-based, the institutions are adequate and supportive, and the staffing is adequate (in number and capacity) at the professional level.

Overall, Africa managed to improve its performance on this indicator during the three BRs, from 62.9 percent to 70.2 percent and further to 74.2 percent. The performance recorded by western Africa remained higher than the average for Africa overall and the other geographic regions during the second and third BRs. However, although northern Africa improved its performance during the three reporting cycles, it remained the lowest-performing when compared to the other groupings (Figure 2.5C).

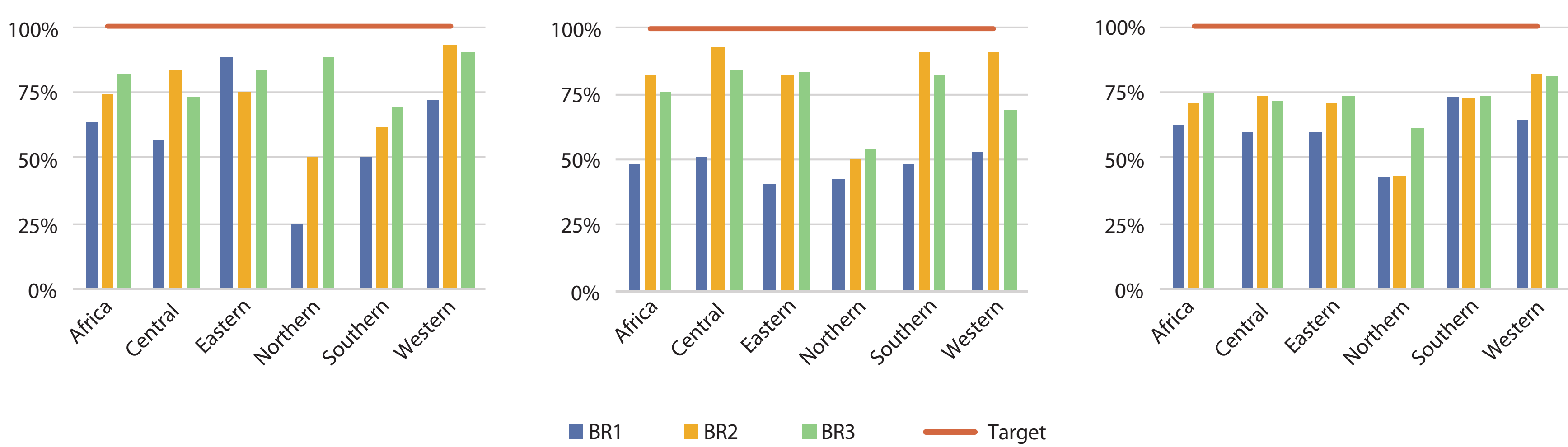
Progress in thematic area 7—mutual accountability for actions and results: Thematic area 7 is composed of three performance categories: *increasing country capacity for evidence-based planning, implementation, and monitoring and evaluation* (PC7.1), *fostering peer review and mutual accountability process* (PC7.2), and *conducting a biennial agriculture review process* (PC7.3). Each performance category under thematic area 7 has one indicator. The indicator corresponding to PC7.1 is the *index of capacity to generate and use agriculture statistical data and information (Agricultural Statistics Capacity Index)* (I7.1). This is an agricultural statistics capacity indicator aimed at providing evidence on the status of rural and agricultural statistics systems. The Malabo target for the Agricultural Statistics Capacity Index is to achieve at least 69 percent by 2025. The results show that Africa and the different geographic regions were able to improve their

FIGURE 2.5—PROGRESS IN INDICATORS UNDER THEMATIC AREA 1 (I1.1, I1.2, AND I1.3)

A: CAADP Process Completion Index (I1.1)

B: Existence of, and quality of, multisectoral and multistakeholder coordination body (I1.2).

C: Existence and adequacy of evidence-based policies, supportive institutions, and corresponding human resources (I1.3)



Source: Authors' calculations based on AUC (2018, 2020, and 2022).

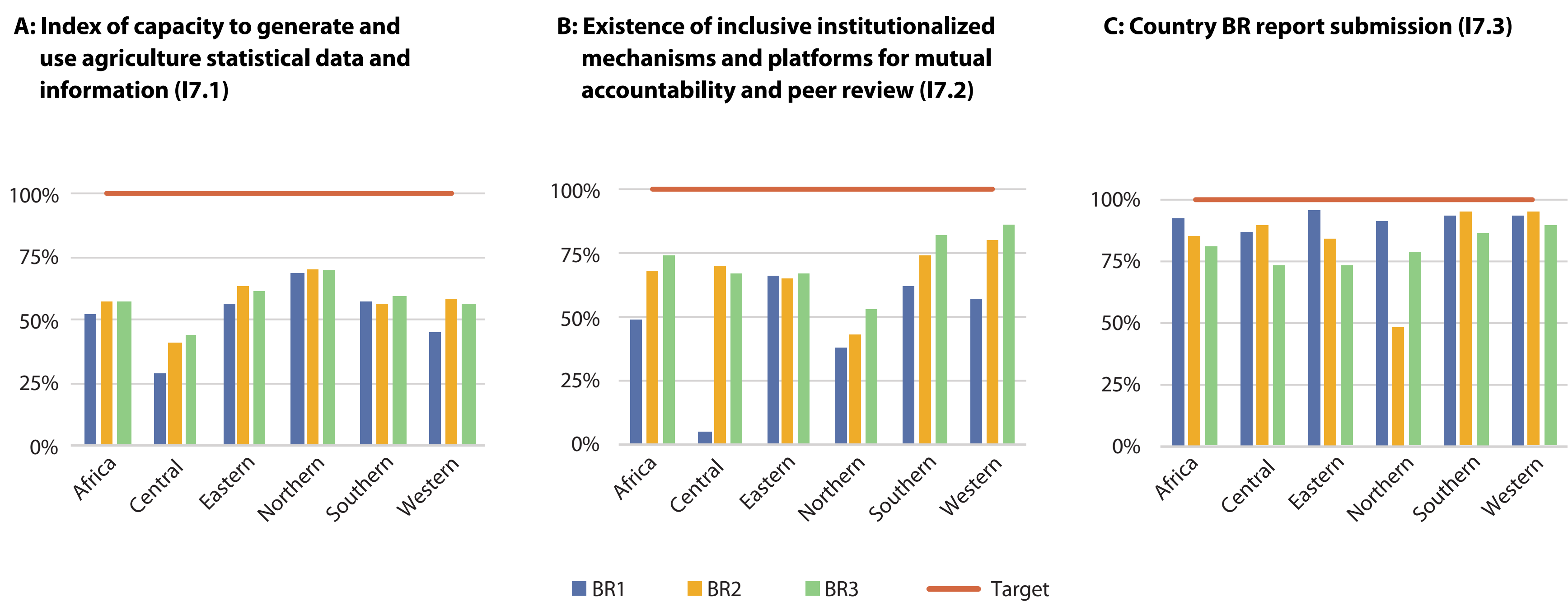
Note: BR = Biennial Review; CAADP = Comprehensive Africa Agriculture Development Programme.

Agricultural Statistics Capacity Index scores. The level of progress was the highest in northern Africa during the three BR periods and the lowest in central Africa (Figure 2.6A).

The indicator associated with PC7.2 is the *existence of inclusive institutionalized mechanisms and platforms for mutual accountability and peer review* (I7.2). The indicator is based on three parameters that measure the extent to which the agriculture review process follows established/standard principles, follows robust review mechanisms, and covers key areas of assessment. The result reveals that Africa improved from 49.5 percent in the first BR to 65.1 percent and 74.2 percent in the second and third BRs, respectively. There are stark differences in the performance of the geographic regions, with southern and western Africa recording notable progress during the second and third BR cycles and northern Africa showing the least progress (Figure 2.6B).

The third indicator is *country BR report submission* (I7.3), which is the indicator for PC7.3. The indicator is based on three parameters that measure progress in drafting the BR report, the quality of the draft BR report, and the technical review process of the BR. As Figure 2.6C reveals, Africa's performance in BR report submission declined from 92.4 percent in the first BR to 84.5 percent and further to 80.9 percent in the second and third BR cycles, respectively. A similar pattern is observed for eastern Africa, while for central, southern, and western Africa, the data reporting rate improved during the second BR before it declined in the third BR period. Central Africa recorded the lowest performance during the third BR period, at 72.5 percent.

FIGURE 2.6—PROGRESS IN INDICATORS UNDER THEMATIC AREA 7 (I7.1, I7.2, AND I7.3)



Source: Authors' calculations based on AUC (2018, 2020, and 2022).
Note: BR = Biennial Review.

The overall performance in the CAADP process (thematic area 1) and mutual accountability (thematic area 7) is presented in Appendix Table A2.3. The results show that Africa improved its scores for both thematic areas, from relatively low scores in the first BR. At the regional level, eastern Africa had the highest score in both thematic areas during the first BR. In the second and third BR cycles, however, western Africa consistently recorded the highest scores. Scores were lowest in northern Africa (for thematic area 1) and central Africa (for thematic area 7). It is important to underline that the scores for Africa and the geographic regions might have been different if a non-equal weighting approach had been applied.

Relationship Between Recommitting to the CAADP Process and Mutual Accountability and Progress in Achieving Outcomes

Correlation Among the Indicators of Recommitting to CAADP and Mutual Accountability

Table 2.2 presents the correlation between the indicators on recommitting to the CAADP process and mutual accountability. The results show a positive and significant association between many of the indicators during the second and third BRs. In the first BR, progress on the *existence of inclusive institutionalized mechanisms and platforms for mutual accountability and peer review* (I7.2) was the only indicator with significant correlation; it was positively correlated with three indicators, I1.1, I1.2, and I7.1, at a significance level of 1 percent to 10 percent. Two other indicators, *existence and adequacy of evidence-based policies, supportive institutions, and corresponding human resources* (I1.3) and *country BR report submission* (I7.3), had a significant correlation with I1.2 and I1.1, respectively, while the correlation was insignificant for all other indicators. During the second and third BR cycles, progress on several indicators produced a significant and stronger correlation with other indicators. This correlation includes all indicators on recommitting to CAADP (I1.1, I1.2, and I1.3) and two out of three indicators on mutual accountability (I7.2 and I7.3). The results suggest the presence of an association between the indicators. However, the agricultural statistics capacity indicator (I7.1) recorded significant correlation with very few indicators.

Mutual accountability in the context of agricultural programs refers to the reciprocal obligations or responsibilities among stakeholders, such as government entities, donors, farmers, civil society organizations, and private sector entities. It is the cornerstone of successful implementation of the CAADP agenda. Mutual accountability encourages stakeholders to participate more actively in agricultural programs, since they are involved in setting targets and held responsible for achieving them. This can lead to better-tailored interventions and enhanced ownership (Global Partnership for Effective Development Cooperation 2016).

A mutual accountability framework can increase transparency in program implementation. Regular reporting and reviewing of progress toward shared goals make it easier to track where resources are going and how they are being used, contributing to greater trust among stakeholders (OECD 2018). When roles, responsibilities, and expectations are clearly defined and monitored, resources can be utilized more efficiently. Mutual accountability can also lead to better results, as stakeholders are incentivized to meet their commitments (Bajpai and Myers 2019).

Regular reviews and feedback loops incorporated within a mutual accountability framework allow for the evaluation of program successes and challenges. This promotes learning and helps in refining and improving future interventions (FAO 2014). Finally, mutual accountability can promote the inclusion of marginalized groups. By ensuring that all stakeholders' voices are heard, these frameworks can help address power imbalances and ensure that program benefits are equitably distributed (IFAD 2019).

Correlation with Outcomes

Appendix Table A2.4 presents the correlation between recommitting to the CAADP process or mutual accountability, and the performance recorded in other thematic areas and targets of the Malabo Declaration. Correlation coefficients are estimated for the relationships between the thematic area scores (T-Scores) for CAADP process and mutual accountability and the scores at the thematic and performance category level, as well as values of the indicators in the other five thematic areas. The results clearly show that the magnitude and significance of the correlation notably improved as Africa moved from the first BR to the second BR and further to the third BR.

TABLE 2.2—CORRELATION AMONG INDICATORS ON RECOMMITTING TO CAADP AND MUTUAL ACCOUNTABILITY, 2015–2020

	Recommitting to CAADP process									Mutual accountability								
	I1.1			I1.2			I1.3			I7.1			I7.2			I7.3		
	BR1	BR2	BR3	BR1	BR2	BR3	BR1	BR2	BR3	BR1	BR2	BR3	BR1	BR2	BR3	BR1	BR2	BR3
I1.1																		
Coeff.	1	1	1															
P value	n.a.	n.a.	n.a.															
Obs.	43	48	51															
I1.2																		
Coeff.	0.25	0.48	0.25	1	1	1												
P value	0.12	0.001***	0.075*	n.a.	n.a.	n.a.												
Obs.	39	47	51	42	47	51												
I1.3																		
Coeff.	0.15	0.31	0.28	0.29	0.24	0.24	1	1	1									
P value	0.350	0.034**	0.049**	0.066*	0.100	0.096*	n.a.	n.a.	n.a.									
Obs.	41	48	51	41	47	51	44	49	51									
I7.1																		
Coeff.	0.17	0.08	-0.2	-0.00	0.40	-0.10	0.23	0.39	0.36	1	1	1						
P value	0.450	0.670	0.290	0.870	0.027**	0.560	0.280	0.029**	0.052**	n.a.	n.a.	n.a.						
Obs.	23	31	30	23	30	51	25	32	30	25	32	30						
I7.2																		
Coeff.	0.47	0.2	0.27	0.37	0.19	0.34	0.23	0.34	0.42	0.39	0.36	0.1	1	1	1			
P value	0.011**	0.190	0.056*	0.042**	0.200	0.016**	0.200	0.021**	0.002***	0.077*	0.050*	0.600	n.a.	n.a.	n.a.			
Obs.	29	46	51	30	46	51	32	47	51	22	31	30	32	47	51			
I7.3																		
Coeff.	0.27*	0.38	0.29	0.20	0.54	0.31	0.27	0.48	0.35	0.24	0.36	166	0.18	0.12	0.64	1	1	1
P value	0.100	0.008***	0.040**	0.200	0.000***	0.025**	0.075*	0.000***	0.013**	0.250	0.040	0.380	0.320	0.420	0.000***	n.a.	n.a.	n.a.
Obs.	43	48	51	42	47	51	44	49	51	25	32	30	32	47	51	47	49	51

Source: Authors' calculations.
Note: BR = Biennial Review; CAADP = Comprehensive Africa Agriculture Development Programme; n.a. = not applicable.

Correlation with recommitting to the CAADP process (thematic area 1): In the first BR, significant correlation was observed with only two thematic areas (thematic areas 3 and 6) and five performance categories under thematic areas 3, 4, and 6. During the second and third BRs, the number of positive and significant relationships improved, with higher magnitude in most cases compared to the first BR. That is, at the thematic area level, significant correlation was observed with four thematic areas in the second BR and three thematic areas in the third BR. Similarly, significant correlation was found with 11 and 8 performance categories in the second and third BRs, respectively, with higher magnitude in most cases. At the indicator level, the number of significant correlations reached 7 in the second BR and 13 in the third BR. That is, the proportion of indicators with significant correlation increased from 2.3 percent in the first BR to 14.9 percent in the second BR and further to 27.7 percent in the third BR. Once again, the magnitude of the correlation showed a growing trend from the first BR to the second and third BRs. The results indicate that as Africa progresses in its BR process, more and more indicators are positively and significantly correlated with progress in recommitting to the CAADP process. Moreover, the results indicate that recommitting to CAADP has a positive and growing association with most of the thematic areas of the Malabo Declaration. This suggests that an improved country CAADP process as well as improved evidence-based policies have a positive and significant relationship with key policy and development outcomes. However, additional studies are required to identify why a strong correlation is observed in some cases but not in others.

Correlation with mutual accountability (thematic area 7): The results show an increasing association between mutual accountability and progress in the underlying indicators as Africa proceeds with its BR reporting. Particularly, the third BR exhibits a significant and higher association compared to the second BR, which in turn had a higher number of significant correlations when compared with the first BR. In the third BR, more than 60 percent of the 24 performance categories recorded significant correlation, compared to approximately 40 percent in the previous BRs. In the first BR, progress in 5 of the 43 indicators (11.6 percent) was significantly correlated. This increased to 9 indicators (19.1 percent) in the second BR and further to 19 (40.4 percent) in the third BR. In most of the cases, the correlation coefficient increases and becomes more significant as we move away the first BR. Indicators in thematic area 3 (ending hunger) and thematic area 4 (reducing poverty) have the largest numbers of significantly correlated indicators, followed by thematic area 2 (investment finance in agriculture).

In both recommitting to the CAADP process and mutual accountability, the trend shows increasing correlation in terms of both magnitude and significance as Africa progresses in the CAADP BR process. Further studies are needed to unpack the result and also identify factors that are driving progress in some thematic areas and not in others. Improved data reporting could be one of the factors contributing to stronger correlation among the indicators (see Box 2.1 for a discussion of the data reporting performance of Africa and the regions). However, an increase in the data reporting rate alone cannot explain the significant correlation or higher BR score. BR scores are determined by policy actions and investment decisions and the impact of these interventions on economic agents (Benin et al. 2020).

Econometric Analysis

The correlation discussed above does not imply causation. In other words, the fact that two variables move together does not mean that one is causing the other

TABLE 2.3—EQUATIONS WITH AT LEAST 50% MC

Code	mc	Name
br	0.786	Africa Agricultural Transformation Scorecard
x6_2	0.751	Existence of government budget lines and enabling environment to respond to spending needs on resilience-building initiatives
x3_6i	0.725	Food safety systems indicator
x6_1i	0.682	Improvement in resilience to climate shocks and other shocks
x3_5vii	0.680	Proportion of moderate and severe food insecurity in the population
x3_5iv	0.665	Prevalence of undernourished
x3_5iii	0.663	Prevalence of wasting
x3_5i	0.641	Prevalence of stunting
x4_1iv	0.629	Reduction rate of poverty
x3_5vi	0.602	Proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet
x3_5ii	0.593	Prevalence of underweight
x4_1i	0.578	Growth rate of agriculture value added
x5_1	0.557	Growth rate of the value of trade in agricultural commodities and services within Africa
x3_5v	0.552	Growth rate of the proportion of women who meet the requirements for minimum dietary diversity for women
x5_2i	0.540	Trade Facilitation Index
x3_2ii	0.533	Agricultural land productivity
x3_2iii	0.528	Growth rate yields for the national priority commodities
x3_2i	0.504	Agricultural labor productivity

Source: Authors.

to move. In this section, we use structural equation models built on the BR's own theory of change to capture causality.

Structural equation modeling (SEM) can address endogeneity in various ways. Endogeneity can arise due to omitted variables, measurement error, or simultaneity (reverse causation), which, if unaddressed, can result in biased parameter estimates. One major strength of SEM is its capacity to model latent variables, which can help address the problem of omitted variable bias. By capturing unobserved factors as latent constructs, SEM can account for unobserved heterogeneity that might otherwise induce endogeneity (Antonakis et al. 2010). Moreover, in SEM, each equation has its own error term. By allowing the error terms of different equations to correlate, SEM can capture the unobserved factors that affect multiple endogenous variables simultaneously, thereby addressing some of the concerns related to endogeneity. To account for missing values, we implemented the maximum likelihood multivariate estimator, a statistical method used predominantly within the realm of SEM.

For the sake of parsimony, out of the 42 equations, we chose to focus on 19 whose mc are at least 50 percent,[6] as shown in Table 2.3. In other words, we retained only endogenous variables for which there is a significant correlation between observed and predicted values. Implicitly, this means that there are other important factors that are not included in the CAADP BR reporting system.

Based on the equations presented in Table 2.3, we report the total significant effects for each path (Sobel 1987), along with standard errors obtained by the delta method (see Table 2.4). Figure 2.7 captures the complete network of significant total effects. The total effect is the combined effect of both direct and indirect effects. In other words, it is the sum of the pathways through which one variable impacts another. In the context of a SEM, a direct effect refers to the

TABLE 2.4—SIGNIFICANT DRIVERS OF AFRICA'S AGRICULTURAL TRANSFORMATION

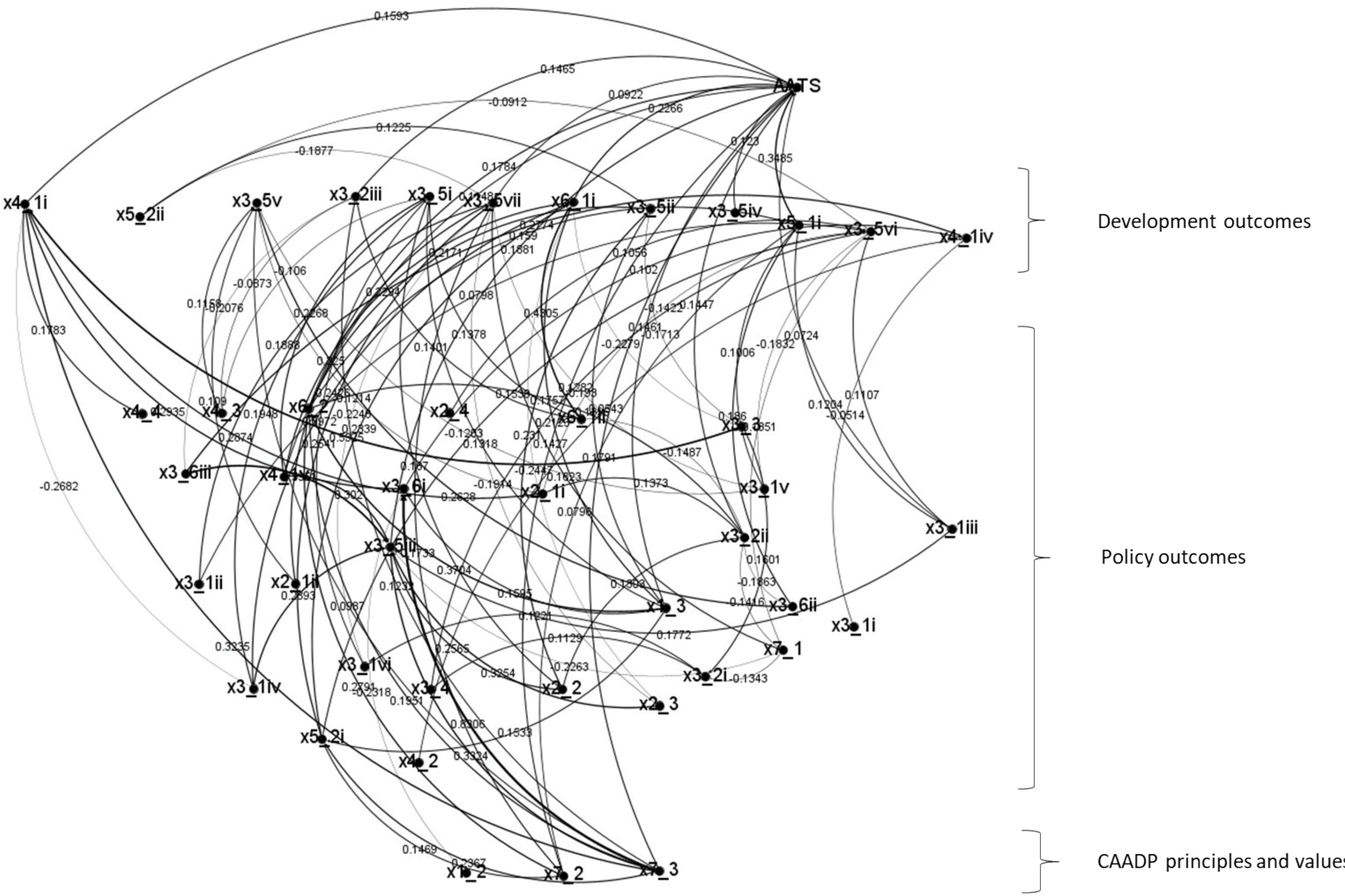
Code	Variable	Total marginal effects	Standard error	
x5_1	Growth rate of the value of trade in agricultural commodities and services within Africa	0.3485	0.0586	***
x6_1i	Percentage of farm, pastoral, and fisher households that are resilient to climate- and weather-related shocks	0.2266	0.0343	***
x3_5iii	Prevalence of wasting (%) among children under 5 years old	0.1881	0.0296	***
x7_3	Country Biennial Review report submission	0.1791	0.0482	***
x6_2	Existence of government budget lines to respond to spending needs on resilience-building initiatives	0.1784	0.0692	***
x4_1i	Growth rate of agriculture value added	0.1593	0.0308	***
x3_2iii	Growth rate of yields for the 5 national priority commodities	0.1465	0.0603	***
x1_3	Existence and adequacy of evidence-based policies, supportive institutions, and corresponding human resources	0.1461	0.0441	***
x3_2ii	Growth rate of agriculture value added, in constant US dollars, per hectare of agricultural land	0.1447	0.0569	***
x7_2	Existence of inclusive institutionalized mechanisms and platforms for mutual accountability and peer review	0.1427	0.0354	***
x3_5iv	Prevalence of undernourished (% of the country's population)	0.1230	0.0438	***
x4_1v	Reduction rate of the gap between the wholesale price and farmgate price	0.1148	0.0522	**
x3_5vii	Prevalence of moderate and severe food insecurity in the population	0.0922	0.0502	*
x3_1iii	Growth rate of the ratio of supplied quality agriculture inputs (seed, breed, fingerlings) to the total national input requirements for the commodity	0.0724	0.0419	*

Source: Authors.

Note: ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively.

6 The term mc represents the correlation between the dependent variable and its prediction. In the context of SEM, it is equivalent to the square root of the model's explained variance for the dependent variable. It provides a measure of the strength and direction of the linear relationship between the observed and predicted values of the dependent variable.

FIGURE 2.7—NETWORK OF SIGNIFICANT TOTAL EFFECTS



Source: Authors' calculations based on AUC (2018, 2020, and 2022).

Note: BM = benchmark; BR = Biennial Review; CEN-SAD = Community of Sahel-Saharan States; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority on Development; SADC = Southern African Development Community; UMA = Union du Maghreb Arabe.

immediate relationship between two variables, without any mediation through other variables. It is essentially the influence of one variable on another when all other variables are held constant. An indirect effect arises when the relationship between two variables is mediated through one or more intervening variables. This implies that the influence of the first variable on the second is channeled through another variable.

Over the 2017–2021 period, out of the 45 BR performance categories, only 14 (about 31.1 percent) have had significant total effects on the Africa Agriculture Transformation Scorecard (AATS), which captures the continent's overall progress toward achieving the CAADP/Malabo Declaration aims. This implies that either the selection of drivers may have been overly ambitious or the implementation process has not been very effective. Either way, the results call for a thorough assessment of the complete CAADP theory of change in terms of both policy instruments and expected outcomes in preparation for the post-Malabo agenda. The magnitude of the total effects varies between 0.3485 (*growth rate of the value of trade in agricultural commodities and services within Africa*, in constant US dollars) and 0.0724 (*growth rate of the ratio of supplied quality agriculture inputs to the total national inputs to the total national input requirements for the commodity*). It is worth noting that except for thematic area 2 (investment finance in agriculture), all other thematic areas have at least one performance category that is a significant driver of the overall CAADP/Malabo agenda. If anything, this confirms the need for a multifaceted approach in the design and implementation of a transformative agenda such as CAADP.

In a comprehensive program such as the CAADP/Malabo agenda, pathways from principles to policy and development outcomes are complex by nature. As reported in Figure 2.7, some of the findings are rather unexpected.[7] CAADP under the Malabo agenda, as articulated by the African Union, is an ambitious initiative aiming to transform the agricultural sector in Africa. With goals of spurring economic growth, improving food security, and fostering collaboration among member states, the initiative is holistic in its approach. As with any broad-scale program, the CAADP/Malabo agenda, while being a blueprint, can result in unanticipated outcomes once policy instruments are applied in real-world contexts. Explaining these unexpected findings, be they positive or negative, requires a nuanced understanding.

One of the primary reasons unexpected outcomes might arise is the vast heterogeneity of the African continent. Policies that might be effective in one country or region might not be as impactful elsewhere due to cultural, economic, or climatic differences. For instance, a policy aimed at bolstering irrigated farming might see incredible success in a country with abundant water resources but fail in a more arid nation. Moreover, policies do not operate in isolation. An intervention in one sector could have cascading impacts on another. For instance, improving agricultural productivity might unexpectedly lead to a decrease in prices if the output is not matched by demand, thereby negatively affecting farmer incomes. Policies, as they transition from paper to practice, might confront a myriad of on-the-ground challenges. Infrastructure bottlenecks, bureaucratic delays, or gaps in skill sets can lead to deviations from expected outcomes.

Global events, such as trade wars, pandemics, or climate phenomena, can significantly alter the expected outcomes of policy instruments. The recent COVID-19 pandemic, for example, impacted agricultural supply chains worldwide, an external shock that could lead to unforeseen results for initiatives under the CAADP/Malabo framework. The dynamics of socioeconomic systems can sometimes result in feedback loops that amplify or dampen the impacts of a policy. For example, an initial success in a particular agricultural initiative might attract more investment and talent into the sector, leading to even more significant positive outcomes than initially projected.

Unexpected findings in comprehensive programs like CAADP/Malabo are not necessarily indications of flawed design but are often a testament to the complexity of real-world systems. Recognizing, understanding, and adapting to these outcomes is crucial for refining policy instruments and ensuring that the overarching goals of the agenda are realized.

With that in mind, we also note that many of the findings were in line with expectations. We highlight below some of the key expected findings:

- *Budget lines on social protection* have a positive impact on the proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet and on agricultural labor productivity.

7 The full results of the estimation are available on request from the authors.

- *Domestic Food Price Volatility Index* has a positive impact on the proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet.
- *Domestic private sector investment in agriculture as a percentage of agriculture value added* has a positive impact on agricultural land productivity.
- *Existence and adequacy of evidence-based policies, supportive institutions, and corresponding human resources* has a positive impact on the percentage of farm, pastoral, and fisher households that are resilient to climate- and weather-related shocks; on the level of improvement of food safety systems (Food Safety Systems Index); and on the Trade Facilitation Index.
- *Existence of government budget lines to respond to spending needs on resilience-building initiatives* has a positive impact on agricultural land productivity and on the growth rate of the value of trade in agricultural commodities and services within Africa.
- *Existence of inclusive institutionalized mechanisms and platforms for mutual accountability and peer review* has a positive impact on the growth rate of the value of trade in agricultural commodities and services within Africa and on the Trade Facilitation Index.
- *Fertilizer consumption (kilograms per hectare of arable land)* has a negative impact on the poverty head count ratio at the international poverty line.
- *Government agriculture expenditure as a percentage of agriculture value added* has a positive impact on the growth rate of the proportion of women who meet the requirements for Minimum Dietary Diversity for Women, on the growth rate of agricultural land productivity, and on the growth rate of agriculture value added.
- *Growth rate of the ratio of supplied quality agriculture inputs* has a positive impact on the proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet and on the growth rate of the value of trade in agricultural commodities and services within Africa.
- *Growth rate of the size of irrigated areas from their value in the year 2000* has a positive impact on the proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet.
- *Index of capacity to generate and use agriculture statistical data and information* has a positive impact on the growth rate of agricultural land and labor productivity and on the proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet while reducing the prevalence (percent) of food-insecure adults.
- *Proportion of adult agricultural population with ownership or secure land rights over agricultural land* has a positive impact on the growth rate of agricultural labor productivity while reducing the prevalence (percent) of food-insecure adults.
- *Proportion of men and women engaged in agriculture with access to financial services* has a positive impact on the proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet.
- *Proportion of rural women who are empowered in agriculture* has a positive impact on the growth rate of agriculture value added.
- *Reduction rate of postharvest losses for (at least) the five national priority commodities* has a negative impact on the prevalence of underweight (percent) among children under 5 years old and a positive impact on the growth rate of agriculture value added and on the growth rate of agricultural labor productivity.
- *Reduction rate of the gap between the wholesale price and farmgate price* has a positive impact on the percentage of farm, pastoral, and fisher households that are resilient to climate- and weather-related shocks.
- *Share of agricultural land under sustainable land management practices* has a positive impact on the growth rate of yields for the five national priority commodities and on the percentage of farm, pastoral, and fisher households that are resilient to climate- and weather-related shocks.
- *Total agricultural research spending as a share of agricultural GDP* has a positive impact on the growth rate of the value of trade in agricultural commodities and services within Africa while reducing the prevalence (percent) of food-insecure adults.

Overall, the findings show that CAADP values and principles help improve policy outcomes, with different levels of magnitude. The impact of recommitting to the CAADP principles and values does influence a few policy outcomes. These are youth engaged in new job opportunities in agricultural value chains, access to financial services in agriculture, access to agricultural advisory services, existence of government budget lines to respond to spending needs on resilience-building initiatives, and the Trade Facilitation Index. This influence is exerted mainly through the completion of the CAADP process and the presence of evidence-based policies, supportive institutions, and corresponding human resources. The existence and quality of a multisectoral and multistakeholder coordination body has not been shown to have significant impact on policy outcomes. Moreover, completion of the CAADP process, which refers to achieving higher stages of implementation, has a significant and positive impact on only two policy outcomes. This falls short of the expectation that moving further in the CAADP implementation process would consistently produce additional positive policy outcomes.

Conceptually, committing to mutual accountability for results and actions plays a pivotal role in facilitating a better policymaking process and its implementation. The findings show that as more and more countries achieve inclusive institutionalized mechanisms and platforms for mutual accountability, as well as submission of BR reports that satisfy the required parameters, we observe increased public expenditure on agriculture, increased investment, and increased access to finance.

Concluding Remarks and Recommendations

CAADP, initiated by the African Union in 2003, aims to help African countries reach a higher path of economic growth through agriculture-led development. The last three BRs show that more and more countries have joined the BR exercise, and the overall data reporting rate has increased for the continent as a whole. In addition, the prevalence of missing data declined in the successive BRs, although the problem has persisted throughout the BR cycles. The continent has maintained high scores for Malabo thematic areas 1 (committing to the CAADP principles and values) and 7 (committing to mutual accountability for results and actions) during the three BRs. With their perceived contribution in improving the policymaking process, these two thematic areas are expected to improve policy and development outcomes. However, the findings show limited causation.

Overall, the findings underscore the fact that challenges faced by food systems in Africa cannot be attributed to a single factor. Indeed, the use of outdated farming practices and the low adoption rate of improved agricultural technologies have contributed to low productivity. Issues such as monocultures, lack of crop rotation, and poor soil management are still prevalent across the continent. Poor infrastructure such as roads, storage, and processing facilities limits access to markets and increases postharvest losses. Across the continent, some countries have made significant progress in implementing the CAADP/Malabo agenda or related processes, while others face greater challenges. The lack of progress in achieving CAADP/Malabo targets is a result of numerous factors including policy and institutional failures. In general, our findings suggest that commitment to CAADP values and principles has failed to significantly improve some key policy outcomes. Moreover, several policy outcomes (share of public agriculture expenditure in total expenditure, fertilizer consumption per hectare of arable land, supplied quality agriculture inputs as a share of total national input requirements, Food Safety Systems Index, and Food Safety Trade Index) have failed to produce the expected impact on development outcomes.

Africa's journey toward transforming its food systems is still a long and complex road woven with myriad threads of challenges, ambitions, and potential. At the heart of this transformation is the CAADP/Malabo agenda, a continental beacon guiding efforts to revolutionize agricultural systems. As we reflect upon the pivotal drivers shaping this transformation, our findings point to several key factors discussed below.

The bolstering of intra-Africa trade is not just an economic decision; it is a strategic move to ensure that the continent is self-reliant. By boosting internal trade, Africa will improve its food security and foster an environment in which local produce is valued, shared, and traded without heavy reliance on imports. Africa is, unfortunately, at the forefront of climate change impacts. Recognizing this, increasing resilience to climatic fluctuations is paramount. By nurturing crops that can withstand unpredictable weather patterns and using innovative agricultural practices, Africa is laying the foundation for sustainable healthy diets for all Africans. Governments' commitments are highlighted in their budgetary allocations as part of CAADP principles. Similarly, the establishment of dedicated budget lines for resilience-building initiatives shows a proactive approach in foreseeing challenges and planning for them. For Africa's agricultural production to keep pace with its booming population, increasing the yield of priority commodities is essential as yield growth directly correlates to food security, employment opportunities, and economic stability.

For transformation to occur under the CAADP agenda, investment programs must not be based on whims but on grounded, empirical evidence. Africa's focus on evidence-based policies, backed by strong institutions and skilled human resources, promises a robust and comprehensive approach to the continent's food system overhaul. Moreover, transparency, mutual accountability, and peer review are pillars upon which trust is built. The institutionalized mechanisms for these processes ensure that the journey is not just forward-moving but also transparent and inclusive.

The shrinking gap between wholesale and farmgate prices is indicative of a more equitable distribution system. It ensures that farmers, the backbone of Africa's agriculture, receive a fair share of the gain for their tireless efforts. Lastly, the key to great produce lies in its genesis—the quality of inputs used. By augmenting the supply of quality seeds, fertilizers, and tools, Africa will ensure that its products are not just abundant but also of superior quality.

The inherent complexity of the CAADP agenda means that unexpected results can arise from various sources, be they environmental, economic, or political. Therefore, it is critical to minimize the impact of unexpected outcomes in a comprehensive program like CAADP. They should be minimized, but they also provide learning opportunities, revealing ways to refine and improve the program further.

We would like to close this chapter by highlighting the importance of data to produce policy-relevant evidence in support of the CAADP/Malabo agenda. Accurate, timely, and comprehensive data are paramount to making informed decisions. For the CAADP/Malabo agenda to translate from policy to effective action, policymakers and stakeholders must be armed with quality data. Only with accurate data can the complex dynamics of agricultural systems—involving interrelated factors such as crop yields, weather patterns, and market demand—be understood and addressed. The CAADP/Malabo agenda sets specific targets to be achieved by 2025. Monitoring progress toward these targets necessitates a robust data management system. Only with high-quality data can there be confidence in the reported progress, ensuring that real gains are made. Quality data promote transparency, which in turn fosters accountability. Stakeholders, from farmers to governments and international partners, need to be held accountable for their roles in this transformative journey. Clear, accurate data allow for a transparent review process in which stakeholders can be held accountable for their contributions, or lack thereof.

Beyond monitoring the present, data play a pivotal role in predicting future trends and challenges. With the increasing threat of climate change and evolving global markets, African agriculture must be forward-looking. Quality data feed predictive models, helping stakeholders to anticipate future challenges and opportunities. The success of the CAADP/Malabo agenda is not the responsibility of governments alone but involves private sector players, international partners, and local communities. For these stakeholders to invest time, resources, and capital, they need confidence in the program's viability and effectiveness. Quality data provide the evidence base that can inspire such confidence. High-quality data can shed light on disparities within the agricultural sector, whether they be regional, gender-based, or related to specific crops or practices. Addressing these disparities is crucial to ensuring that the CAADP/Malabo agenda benefits all segments of the population equitably.

Appendix

TABLE A2.1—MALABO BR INDICATORS AND IMPACT PATHWAYS

Label	Thematic area, performance category, and indicator	Impact pathway node
	Thematic area (TA)	
TA1	Recommitting to the CAADP process	Principles and values
TA2	Enhancing investment finance in agriculture	Policy outcome
TA3	Ending hunger by 2025	Development outcome
TA4	Halving poverty through agriculture by 2025	Development outcome
TA5	Boosting intra-African trade in agriculture commodities and services	Development outcome
TA6	Enhancing resilience to climate variability	Development outcome
TA7	Mutual accountability for actions and results	Principles and values
	Performance category (PC)	
PC1.1	Completing national CAADP process	Principles and values
PC1.2	Establishing CAADP-based cooperation, partnership, and alliance	Principles and values
PC1.3	Establishing CAADP-based policy and institutional review, setting, and support	Policies and plans
PC2.1	Public expenditures in agriculture	Policy outcome
PC2.2	Domestic private sector investment in agriculture, agribusiness, and agroindustry	Policy outcome
PC2.3	Foreign private sector investment in agriculture, agribusiness, and agroindustry	Policy outcome
PC2.4	Enhancing access to finance	Policy outcome
PC3.1	Access to agriculture inputs and technologies	Policy outcome
PC3.2	Doubling agricultural productivity	Development outcome
PC3.3	Reduction of postharvest loss	Policy outcome
PC3.4	Strengthening social protection	Policy outcome
PC3.5	Improving food security and nutrition	Development outcome
PC3.6	Food safety	Policy outcome
PC4.1	Sustaining agricultural GDP for poverty reduction	Development outcome
PC4.2	Establishing inclusive PPPs for commodity value chains	Policy outcome
PC4.3	Creating jobs for youth in agricultural value chains	Policy outcome
PC4.4	Women’s participation in agribusiness	Policy outcome
PC5.1	Tripling intra-African trade in agriculture commodities and services	Development outcome
PC5.2	Establishing Intra-African trade policies and institutional conditions	Policy outcome

continued

Appendix

TABLE A2.1—MALABO BR INDICATORS AND IMPACT PATHWAYS

Label	Thematic area, performance category, and indicator	Impact pathway node
PC6.1	Ensuring resilience to climate-related risks	Development outcome
PC6.2	Investment in resilience building	Policy outcome
PC7.1	Increasing country capacity for evidence-based planning, implementation, and monitoring and evaluation	Policy outcome
PC7.2	Fostering peer review and mutual accountability process	Principles and values
PC7.3	Conducting a biennial agriculture review process	Principles and values
	Indicator (I)	
I1.1	Country CAADP process	Principles and values
I1.2	Existence of, and quality of, multisectoral and multistakeholder coordination body	Principles and values
I1.3	Existence and adequacy of evidence-based policies, supportive institutions, and corresponding human resources	Policies and plans
I2.1i	Public agriculture expenditure as a share of total public expenditure	Policy outcome
I2.1ii	Public agriculture expenditure as a percentage of agriculture value added	Policy outcome
I2.1iii	Official development assistance disbursed to agriculture as a percentage of commitment	Policy outcome
I2.2	Ratio of domestic private sector investment to public investment in agriculture	Policy outcome
I2.3	Ratio of foreign private direct investment to public investment in agriculture	Policy outcome
I2.4	Proportion of men and women engaged in agriculture with access to financial services	Policy outcome
I3.1i	Fertilizer consumption (kilograms of nutrients per hectare of arable land)	Policy outcome
I3.1ii	Growth rate of the size of irrigated areas from its value in the year 2000	Policy outcome
I3.1iii	Growth rate of the ratio of supplied quality agriculture inputs (seed, breed, fingerlings) to the total national input requirements for the commodity	Policy outcome
I3.1iv	Proportion of farmers having access to agricultural advisory services	Policy outcome
I3.1v	Total agricultural research spending as a share of agricultural GDP	Policy outcome
I3.1vi	Proportion of farm households with ownership or secure land rights	Policy outcome
I3.2i	Growth rate of agriculture value added, in constant US dollars, per agricultural worker	Development outcome
I3.2ii	Growth rate of agriculture value added, in constant US dollars, per hectare of agricultural land	Development outcome
I3.2iii	Growth rate of yields for the 5 national priority commodities	Development outcome
I3.3	Reduction rate of postharvest losses for (at least) the five national priority commodities	Policy outcome
I3.4	Budget lines (%) on social protection as a percentage of the total resource requirements for coverage of the vulnerable social groups	Policy outcome
I3.5i	Prevalence of stunting (%) among children under 5 years old	Development outcome

continued

Appendix

TABLE A2.1—MALABO BR INDICATORS AND IMPACT PATHWAYS

Label	Thematic area, performance category, and indicator	Impact pathway node
I3.5ii	Prevalence of underweight (%) among children under 5 years old	Development outcome
I3.5iii	Prevalence of wasting (%) among children under 5 years old	Development outcome
I3.5iv	Prevalence of undernourished (% of the country's population)	Development outcome
I3.5v	Growth rate of the proportion of women who meet the requirements for minimum dietary diversity for women	Development outcome
I3.5vi	Proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet	Development outcome
I3.5vii	Prevalence of moderate and severe food insecurity in the population	Development outcome
I3.6i	Food Safety Systems Indicator	Policy outcome
I3.6ii	Food Safety Health Indicator	Policy outcome
I3.6iii	Food Safety Trade Indicator	Policy outcome
I4.1i	Growth rate of agriculture value added	Development outcome
I4.1ii	Agriculture contribution to overall poverty reduction target	Development outcome
I4.1iii	Reduction rate of poverty head count ratio at national poverty line (% of population)	Development outcome
I4.1iv	Reduction rate of poverty head count ratio at international poverty line (% of population)	Development outcome
I4.1v	Reduction rate of the gap between the wholesale price and farmgate price	Policy outcome
I4.2	Number of priority agricultural commodity value chains for which a PPP is established with strong linkages to smallholder agriculture	Policy outcome
I4.3	Percentage of youth engaged in new job opportunities in agricultural value chains	Policy outcome
I4.4	Proportion of rural women who are empowered in agriculture	Policy outcome
I5.1	Growth rate of the value of trade in agricultural commodities and services within Africa	Development outcome
I5.2i	Trade Facilitation Index	Policy outcome
I5.2ii	Domestic Food Price Volatility Index	Policy outcome
I6.1i	Percentage of farm, pastoral, and fisher households that are resilient to climate- and weather-related shocks	Development outcome
I6.1ii	Share of agricultural land under sustainable land management practices	Policy outcome
I6.2	Existence of government budget lines to respond to spending needs on resilience-building initiatives	Policy outcome
I7.1	Index of capacity to generate and use agriculture statistical data and information (Agricultural Statistics Capacity Index)	Policy outcome
I7.2	Existence of inclusive institutionalized mechanisms and platforms for mutual accountability and peer review	Principles and values
I7.3	Country BR report submission	Principles and values

Source: Authors' synthesis based on Benin, Ulimwengu, and Tefera (2018).
Note: BR = Biennial Review; PPP = public–private partnership. PC3.6, I3.5vii, I3.6i, I3.6ii, and I3.6iii were introduced after the second BR.

Appendix

TABLE A2.2—NUMBER OF VALID OBSERVATIONS BY INDICATOR FOR ALL REPORTING COUNTRIES

Indicator	Number of valid observations					
	Including reported zeros			Excluding reported zeros		
	First BR	Second BR	Third BR	First BR	Second BR	Third BR
I1.1	47	49	51	43	48	49
I1.2	47	49	50	42	47	49
I1.3	47	49	50	44	49	47
I2.1i	44	49	49	44	49	49
I2.1ii	44	46	48	44	46	48
I21.iii	36	44	43	36	44	43
I2.2	39	—	33	38	—	32
I2.3	39	—	27	29	—	26
I2.4	34	39	40	33	39	40
I3.1i	45	42	44	45	42	44
I3.1ii	41	41	44	40	38	41
I3.1iii	24	42	26	23	36	26
I3.1iv	40	41	44	40	41	43
I3.1v	36	42	46	36	42	46
I3.1vi	32	36	38	32	36	38
I3.2i	30	30	35	30	30	35
I3.2ii	42	35	37	41	35	37
I3.2iii	35	45	39	34	45	39
I3.3	7	19	26	7	19	26
I3.4	26	27	40	26	27	40
I3.5i	38	45	43	38	45	42
I3.5ii	39	44	43	39	44	41
I3.5iii	40	48	41	40	48	40
I3.5iv	32	33	40	32	33	40
I3.5v	7	15	21	7	9	15

TABLE A2.2—NUMBER OF VALID OBSERVATIONS BY INDICATOR FOR ALL REPORTING COUNTRIES

Indicator	Number of valid observations					
	Including reported zeros			Excluding reported zeros		
	First BR	Second BR	Third BR	First BR	Second BR	Third BR
I3.5vi	33	30	37	33	30	35
I3.5vii	—	22	32	—	20	30
I3.6i	—	49	51	—	47	49
I3.6ii	—	25	21	—	25	21
I3.6iii	—	7	6	—	7	6
I4.1i	47	40	43	46	40	43
I4.1ii	—	—	—	—	—	—
I4.1iii	13	36	39	13	12	24
I4.1iv	6	23	17	6	6	17
I4.1v	23	15	22	23	15	22
I4.2	47	18	38	16	18	23
I4.3	22	32	37	22	32	37
I4.4	19	22	29	19	22	29
I5.1	29	38	27	29	38	27
I5.2i	35	48	43	35	48	43
I5.2ii	32	45	47	32	35	47
I6.1i	19	25	33	19	25	33
I6.1ii	30	36	42	30	36	42
I6.2	47	49	51	35	46	48
I7.1	26	46	45	25	46	45
I7.2	47	49	51	32	47	50
I7.3	47	49	51	47	49	51

Source: AUC (2018, 2020, 2022).
Note: BR = Biennial Review. —= data not available .

Appendix

TABLE A2.3—SUMMARY OF PERFORMANCE IN CAADP PROCESS AND MUTUAL ACCOUNTABILITY, 2015–2020

	T-Score in thematic area			C-Score in performance category									Progress on indicator								
CAADP process	**TA1**			**PC1.1**			**PC1.2**			**PC1.3**			**I1.1**			**I1.2**			**I1.3**		
	BR1	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**
Target Progress	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	100%	100%	100%	100%	100%	100%	100%	100%	100%
Africa	5.53	7.29	7.28	5.94	7.14	7.70	4.69	7.96	7.13	5.95	6.76	7.00	63.16%	74.12%	81.51%	47.95%	82.63%	75.51%	62.86%	70.19%	74.17%
Central	5.33	7.29	6.68	5.24	7.32	6.43	4.93	8.08	7.33	5.82	6.46	6.30	57.14%	83.67%	73.47%	50.51%	92.35%	83.75%	59.44%	73.83%	71.96%
Eastern	6.59	7.01	7.89	9.58	6.92	8.31	4.54	7.59	8.13	5.66	6.51	7.23	88.32%	75.00%	83.33%	40.34%	82.24%	82.89%	59.27%	70.55%	73.48%
Northern	3.66	4.10	6.77	2.50	4.29	8.81	4.20	4.29	5.40	4.28	3.72	6.11	25.00%	50.00%	88.10%	41.96%	50.00%	54.04%	42.82%	43.40%	61.09%
Southern	5.72	7.50	6.55	5.12	6.19	6.02	4.50	9.08	7.20	7.54	7.25	6.42	50.00%	61.90%	68.83%	48.30%	90.75%	82.56%	72.75%	72.47%	73.80%
Western	6.33	8.85	8.03	7.26	9.33	9.05	5.28	9.05	6.92	6.44	8.18	8.13	72.60%	93.33%	90.48%	52.80%	90.46%	69.19%	64.39%	81.79%	81.25%
Mutual accountability	**TA7**			**PC7.1**			**PC7.2**			**PC7.3**			**I7.1**			**I7.2**			**I7.3**		
	BR1	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**	**BR1**	**BR2**	**BR3**
Target Progress	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	63%	69%	69%	100%	100%	100%	100%	100%	100%
Africa	5.35	5.98	6.26	2.12	3.20	3.35	4.70	6.60	7.37	9.22	8.14	8.06	52.44%	57.38%	57.54%	49.53%	68.50%	74.19%	92.44%	84.47%	80.91%
Central	3.04	4.89	4.71	0.00	0.72	0.14	0.40	6.11	6.77	8.71	7.85	7.23	29.00%	41.00%	44.48%	4.51%	69.84%	67.71%	86.95%	89.68%	72.49%
Eastern	7.16	5.58	6.59	4.70	2.99	3.92	7.19	5.98	7.58	9.60	7.75	8.27	56.86%	63.16%	61.56%	66.36%	64.81%	67.06%	95.65%	83.95%	73.23%
Northern	5.15	3.95	6.53	2.50	4.07	6.41	3.82	3.69	5.28	9.13	4.10	7.90	68.10%	70.10%	70.03%	38.19%	43.06%	52.78%	91.30%	47.78%	78.95%
Southern	5.94	6.95	6.14	2.09	3.91	3.86	6.39	7.48	7.06	9.35	9.48	7.49	57.47%	56.06%	59.24%	62.04%	74.77%	81.94%	93.08%	94.76%	85.70%
Western	5.45	7.08	6.86	1.32	3.73	2.95	5.69	8.06	8.67	9.33	9.45	8.95	45.53%	58.60%	56.38%	56.94%	80.56%	86.67%	93.29%	94.52%	89.52%

Source: Authors' calculations based on AUC (2018, 2020, and 2022).
Note: BR = Biennial Review; CAADP = Comprehensive Africa Agriculture Development Programme; n.a. = not applicable.

Appendix

TABLE A2.4—CORRELATION BETWEEN RECOMMITTING TO CAADP PROCESS AND MUTUAL ACCOUNTABILITY AND PROGRESS MADE IN OTHER MALABO COMMITMENTS, 2015–2020

Label	Malabo thematic area, performance category, or indicator	CAADP process (T-Score)						Mutual accountability (T-Score)					
		First BR		Second BR		Third BR		First BR		Second BR		Third BR	
		Coef.	P value	Coef.	P value	Coef.	P-value	Coef.	P value	Coef.	P value	Coef.	P-value
Malabo thematic area (T-Score)													
TA2	Enhancing Investment finance in agriculture	-0.057	0.703	0.273	0.057*	0.148	0.301	0.217	0.143	0.437	0.002***	0.376	0.007***
TA3	Ending hunger by 2025	0.361	0.013**	0.462	0.001***	0.290	0.033**	0.704	0.000***	0.436	0.002***	0.657	0.000***
TA4	Halving poverty through agriculture by 2025	0.140	0.348	0.513	0.001***	0.361	0.009***	0.328	0.025**	0.594	0.000***	0.560	0.000***
TA5	Boosting intra-African trade in agriculture commodities and services	0.175	0.239	0.412	0.004***	0.0317	0.825	0.429	0.003***	0.146	0.321	0.363	0.009***
TA6	Enhancing resilience to climate variability	0.381	0.008***	0.189	0.200	0.414	0.003***	0.509	0.000***	0.428	0.003***	0.498	0.000***
Performance category (C-Score)													
PC2.1	Public expenditures in agriculture	-0.007	0.961	0.375	0.001***	0.332	0.017**	0.252	0.087*	0.445	0.001***	0.418	0.002***
PC2.2	Domestic private sector investment in agriculture, agribusiness, and agroindustry	—	—	—	—	0.0508	0.723	—	—	—	—	0.313	0.026***
PC2.3	Foreign private sector investment in agriculture, agribusiness, and agroindustry	—	—	—	—	-0.030	0.835	—	—	—	—	0.075	0.601
PC2.4	Enhancing access to finance	-0.062	0.679	0.073	0.619	0.180	0.205	0.058	0.696	0.241	0.096*	0.322	0.021**
PC3.1	Access to agriculture inputs and technologies	0.273	0.063*	0.325	0.023**	0.365	0.008***	0.510	0.000***	0.578	0.000***	0.542	0.000***
PC3.2	Doubling agricultural productivity	0.001	0.996	0.089	0.542	0.163	0.254	0.090	0.547	0.054	0.714	0.219	0.123
PC3.3	Reduction of postharvest loss	0.260	0.077*	0.312	0.029**	0.139	0.331	0.329	0.024**	0.138	0.344	0.244	0.085*
PC3.4	Strengthening social protection	0.238	0.107	0.319	0.025**	0.108	0.451	0.522	0.000***	0.261	0.069*	0.571	0.000***
PC3.5	Improving food security and nutrition	0.261	0.076*	0.246	0.089*	0.336	0.016**	0.419	0.003***	0.243	0.092*	0.438	0.001***
PC3.6	Food safety	—	—	0.275	0.561*	0.121	0.399	—	—	0.299	0.037	0.465	0.001***
PC4.1	Sustaining agricultural GDP for poverty reduction	0.084	0.573	0.349	0.031**	0.242	0.087*	-0.011	0.939	0.150	0.369	0.419	0.002***

continued

Appendix

TABLE A2.4—CORRELATION BETWEEN RECOMMITTING TO CAADP PROCESS AND MUTUAL ACCOUNTABILITY AND PROGRESS MADE IN OTHER MALABO COMMITMENTS, 2015–2020

Label	Malabo thematic area, performance category, or indicator	CAADP process (T-Score)						Mutual accountability (T-Score)					
		First BR		Second BR		Third BR		First BR		Second BR		Third BR	
		Coef.	P value	Coef.	P value	Coef.	P-value	Coef.	P value	Coef.	P value	Coef.	P-value
PC4.2	Establishing inclusive PPPs for commodity value chains	0.303	0.039**	0.323	0.047**	0.226	0.110	0.515	0.000***	0.476	0.002***	0.464	0.001***
PC4.3	Creating jobs for youth in agricultural value chains	-0.017	0.908	0.355	0.029**	0.352	0.011**	0.171	0.250	0.253	0.125	0.355	0.011***
PC4.4	Women's participation in agribusiness	-0.042	0.776	0.235	0.156	0.206	0.146	-0.057	0.704	0.396	0.014**	0.373	0.007***
PC5.1	Tripling intra-African trade in agriculture commodities and services	-0.057	0.701	0.131	0.376	-0.188	0.186	0.159	0.287	-0.086	0.559	0.188	0.187
PC5.2	Establishing intra-African trade policies and institutional conditions	0.208	0.161	0.429	0.002***	0.309	0.027**	0.362	0.012**	0.295	0.042**	0.397	0.004***
PC6.1	Ensuring resilience to climate-related risks	0.222	0.134	0.098	0.511	0.339	0.015**	0.269	0.067*	0.375	0.009***	0.359	0.010***
PC6.2	Investment in resilience building	0.319	0.029**	0.302	0.039**	0.394	0.004***	0.457	0.001***	0.339	0.019**	0.551	0.000***
Indicator													
I2.1i	Public agriculture expenditure as share of total public expenditure	0.033	0.833	0.456	0.001***	0.368	0.008***	0.173	0.261	0.435	0.002***	0.352	0.011***
I2.1ii	Public agriculture expenditure as % of agriculture value added	-0.082	0.594	-0.172	0.265	0.096	0.505	0.211	0.169	0.105	0.496	0.147	0.302
I2.1iii	Official development assistance disbursed to agriculture as % of commitment	0.008	0.962	0.354	0.018**	0.259*	0.066*	-0.060	0.727	0.000	0.998	0.419	0.002***
I2.2	Ratio of domestic private sector investment to public investment in agriculture	-0.043	0.797	—	—	0.051	0.723	0.012	0.943	—	—	0.313	0.026**
I2.3	Ratio of foreign private direct investment to public investment in agriculture	0.135	0.413	—	—	-0.030	0.835	-0.192	0.242	—	—	0.075	0.601
I2.4	Proportion of men and women engaged in agriculture with access to financial services	-0.048	0.786	-0.096	0.566	0.180	0.205	0.031	0.864	0.187	0.259	0.322	0.021**
I3.1i	Fertilizer consumption (kilograms of nutrients per hectare of arable land)	0.054	0.723	0.025	0.893	0.190	0.181	0.059	0.701	0.415	0.018**	0.518	0.000***

continued

Appendix

TABLE A2.4—CORRELATION BETWEEN RECOMMITTING TO CAADP PROCESS AND MUTUAL ACCOUNTABILITY AND PROGRESS MADE IN OTHER MALABO COMMITMENTS, 2015–2020

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		First BR		Second BR		Third BR		First BR		Second BR		Third BR	
		Coef.	P value	Coef.	P value	Coef.	P-value	Coef.	P value	Coef.	P value	Coef.	P-value
I3.1ii	Growth rate of the size of irrigated areas from its value in the year 2000	0.078	0.627	0.080	0.652	0.054	0.705	0.055	0.732	-0.059	0.741	0.101	0.483
I3.1iii	Growth rate of the ratio of supplied quality agriculture inputs (seed, breed, fingerlings) to the total national input requirements for the commodity	0.266	0.209	-0.238	0.298	0.240	0.090*	0.435	0.034**	-0.171	0.460	0.184	0.195
I3.1iv	Proportion of farmers having access to agricultural advisory services	0.044	0.789	0.064	0.692	0.268	0.058*	0.160	0.324	0.495	0.001***	0.572	0.000***
I3.1v	Total agricultural research spending as a share of agricultural GDP	-0.020	0.909	-0.041	0.801	0.201	0.157	0.160	0.350	0.165	0.301	0.204	0.152
I3.1vi	Proportion of farm households with ownership or secure land rights	-0.229	0.208	-0.094	0.597	0.234	0.098*	-0.148	0.420	0.227	0.196	0.191	0.180
I3.2i	Growth rate of agriculture value added, in constant US dollars, per agricultural worker	0.122	0.520	0.086	0.752	0.196	0.167	-0.139	0.464	-0.142	0.599	0.0572	0.690
I3.2ii	Growth rate of agriculture value added, in constant US dollars, per hectare of agricultural arable land	0.049	0.756	0.101	0.617	0.129	0.369	-0.064	0.687	-0.156	0.429	0.094	0.511
I3.2iii	Growth rate of yields for the national priority commodities	-0.119	0.496	-0.193	0.344	0.008	0.954	-0.017	0.921	-0.034	0.867	0.327	0.019**
I3.3	Reduction rate of postharvest losses for (at least) the 5 national priority commodities	-0.560	0.191	-0.077	0.813	0.139	0.331	0.422	0.345	-0.238	0.455	0.244	0.085*
I3.4	Budget lines (%) on social protection as percentage of the total resource requirements for coverage of the vulnerable social groups	0.282	0.163	-0.162	0.420	0.108	0.451	0.644	0.000***	0.061	0.761	0.571	0.000***
I3.5i	Prevalence of stunting (%) among children under 5 years old	-0.252	0.128	-0.424	0.044**	0.078	0.589	0.005	0.974	0.049	0.822	0.285	0.043**
I3.5ii	Prevalence of underweight (%) among children under 5 years old	-0.076	0.643	0.030	0.905	0.0706	0.622	-0.258	0.112	-0.135	0.594	0.199	0.162

continued

Appendix

TABLE A2.4—CORRELATION BETWEEN RECOMMITTING TO CAADP PROCESS AND MUTUAL ACCOUNTABILITY AND PROGRESS MADE IN OTHER MALABO COMMITMENTS, 2015–2020

Label	Malabo thematic area, performance category, or indicator	CAADP process (T-Score)						Mutual accountability (T-Score)					
		First BR		Second BR		Third BR		First BR		Second BR		Third BR	
		Coef.	P value	Coef.	P value	Coef.	P-value	Coef.	P value	Coef.	P value	Coef.	P-value
I3.5iii	Prevalence of wasting (%) among children under 5 years old	-0.040	0.807	-0.097	0.622	0.336	0.016**	-0.304	0.056*	-0.061	0.758	0.157	0.272
I3.5iv	Proportion of the population that is undernourished	0.109	0.552	0.164	0.515	0.453	0.001***	-0.025	0.890	0.442	0.066	0.458	0.001***
I3.5v	Growth rate of the proportion of women who meet the requirements for minimum dietary diversity for women	0.143	0.760	0.382	0.526	-0.207	0.146	0.027	0.954	-0.049	0.937	0.033	0.821
I3.5vi	Proportion of 6- to 23-month-old children who meet the requirements for a minimum acceptable diet	0.026	0.887	-0.583	0.099*	0.085	0.554	-0.092	0.612	-0.474	0.197	0.049	0.731
I3.5vii	Prevalence of moderate and severe food insecurity in the population	—	—	-0.063	0.829	0.174	0.222	—	—	0.010	0.972	0.317	0.023**
I3.6i	Food Safety Systems Indicator	—	—	0.371	0.010**	0.135	0.346	—	—	0.443	0.002***	0.577	0.000***
I3.6ii	Food Safety Health Indicator	—	—	-0.288	0.262	0.030	0.835	—	—	-0.300	0.242	0.134	0.349
I3.6iii	Food Safety Trade Indicator	—	—	—	—	0.093	0.515	—	—	—	—	0.211	0.137
I4.1i	Growth rate of agriculture value added	0.066	0.660	0.411	0.072*	0.136	0.342	-0.004	0.978	0.228	0.334	0.272	0.053*
I4.1ii	Agriculture contribution to overall poverty reduction target	—	—	—	—	—	—	—	—	—	—	—	—
I4.1iii	Reduction rate of poverty head count ratio at national poverty line (% of population)	0.147	0.631	0.134	0.774	0.104	0.469	-0.181	0.555	0.513	0.239	0.314	0.025**
I4.1iv	Reduction rate of poverty head count ratio at international poverty line (% of population)	-0.136	0.798	0.189	0.760	0.006	0.965	-0.355	0.490	0.140	0.822	0.389	0.005***
I4.1v	Reduction rate of the gap between the wholesale price and farmgate price	0.163	0.457	-0.408	0.315	0.249	0.078*	0.021	0.923	-0.637	0.089*	0.221	0.119
I4.2	Number of priority agricultural commodity value chains for which a PPP is established with strong linkages to smallholder agriculture	0.217	0.142	0.258	0.301	0.226	0.110	0.460	0.001***	0.529	0.024**	0.464	0.001***

continued

Appendix

TABLE A2.4—CORRELATION BETWEEN RECOMMITTING TO CAADP PROCESS AND MUTUAL ACCOUNTABILITY AND PROGRESS MADE IN OTHER MALABO COMMITMENTS, 2015–2020

Label	Malabo thematic area, performance category, or indicator	CAADP process (T-Score)						Mutual accountability (T-Score)					
		First BR		Second BR		Third BR		First BR		Second BR		Third BR	
		Coef.	P value	Coef.	P value	Coef.	P-value	Coef.	P value	Coef.	P value	Coef.	P-value
I4.3	Percentage of youth engaged in new job opportunities in agricultural value chains	-0.185	0.410	0.345	0.072	0.352	0.011**	-0.145	0.520	0.064	0.745	0.355	0.011**
I4.4	Proportion of rural women who are empowered in agriculture	-0.181	0.459	0.364	0.126	0.206	0.146	0.064	0.793	0.499	0.029**	0.373	0.007***
I5.1	Growth rate of the value of trade in agricultural commodities and services within Africa	-0.110	0.571	0.085	0.666	-0.188	0.186	0.072	0.710	-0.288	0.137	0.188	0.187
I5.2i	Trade Facilitation Index	-0.077	0.659	-0.146	0.321	0.400	0.004***	-0.036	0.836	-0.024	0.870	0.446	0.001***
I5.2ii	Domestic Food Price Volatility Index	0.287	0.112	-0.093	0.632	0.022	0.881	0.036	0.845	-0.072	0.709	0.129	0.367
I6.1i	Percentage of farm, pastoral, and fisher households that are resilient to climate- and weather-related shocks	-0.164	0.503	0.079	0.708	0.292	0.038**	-0.293	0.224	0.532	0.006***	0.398	0.004***
I6.1ii	Share of agricultural land under sustainable land management practices	-0.222	0.239	-0.082	0.655	0.272	0.054*	-0.049	0.797	0.063	0.732	0.195	0.170
I6.2	Existence of government budget lines to respond to spending needs on resilience-building initiatives	0.319	0.029**	0.358	0.015**	0.394	0.004***	0.457	0.001***	0.359	0.014**	0.551	0.000***

Source: Authors' calculations based on AUC (2018, 2020, and 2022).
Note: ***, **, and * represent statistical significance at the 1%, 5%, and 10% level, respectively. — = data not available.

CHAPTER 3

Food System Diagnostics and Policy Implications: The Malawi Case

Greenwell Matchaya and Paul Guthiga

Introduction

Food systems are at the heart of Africa's economic growth and development plan, Agenda 2063: The Africa We Want. Without ending hunger and improving the food and nutrition status of Africa's population, the agenda's first aspiration for a "prosperous Africa based on inclusive growth and sustainable development" cannot be effectively reached. To realize this aspiration, African countries need to progressively implement the seven Comprehensive Africa Agriculture Development Program (CAADP) Malabo commitments while having strategies to address wider food system challenges (AU 2023). The concept of a food system has various definitions, but for the purposes of this chapter, a food system is considered as a network of actors or players and their activities along the entire food value chain from inputs to production, distribution, and consumption. This aligns with the definition espoused by the Scientific Group of the UN Food Systems Summit (UNFSS), that food systems are constitutive of food actors and their interlinked activities from production all the way to consumption or utilization (von Braun et al. 2020).

Food systems in Africa are currently under pressure due to climate change, conflict, low productivity, rising population, changing diets with rapid urbanization, and external shocks, among other factors. The continent is not on track to achieving the Malabo target on zero hunger by 2025. Currently, the number of people facing food insecurity and the number of undernourished remain high. While some positive progress was made in reducing the number of food-insecure people in the period between 2000 and 2014, the trend has since reversed; for example, between 2016 and 2019, the prevalence of food insecurity was stabilizing in Africa, although the proportion remained the highest in the world. By 2019, the number of moderately or severely food-insecure people in the continent was 658 million. This increased to 750.9 million and further up to 794.7 million in 2020 and 2021. The prevalence of undernourishment in Africa remains high at 20.2 percent compared to the world average of 9.8 percent in 2021 (FAO et al. 2022).

Understanding the complexity of food systems and designing and implementing effective policies and programs in a coordinated way can help achieve at least 12 of the 17 Sustainable Development Goals (UNEP 2016). The complexity of food systems combined with their multifaceted impacts on human and environmental health has made it difficult for policymakers to target a specific challenge in the food systems (Herforth et al. 2022). To overcome such difficulty, policymakers must rely on food system diagnostics to identify critical leverage points for intervention and guide their policy decisions.

Food system diagnostics are a systematic analysis and assessment of various components and interdependencies within a food system. The process involves identifying the main components within a defined context and assessing their functionality, with specific focus on linkages and interdependences, which are usually complex and dynamic. The assessment goes further to highlight strengths, weaknesses, and challenges in a country's food system. By understanding the complex dynamics of a food system and evaluating the implications of related policies, stakeholders can identify food system policy gaps, determine achievable targets, promote sustainable agricultural practices, and explore existing opportunities for food system transformation (Rockefeller Foundation et al. 2021b). In Africa, the food systems discourse has recently had three important phases:

1. *Prior to 2021 UNFSS*, several countries (including Malawi) undertook country-level dialogues, conducting stakeholder engagements at regional, continental, and global levels.
2. *At the UNFSS itself*, countries made commitments to undertake food system transformation. After the UNFSS, the UN's priority action is for countries to develop and implement national pathways to the year 2030 for food system transformation.
3. *After the UNFSS*, there have been calls for development of robust mechanisms for tracking progress in food system transformation in the continent.

Given this recent historical context, where would food system diagnostics play a critical role in food system transformation? Food system diagnostics could potentially play an essential role in shaping food system transformation strategies at the country level as well as benchmarking food system changes. Diagnostics can help identify critical drivers of food system transformation and identify critical indicators for tracking changes in food system transformation in the country. Several African countries— including Ghana, Malawi, and Rwanda—undertook food system diagnostics to address the country's complex food systems challenges and developed long-term visions to transform their food systems. These were conducted in the period leading up to the UNFSS in 2021 under the Food System Transformative Integrated Policy (FS-TIP) initiative. The initiative developed a toolkit that guides users to conduct a landscaping and diagnostic analysis of a country's food system to generate a thorough, systematic, and comprehensive overview of a national food system. This overview then forms the basis from which policymakers and other stakeholders can map their food system transformation agenda through integrated policies and investment programs.

Though essential for greater accountability toward healthier and more environmentally friendly food systems, there are very few robust food system diagnostics and policy assessments currently being conducted. Lack of data and information on these components and their functions makes it difficult to assess the current state of food systems properly (Sokourenko et al. 2022). Furthermore, opportunities and challenges unique to a particular country or region can be difficult to effectively identify and address. It is often especially challenging to gain an accurate view of the underlying biological and ecological systems, as well as to quantify the various socioeconomic and cultural factors that impact food production, processing, distribution, purchasing, and consumption (Herforth et al. 2020). Moreover, these complexities are further compounded by power dynamics at play, such as the disparity in wealth and access between small-scale producers, large-scale commercial distributors, and both wholesalers and retailers. Therefore, the development of appropriate and adequate diagnostics and assessments is essential not only for assessing the performance and sustainability of food systems but also for ensuring proper accountability toward enhancing the nutritional sustainability and low environmental impact of food systems. The most recent comprehensive food systems diagnostics assessments were conducted under the FS-TIP initiative but were limited to three countries (Ghana, Malawi, and Rwanda). Lessons gained from these assessments can be useful to other countries that intend to carry out such assessments in the future.

Using the case study of food system diagnostics undertaken in Malawi under the FS-TIP initiative, this chapter aims to demonstrate the role of food system diagnostics informing policy options to guide food systems transformation. The specific objectives of the chapter are (1) to illustrate the importance and pivotal role of diagnostics in guiding food systems transformation initiatives, particularly around the policy aspects; (2) to use Malawi as a case study illustrating how diagnostics were crucial to shaping the country's food systems initiatives; and (3) to review the country-level experiences, challenges, and lessons learned during the FS-TIP work in Malawi.

Conceptual Framework for Guiding Food System Diagnostics

Food systems are complex, interconnected networks of actors involving producers, processers, distributors, retailers, consumers, and policymakers. All components of a food system interact to produce food while also considering environmental, economic, and social impacts (Ericksen 2008). Food systems ultimately aim at providing a safe, nutritious, and accessible food supply to everyone. A "food systems approach" has gained increased prominence as it is a key component in addressing global challenges such as food security, nutrition, climate change, biodiversity loss, and social inequalities. According to Rockefeller Foundation and others (2021b), this calls for an integrated approach to ensure the linkages between the different components of the food system are effectively monitored, understood, and leveraged. A food systems approach ensures that there is continuous engagement and collaboration across different stakeholders among food systems actors, without leaving behind those most affected by food insecurity (Bortoletti and Lomax 2019). This enhances the capability of sustainable food system to efficiently respond to local and domestic circumstances and global challenges.

Given the nature of food systems, food system diagnostics require a systems thinking, holistic approach by considering various interconnected components within and across production, processing, distribution, consumption, and waste management as well as their interactions with social (that is, culture and traditions) and climate-environment ecosystems. This uncovers the interdependencies and complexities within the system and thereby helps to identify integrated interventions and promote broad stakeholder engagement. It promotes collaboration and dialogue that leverages each stakeholder's resources and capacities addressing food system challenges, fostering collective action for transformative change. It helps bridge the gap between scientific knowledge, local context, and policy implementation, facilitating evidence-based decision-making and fostering sustainable food system transformations. Diagnostics also help identify vulnerabilities to shocks and stresses such as climate change, natural disasters, or socioeconomic disruptions and enables the development of strategies to build a more resilient and sustainable food system. Diagnostics establish baseline data and indicators to monitor and evaluate the performance of the food system over time. The process helps track progress, measure the impact of interventions, and identify areas that require further attention or adjustment.

Food system diagnostics involve an iterative process with multiple stakeholders at country level. They encompass both qualitative and quantitative processes that aim to identify priority challenges and game-changing solutions to transform the food system to deliver on desired outcomes. The process starts by assessing country performance to identify the main food systems challenges and potential transformative solutions that are then validated by stakeholders. The identified challenges and solutions are then analyzed in detail and aligned with country stakeholders. This diagnostics process enables country stakeholders to broadly assess their food systems, identify drivers of change, prioritize key challenges, and develop innovative solutions. It also identifies indicators for measuring food system transformation from the lowest level to the highest, referred to as *supra-indicators*.

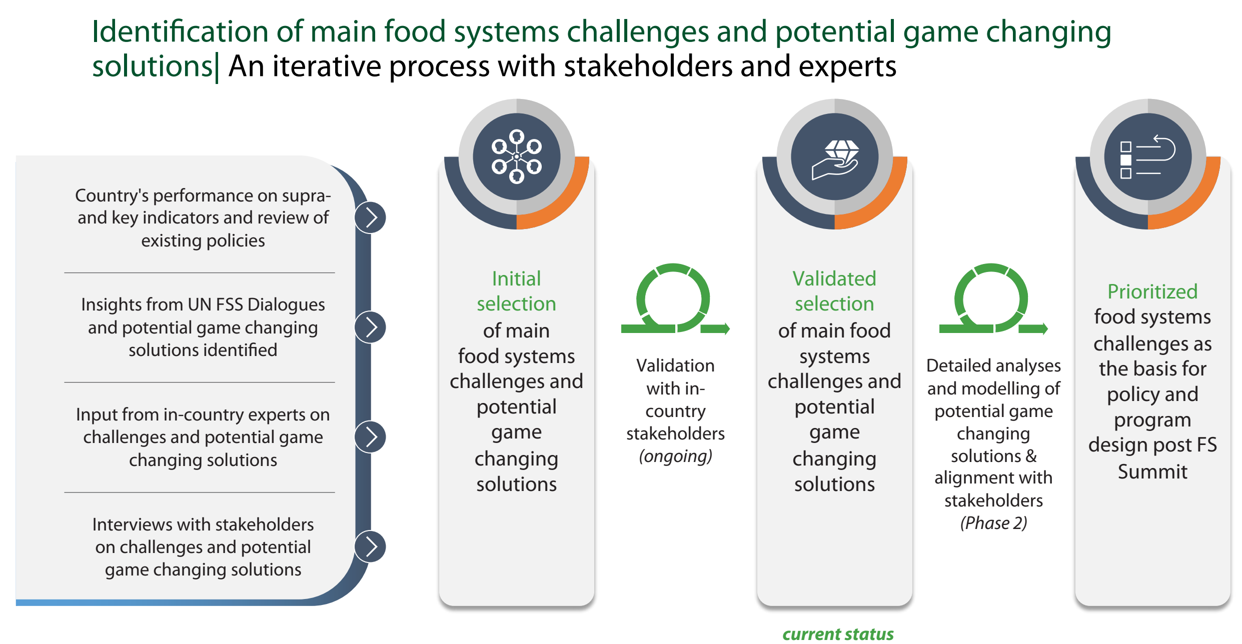
The diagnostics process also benefited from feedback from various local experts and stakeholders across Malawi's food systems, including the Ministry of Agriculture, Ministry of Health, Ministry of Trade, Farmers Union of Malawi, the Agricultural Development and Marketing Board (ADMARC), and others. The FS-TIP initiative also supported a team of local researchers to identify key challenges and draw out recommendations on food system strengthening. The FS-TIP program management office and an advisory committee provided guidance and overall coordination in the food system diagnostics process. Thus, the diagnostic analysis was informed by extensive research and feedback, and the identification of the main food systems challenges and potential game-changing solutions was therefore largely an iterative process with stakeholders and experts.

The processes involved in the diagnostics are summarized in Figure 3.1, and key steps in the analysis are described in the sections that follow.

Methodology of the Food System Transformative Integrated Policy

To undertake the food systems diagnostics and policy implications in Malawi, a series of steps were undertaken by a large coalition of diverse stakeholders. The research process followed a five-part qualitative framework adapted from the Food Systems Dashboard, examined 22 quantitative supra-indicators across the five UNFSS action tracks, and included an exercise in stakeholder and policy landscaping (GAIN 2023). The research from these steps was further complemented by emerging insights from the national, regional, and district Food Systems Summit Dialogues that took place to articulate food systems transformation gaps and potential ways to address them.

FIGURE 3.1—SUMMARY OF THE PROCESS OF DIAGNOSTICS IN MALAWI



Source: Rockefeller Foundation et al. (2021a).

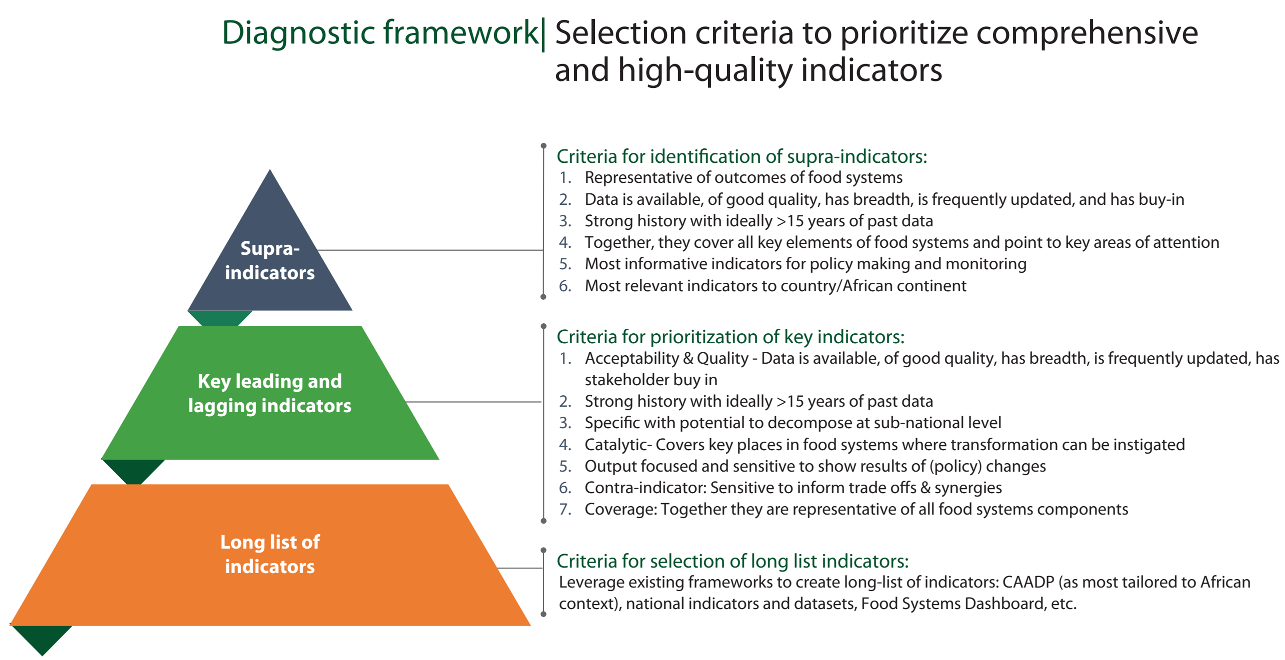
Qualitative and Quantitative Diagnostics

The qualitative aspect of the diagnostics used qualitative discussions with stakeholders on external drivers of the food system, the nature of food supply chains, food and the environment, and consumer characteristics, as well as cross-cutting issues such as gender, youth, and human rights. These qualitative discussions were held throughout the subnational and national stakeholder consultations (see Rockefeller Foundation et al. 2021a).

Under the quantitative component, the food systems diagnostic analysis was structured along three levels on indicators and aligned to the UNFSS action tracks and action areas for their outcome orientation. At the highest level, supra-indicators reflect desired outcomes of food systems transformation that are representative of the UNFSS action tracks. The research involved selecting and analyzing four to five supra-indicators per UNFSS action track that represent outcomes of food systems transformation and key cross-cutting elements such as governance, to enable easy assessment of the country's status and main areas of attention. The second level of indicators, referred to as *leading and lagging indicators*, enable identification of main high-level drivers for good or bad performance on food systems transformation. The leading indicators are drivers of supra-indicators, while the lagging indicators show the effects of supra-indicators on the population, environment, and other factors. The third level, *other indicators*, represent intermediary parameters across all components of the food system. These were analyzed to provide a granular view of outcomes and drivers of food systems transformation. To source indicators, the analysis used existing resources such as CAADP, the Food Systems Dashboard, and national policies (Rockefeller Foundation et al. 2021a). Stakeholder input helped to identify the interdependencies, feedback loops, and trade-offs between indicators by linking supra-indicators to key leading and lagging indicators as well as linking the quantitative results to the qualitative considerations. Figure 3.2 summarizes the selection of indicators process.

The criteria described in Figure 3.2 led to the identification and prioritization of 22 supra-indicators, with 21 identified across the food system tracks and one identified as cross-cutting (Table 3.1). Importantly, while diagnostics can be done at the national level, a complete picture would require gathering, analyzing, and presenting data that can be disaggregated at a much more granular level. For example, disaggregating data on supra-indicators for regions, income groups, genders, and age levels would allow narrowing in on those areas that require the most attention and developing tailored policy interventions. Following the

FIGURE 3.2—THE SELECTION CRITERIA FOR FOOD SYSTEMS INDICATORS FOR EXAMINATION



Source: Rockefeller Foundation et al. (2021a).

identification of indicators, the analysis involved collecting data in collaboration with national experts, leveraging national databases as well as stakeholder consultations and a review of literature, followed by an analysis of data gaps. The Malawi diagnostic analysis built a data- and information-base that is as comprehensive as possible, with a recognition of its limitations in terms of indicator and data availability. The diagnostics identified these gaps and proposed solutions to close them in a prioritized and cost-efficient manner.

Analysis of Policy Gaps

In addition to the qualitative and quantitative analyses, the diagnostic process involved a further analysis of the policies relevant for the delivery of food systems to identify policy areas that would need reinforcement or revisions for food system strengthening. This process examined policies at the international, continental, regional, national, and subnational levels in the context of the key food system elements as well as the five UNFSS action tracks. Policies were mapped to assess coverage and alignment with food systems components of the UNFSS action tracks. The analysis highlighted potential gaps or conflicts between policy areas and identified potential policy implications.

Stakeholder Engagement

For the diagnostic process results to be useful, securing buy-in from key stakeholders within the country is essential. The key government ministries, departments, and agencies must see the need for these assessments and must understand why the systems approach is useful as compared to the previous siloed approaches to the appraisal of food security. In the Malawi case, the researchers and collaborators held many meetings with the minister of agriculture, department heads of many ministries, and other leaders from the agriculture, health, energy, and water sectors to secure buy-in and cocreate steps in the assessment process. These steps ensured local buy-in.

The assessment involved a wide range of food system stakeholders and actors that can largely be grouped into six constituencies: (1) private sector actors such as farmers, food manufacturers, traders, retailers, food services, input suppliers, processors, transporters, retailers, and consumers; (2) public institutions, including policymakers at various levels of government in various ministries, departments, government-owned institutions, and agencies; (3) development partners; (4) civil society organizations; (5) research organizations; and (6) farmer organizations. Food system diagnostics must involve these constituencies for the results to reflect reality and be put to use.

Results

The results presented here include three key areas covered by the food system diagnostics: (1) Malawi's status on the 22 supra-indicators, (2) key food systems challenges emerging from the analysis, and (3) policy gaps and their implications for Malawi. Results from additional analysis carried out under FS-TIP, including high-level syntheses of the food systems elements drawing from the qualitative analysis, are provided in Rockefeller Foundation and others (2021a).

Malawi's Performance on Supra-Indicators

Table 3.1 presents the status of the food system as summarized by the current values of the supra-indicators. Indicators are organized according to the five UNFSS action tracks.

Access to Safe and Nutritious Food for All

Supra-indicators related to the UNFSS action track on ensuring access to safe and nutritious food for all include measures of diet quality and nutrient supply, undernourishment and overnourishment, and food safety. The Food Consumption Score measures diet quality by aggregating household-level data on diversity and frequency of food groups, weighting according to the relative nutritional value. On this indicator, Malawi scores "poorly" (1 percent) and "borderline" (16 percent). Most Malawians do not have an adequately diverse diet, with 70 percent of dietary energy derived from cereals, roots, and tubers (GAIN 2023). This is largely due to overreliance on maize cultivation, which reduces production and availability of nutrient-rich foods (such as fruits and vegetables) and increases their prices.

Nutrient supply is measured by the net supply of key macro- and micronutrients as a share of total consumption requirements for a healthy diet. There is inadequate supply of macro- and micronutrients because maize is the predominant crop grown, with limited farming of nutritious legumes and livestock, thus limiting their availability and increasing the cost of a nutrient-adequate diet (see the supra-indicator on affordability). There are also limited imports to fill dietary gaps and high levels of food loss along the value chain, resulting in part in the population not having access to a diverse diet (GAIN 2023).

TABLE 3.1—CURRENT STATUS OF MALAWI'S FOOD SYSTEM CAPTURED IN SUPRA-INDICATORS

Action tracks	Supra-indicators	Indicative source	Unit	Malawi	Sub-Saharan Africa	World
1. Ensure access to safe	**Diet quality:** Food Consumption Score	WFP CFSVA	%	Poor: 1 Borderline: 16	97.3	86.5
	Nutrient supply: Net supply in country of key macro- and micronutrients as a share of total consumption requirements for a healthy diet	National Survey		Nutrient gaps	43.9	47.0
	Undernourishment: % of population undernourished	World Bank	%	18.8	24.1	8.9
	Overweight and obesity: % of population overweight or obese (adult population)	WHO	%	20.1	41.7	39.1
	Food safety: Food Systems Safety Index	WHO	Index (0–100)	66.7		75.3
2. Shift to sustainable consumption patterns	**Affordability:** Cost of a healthy diet as a percent of household food expenditure	FAO-SOFI	%	219		95
	Sustainability of diets: Per capita GHG emissions of food consumption	WWF	Kg CO2eq./person	1,369		2,603
	Food waste: Food Waste Index	UNEP	Kg/capita/year	146.0	120-170	121
	Food environment: Composite index combining food environment policies	WHO NCD Monitor	Index (0–14)	3		n.a.
3. Boost nature-positive production	**Emissions:** GHG emissions from agriculture	Climate Watch	MtCO2e	7.5		30.1
	Land: Average % forest land being deforested for agriculture use over past 3 years	World Bank, Forest Watch	%	0.55		0.17
	Food loss: % food loss across supply chain	National sources	%	15		5
	Regeneration: Biodiversity and habitat index	BHI	%	50.7		54.5
4. Advance equitable livelihoods	**Income**: Gini coefficient (specific) based on incomes across the food system	National survey	Coefficient (0–1)	0.45	0.442	n.a.
	Income: Gap between farmgate price and wholesale price	CAADP Biennial Review	%	68	n.a.	n.a.
	Gender equity: Women's Empowerment in Agriculture Index	IFPRI	Index (0–1)	0.84	n.a.	n.a.
5. Build resilience to vulnerabilities, shocks and stress	**Economic:** Household Resilience Capacity Index	National survey	Index	0.26	n.a.	n.a.
	Risk distribution: Proportion of men and women engaged in agriculture with access to macro- and microcredit financial services	CAADP Biennial Review	%	12	n.a.	n.a.
	Social: Government social security budget as a % of total requirements to cover vulnerable social groups	CAADP Biennial Review	%	87.0	n.a.	n.a.
	Environmental: ND-GAIN Country Index	ND-GAIN	Index (0–100)	35.2		49.0
	Production diversity: % production from top 5 crops	FAO	%	75	n.a.	n.a.
	Governance: Presence of food systems–related governance bodies and mechanisms	National policies	Index (0-16)	3	n.a.	n.a.

Source: Rockefeller Foundation et al. 2021a.

Note: n.a. = not applicable; ND-GAIN = Notre Dame Global Adaptation Initiative; WFP CFSVA= World Food Program, Comprehensive Food Security & Vulnerability Analysis; WHO= World Health Organization; FAO-SOFI= Food and Agriculture Organization- The State of Food Security and Nutrition in the World; WWF=The World Wide Fund for Nature; Kg CO2eq= kilograms of carbon dioxide equivalent; UNEP= United Nations Environmental Program; NCD = noncommunicable diseases; MtCO2e= Metric Tons of Carbon dioxide equivalent; EPI= Environmental Performance Index; BHI = Biodiversity and habitat index.

Undernourishment has been on the rise from 17 percent in 2014 to 19 percent in 2018 due to food insecurity affecting 52 percent of Malawians. For children, 23 percent of all child deaths are related to undernutrition, with 39 percent of children under 5 years old considered stunted while 4 percent suffer from acute malnutrition. Among younger children, only 60 percent of children younger than 6 months old are exclusively breastfed, and 8 percent of children ages 6–23 months consume a minimum acceptable diet (GAIN 2023). One driver of this undernourishment is the fact that subsidized maize production and tobacco cultivation for export reduce supply, availability, and affordability of more nutritious produce. Potential interventions include providing subsidies for farming nutritious and/or biofortified food (such as livestock, fruits, and vegetables) along with resilience and soil management support through agricultural programs such as the Affordable Input Program (AIP) to increase availability and affordability of nutritious food. Collaboration between ministries to sponsor targeted behavior change communication to drive desired nutrition, hygiene, and other health practices should be encouraged.

The percentage of the adult population considered overweight or obese is estimated at 20.1 percent. Although Malawi's obesity rates are lower than regional rates, both adult and child obesity are rising steadily by about 8 percent compound annual growth rate from 2010 to 2016 (GAIN 2023). Specifically, 13 percent of children and adolescents, 25 percent of women, and 15 percent of men are overweight or obese, with higher prevalence in urban areas than rural areas. One key driver of overweight and obesity is rising urbanization, with increased sedentary behaviors and less consumption of own-grown food in urban areas. The rising overweight and obesity rates are linked to rising rates of diet-related noncommunicable diseases such as diabetes (which increased from 4.6 percent of adults in 2000 to 6.3 percent in 2014) and high blood pressure (which increased from 26.5 percent of adults in 2000 to 28.7 percent in 2015), contributing to Malawi's overall disease burden.

Although food safety has improved in recent years, there are still substantial gaps to reach global standards, as illustrated by Malawi's low performance on the Food Systems Safety Index (66.7 percent) as compared to the world average (75.3 percent). There is no nationwide strategy for food safety control (Morse et al. 2019), and there is inadequate monitoring of food standards. Malawi has an extensive food regulatory framework of policies and standards, but it is fragmented and lacks harmonization, with oversight of food safety issues shared among six ministries. A food safety act is currently being developed within the Ministry of Health. Food safety challenges are partly attributable to limited collaboration across departments and ministries due to overlaps in departments and mandates. The quality of inspection services is impacted by underresourcing of food inspectors and lack of guidance and consistency (Rockefeller Foundation et al. 2021a). Surveillance of foodborne disease is constrained by underdeveloped infrastructure and limited research on the bacteriological and chemical contamination of food. However, significant steps have been made in surveillance of aflatoxins due to their major impact on both trade and health.

The resulting high levels of food loss, food waste, and increasing disease burden (such as liver cancer associated with aflatoxins) have economic and health costs to the population. In the absence of an integrated approach to food safety regulations, enforcement, and public awareness and mindset, foodborne diseases will continue to lower the quality of life for people in Malawi, affecting overall productivity and well-being.

Sustainable Consumption Patterns

The UNFSS action track on shifting to sustainable consumption patterns is represented by indicators on food affordability, diet sustainability, food waste, and the food environment. The cost of a healthy diet is estimated at 219 percent of average household food expenditure, suggesting that a healthy diet is very costly and out of reach for many Malawians. The drivers include a relatively high share of cereal farming, with 70 percent of Malawians cultivating maize while only 25 percent and 45 percent farm fruits and livestock, respectively, thus impacting supply and affordability of more nutritious food (Rockefeller Foundation et al. 2021a). Foods typically come from own production—which relies on small land parcels and low-yield agriculture practices—or are bought from markets constrained by poor infrastructure. Many farmers' low incomes limit purchasing power and ability to buy products when own production is insufficient. Malawians spend up to 65 percent of income on food, mainly on cheaper cereals, roots, and tubers (the source of 70 percent of dietary energy), which are less nutritious than the costlier animal-source foods (ASF), legumes, fruits, and vegetables. In addition to promoting agricultural diversification for export, there is need to promote diversification for domestic consumption. It is also important to educate communities on the benefits of cultivating and consuming indigenous nutrient-dense foods such as beans and to encourage farming of nutritious and/or biofortified foods (for example, via the AIP subsidy program or tax credits) to increase supply and affordability.

Fresh food waste is a health and urban management problem in Malawi. The UNEP Food Waste Index shows that Malawi wastes more food per capita than the global average despite high levels of food insecurity. The drivers include poor home storage practices leading to rodent and weevil infestation and/or rotting (GAIN 2023). There is also a prevalence of traditional open-air markets, which produce more waste than modern markets. Among modern markets, the few large retail outlets have very high levels of food wastage, especially of fruits and vegetables. However, there is lower food wastage in rural areas than urban areas due to subsistence farming and the prevalence of eating own-grown food in rural areas. In the city of Blantyre (GAIN 2023), the city council transports the waste from markets to a composting facility where it is turned into rich, organic compost eventually sold to farmers.

As suggested by Malawi's relatively low performance on the composite index combining food environment policies (the Healthy Food Environment Policy Index), there is an opportunity to strengthen Malawi's food environment, as it currently has few policies that encourage consumption of sustainable and healthy diets. Malawi has no restrictions on marketing junk food and nonalcoholic beverages to children. There is also no policy to reduce consumption of salt/sodium and saturated fatty acids. However, it has provisions guiding the marketing of breastmilk substitutes. Interventions could be focused on filling current gaps in food environment policies by reducing tax on healthy foods and increasing tax on unhealthy foods, as well as by restricting the promotion of unhealthy foods to children. Developing consumer guidance mechanisms to help consumers make informed choices could also be worthwhile.

Nature-Positive Production

Current status regarding the UNFSS action track on boosting nature-positive production is measured through indicators on greenhouse gas (GHG) emissions from agriculture, deforestation, food loss, and biodiversity and habitat regeneration. Malawi's agriculture-related GHG emissions are lower than the world averages but have been rising steadily since 2000. Agriculture contributes 40 percent of GHG emissions (Rockefeller Foundation et al. 2021a) in Malawi. Drivers include indiscriminate use of fertilizer due to highly subsidized availability of this input, limited knowledge among farmers and extension workers, and an increase in conventional farming (tillage) that releases carbon into the air. However, GHG emissions are moderated by generally short transport distances for food consumed (World Bank 2017) and low farming of animal products, which tend to have higher environment impact. As Malawi shifts toward commercialized agriculture, it must consider the long-term sustainability within the food system. To boost efficient, nature-positive production, pathways include investments in sustainable ASF as well as increasing the efficiency of fertilizer usage.

Agriculture is the leading cause of deforestation in Malawi—in 2019, 90 percent of deforestation was driven by agriculture (GAIN 2023). Forest cover reduced from 47 percent in 1975 to 25 percent in 2018 (World Bank 2017), the highest deforestation rate in the Southern African Development Community region. Drivers include the growing population that is overdependent on agriculture and seeking to expand small land holdings, as well as floods and droughts that lead to soil depletion and drive farmers to clear more land. Although Malawi has a Forestry Act to guide the proper use of forest land, 95 percent of the population is unaware of the act and the importance of forests (World Bank 2017). One of the key solutions to addressing deforestation is to improve the productivity of existing land to reduce the drivers of deforestation, as well as developing other industries to reduce overdependence on agriculture, increasing awareness about the importance of forests, and training farmers on income-increasing opportunities in conservation agriculture and agroforestry.

Malawi is ranked 37 out of 53 African countries on the Biodiversity and Habitat Index (Rockefeller Foundation et al. 2021a). Drivers of biodiversity and habitat loss include deforestation, lack of awareness of the benefits of biodiversity to farmers, and excessive use of pesticides that kill pollinators. While agriculture remains crucial to Malawians, its sustainability and productivity is integrated with the level of biodiversity in the country. Without registering and preserving biodiversity, Malawi risks a reduction in diversity of food and medicinal plants, and an overall less resilient food system. There is a need for investments in eco-friendly technologies and improved articulation and socialization of biodiversity goals.

Malawi's rate of food loss across the supply chain is higher than the world average, with farmers losing from 15 to 50 percent of their hard-earned yields to pests and decay (GAIN 2023). Drivers include poor food storage and handling, limited testing infrastructure resulting in aflatoxins in key foods, and low-quality agricultural infrastructure such as low electrification and a poor transportation system. High levels of food loss in Malawi raise food insecurity, decrease dietary diversity by discouraging the production of nutrient-rich perishable foods, and waste resources, thereby putting an unnecessary burden on the environment. Possible interventions include sustainable investment in storage, electricity, and logistics infrastructure, as well as better education of farmers, middlemen, and processors on loss prevention practices.

Equitable Livelihoods

The UNFSS action track on advancing equitable livelihoods is represented through indicators on income inequality and gender equity. Malawi's Gini coefficient based on incomes across the food system is estimated at 0.45, indicating higher inequality than the sub-Saharan Africa average of 0.44. The Malawi

Livelihood Baseline Profiles carried out by the Famine Early Warning Network (FEWS-NET 2016) recognizes four income profiles: "very poor," "poor," "middle," and "better off." Throughout the country, 64 percent of rural Malawians are found in the bottom two wealth groups. The drivers include low-productivity and limited value-added agriculture (due to crude agricultural techniques and limited use of improved inputs) that is the main income source for the majority of the population, combined with a lack of income-generating opportunities outside farming in rural areas (GAIN 2023).

Malawi shows a limited gap between farmgate and retail prices, with a price difference 45 percent smaller in Malawi than price differences in other African countries, likely related to government intervention (World Bank 2017) around setting price floors for farmgate maize and price ceilings for retailing. Although ADMARC (the national maize aggregator) works to maintain these price floors and ceilings, private-sector activities—buying maize from ADMARC and reselling at a markup in markets—often leads to price ceilings being exceeded. Maize price volatility is still a challenge in Malawi despite government intervention. This causes fluctuations in food insecurity levels based on the maize season. Potential interventions include deploying maize market interventions at the optimum time and frequency to counteract seasonal price changes.

Gender equity is measured through the Women's Empowerment in Agriculture Index (WEAI) developed by the International Food Policy Research Institute. Malawi's WEAI score is 0.84 on a scale from 0–1, with higher scores indicating greater empowerment and gender parity. Although an average WEAI score for Africa is not available, Malawi's score was classified as medium in a 2014 study of 13 African and non-African countries (Malapit et al. 2014). About 57 percent of Malawian women are agricultural landowners. According to GAIN (2023), share of households with livestock is higher among male-led households (46 percent) than female-led households (38 percent), signifying that male-led households are wealthier than female-led households. Fewer female-led households than male-led households operate a nonfarm enterprise (31 percent vs 42 percent), which is typically more lucrative than farming. Additional challenges include smaller sizes of women-managed farms (GAIN 2023) and women's low levels of financial inclusion, with only 12 percent of women engaged in agriculture having access to macro- and microcredit. Although women have equal property ownership and inheritance rights (UNCTAD 2022), they have limited control over resources and decision-making in households and communities, especially in rural areas. Inclusion and empowerment of women in agriculture and all sectors has the potential to increase agricultural production and reduce poverty (GAIN 2023) and should be a priority backed by high levels of political will and progressive policies.

Resilience

The UNFSS action track on building resilience to vulnerabilities, shocks, and stress is captured through indicators measuring economic, social, and environmental resilience as well as distribution of risk and production diversity. Economic resilience to shocks, as measured by a Household Resilience Capacity Index based on household survey data, is low, especially in rural areas where access to basic services and infrastructure is limited. Drivers include high poverty rates and inadequate high-quality livelihood and employment support services for the poorest households. Overreliance on cash crops (such as tobacco) and drought- and flood-sensitive maize cultivation reduces resilience for farmers. Frequent occurrence of floods and droughts often leads to food crises, with millions of people requiring aid to prevent malnutrition and potentially death. Potential interventions to improve households' resilience include providing more credit and insurance to protect smallholder farmers against extreme weather and pest infestations, ensuring the National Food Reserve Agency always has adequate stock and proactively analyzes and manages food crisis risk, and providing infrastructure that helps build household resilience.

Financial resilience to risks is hampered by low financial inclusion rates among both men and women, as only 12 percent have access to credit. Relatives and neighbors make up a large share of loan sources, and informal savings groups help to bridge the credit gap. High interest rates and inadequate collateral hinder access to credit, particularly in rural areas. Other challenges include low levels of financial literacy with limited access to information. Increased access to financial services would improve Malawians' resilience and enable them to invest more in increasing farm productivity. Potential interventions to improve financial access include investing in de-risking initiatives to facilitate private sector creation of tailored credit and insurance products for smallholder farmers, particularly women. There is a further need to strengthen existing savings groups as well as to encourage banks to streamline loan application and approval processes and to invest in financial literacy programs.

Malawi has an active social protection program, although it is usually externally funded. Social welfare was allocated a total of MWK 65 billion in FY 2019–2020, up from a revised estimate of MWK 43 billion in 2018–2019 (GAIN 2023). However, it is still insufficient to cover the entire vulnerable population, with the government social security budget as a share of total requirements estimated at 87 percent. Digitization of the government's Social Cash Transfers Programme (locally known as *Mtukula Pakhomo*) has been introduced to reduce delays and operational cost. High population growth rate and limited paths out of poverty are putting pressure on limited social welfare budgets. Potential interventions to improve the effectiveness of social welfare include increasing the accessibility of interventions to reach the most vulnerable population as well as updating benefit amounts to manage impacts of seasonal food price volatility.

Environmental vulnerability is assessed through the Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index, which summarizes a country's climate change vulnerability and its readiness to improve resilience. Malawi has high vulnerability (ranked 23rd most vulnerable) and a low change readiness score (ranked 23rd least ready out of 181 countries) (Global Nutrition Report 2022). Drivers of vulnerability include low capacity to acquire and deploy agriculture technology, overreliance on flood- and drought-sensitive maize combined with increasing risk of floods and droughts, and high levels of deforestation that increase the risk of floods, particularly in the southern region. Agricultural intensification needs to be implemented and monitored in conjunction with strategies to reduce climate change vulnerability and build adaptive capacity in food systems. Mitigation approaches could focus on improving monitoring, forecasting, and risk assessment capacities along with timely risk information sharing and educating farmers on modern eco-friendly farming techniques.

Malawi's production diversity is relatively low, with a high share of production from the top five crops. The top five produced crops in the country in 2019 were maize, sweet potatoes, cassava, sugarcane, and mangoes, with about 70 percent of Malawians cultivating maize. Maize-based farming was an integral part of Malawi's agricultural development, which continues to influence agricultural interventions and Malawians' perception of maize as their key food item.

Government subsidies on maize seeds make maize cheaper to grow, and dividing the country into agricultural development zones with guidelines on standard crops for production also reduces on-farm production diversity. High dependency on a limited set of crops can be risky in the face of extreme weather conditions and pest infestation. Potential interventions include encouraging farming of a wide range of nutritious, biofortified, and/or drought-resistant crops via the AIP, tax credits, and other programs.

Governance

In addition to indicators associated with the five UNFSS action tracks, a final supra-indicator assesses food systems governance by examining the presence of governance bodies and mechanisms related to food systems. Malawi demonstrates a willingness to look at food systems in a holistic way and high-level support for food system transformation, but governance structures still need to be put into place. The country has no explicit long-term goals or framework to investigate food systems transformation and no permanent supra-ministerial body for food systems transformation with a strong mandate, dedicated resources, and required capabilities. The agriculture sector implements a joint sector platform for performance appraisal and tracking. Such platforms are critical for improving coordination and ensuring mutual accountability among stakeholders. However, coordination across ministries and departments remains a challenge.

Key Challenges Facing Malawi's Food System

Table 3.2 shows some of Malawi's main food system challenges that arose from food system diagnostics. The challenges focused on three of the five action tracks (diet quality and nutrition security, livelihoods equity, and environmental resilience) and on key challenges of infrastructure and agricultural productivity.

Diet Quality and Nutrition Security

This was identified as a priority area because the diagnostics and country-level engagements indicated that Malawi had recently been working to reduce dependence on maize to grow more resilient crops and reduce food insecurity. The country experiences high rates of undernourishment and child malnutrition, and limited dietary diversity has negative impacts on population health, well-being, and productivity. The key drivers of this situation include challenges with food availability, affordability, and food preparation. Farmers typically sell limited amounts of high-quality nutritious food while retaining staple crops such as maize for their own consumption, and nutrient-adequate diets are unaffordable to many. Food preparation and consumption practices are based on culturally acceptable methods rather than nutrition-sensitive approaches.

TABLE 3.2—MAIN FOOD SYSTEM CHALLENGES AND POTENTIAL GAME CHANGERS

Category	Diet quality and nutrition security	Livelihoods equity	Environmental resilience	Infrastructure capacity	Agricultural productivity
Priority challenges	52% of Malawians are food insecure, and 70% of dietary energy comes from cereals, roots, and tubers, with limited consumption of more nutritious foods such as legumes and animal-source foods	Majority (50–70%) of Malawians live under the poverty line, with female-led households typically poorer. They manage by consuming cheaper, less nutritious meals, contributing to high rate of undernourishment	Almost annual occurrence of floods or droughts combined with overdependence on maize, a drought-sensitive crop grown by 70% of Malawians, resulting in high levels of food insecurity	Limited local processing, storage, and transportation infrastructure, especially for perishable nutrient-rich fruits and vegetables, results in low availability in local markets and high food loss and waste	Current crop yield is as low as about 20% of potential yield, with 75% of crop production coming from smallholder farmers who use crude techniques and have limited credit and insurance access
Potential game-changing interventions	• Strengthen end-to-end planning for nutrition-sensitive production (including inputs for nutrient-rich foods, sustainable fish farming and fishing, and seeds) • Develop strategies for behavior change communication and trade to boost healthy foods consumption	• Invest in agriculture commercialization and extension services for a path out of poverty • Facilitate private sector creation of credit and insurance products for smallholder farmers, particularly women • Link social support and input programs to maximize synergies	• Prioritize drought- and flood-resistant crops and animal breeds • Invest in eco-friendly irrigation, processing, storage and logistics infrastructure to reduce water and food wastage • Increase awareness of importance of forests and train farmers on conservation agriculture	• Strengthen market linkages and infrastructure to facilitate better storage and local trade • Develop and implement strategy to increase PPPs to invest in infrastructural development • Incentivize credit extension for infrastructure.	• Increase commercial farming and put measures in place to reduce disease vulnerability • Invest in community food storage facilities and structured markets to limit food loss and waste • Improve effectiveness of anchor farming and farming cooperatives via training

Source: Authors, based on Rockefeller Foundation et al. (2021a) for Malawi.
Note: PPP = public- private partnership.

Key steps need to be taken to increase demand, affordability, and access to more nutrient-rich foods such as legumes, fish, fruits, and vegetables. The benefits of addressing diet quality and nutritional security are clear: By increasing Malawians' consumption of adequate, healthy diets, Malawi can make progress toward the 2025 goal of reducing stunting to 27 percent, reducing child mortality to 2.5 percent by 2030, and reversing the trend of increasing obesity and overweight rates. Improved nutrition could also contribute to better cognitive development, increasing Malawians' lifelong productivity.

However, achieving this requires facing that there are trade-offs to consider. For instance, fixing price caps on nutritious food could increase their affordability but would reduce farmers' income and discourage production. On the other hand, increasing consumption of ASF (especially beef) to desirable levels would increase diet diversity but may also increase GHG emissions that negatively affect the environment. Again, while increased local consumption of more nutritious foods (such as legumes and ASF) would be good for Malawians' health, it could leave less for export and reduce export income if production remains constant.

There are also some policy opportunities and implications if diet quality and nutrition security priority are to be achieved. Policies focus on maize subsidies and availability, with less attention paid to increasing production and access to other foods such as legumes and fruits, and these would need to refocus to ensure that other nutritious crops also receive emphasis. The challenge of changing the current orientation toward maize-based diets is that it may be difficult to shift Malawians' long-held consumption habits. There is also a need to increase the purchasing power of a growing, agriculture-dependent population to ensure that they can afford other sources of nutrients.

Environmental Resilience

Environmental resilience is a key action track and priority area for Malawi, considering that Malawi's GHG emissions from food consumption and agriculture are on the rise due to increasing deforestation for agricultural purposes. This is exacerbating Malawi's vulnerability to floods and droughts, which ultimately reduces food supply. Malawi needs to strengthen and expand its agriculture transformation programs to increase environmental resilience. Addressing this challenge is beneficial because increasing Malawi's environmental resilience could increase agricultural productivity, stabilize incomes, reduce food insecurity, and minimize loss of life and wealth during extreme weather conditions.

Nevertheless, addressing this priority area has some challenges and trade-offs that need to be considered. For instance, increasing water allocated for irrigation could reduce water available to generate hydropower for food storage, agriculture extension services, and other key sectors; similarly, prioritization of eco-friendly activities could lead to reduction in AIP's distribution of chemical fertilizer, thus reducing fertilizer use and agricultural productivity. Preventing deforestation increases environmental resilience but may limit expansion of small landholdings and food supply.

At the policy level, no systems approach toward improving environmental resilience (such as irrigation and storage schemes) can be done in isolation, and there are some constraints that may hamper implementation. For example, land consolidation programs can facilitate irrigation schemes but need to be equitable and beneficial to be attractive to Malawians. There are also inadequate resources to enforce forest conservation laws. Policy interventions to address these challenges should include efforts to increase resilient and sustainable production, invest in eco-friendly infrastructure, and improve awareness of conservation agriculture and agroforestry.

Infrastructure Capacity

Malawi is one of the fastest urbanizing countries in the world, with an annual urban population growth rate of about 4 percent (World Bank 2023). However, it lacks adequate agriculture infrastructure (such as supply chains, storage, electricity, processing capacity, and transport networks), which limits farmers' capacity to extend produce shelf life and reach local and international markets. This is evident in the high levels of food loss and waste, especially of nutritious but perishable fruits and vegetables.

Addressing this priority area of improved infrastructure has widespread benefits beyond increasing food safety and availability. It would also spur development of the agro-processing industry, creating more jobs and facilitating export of higher value produce for higher income. Addressing this priority area also involves some challenges and trade-offs. For instance, improved infrastructure could lead to increased food supply but also higher production and consumption of unhealthy ultra-processed food. More nonfarm jobs would increase income but could reduce food supply due to reduced farm labor, especially among youth who practice more modern agriculture. At the policy level, limited rural grid electricity development undermines rural development of agro-industry. There is also a limited focus on increasing private-sector investment and public-private partnerships in the food supply chain. A key constraint in resolving Malawi's infrastructure gaps is the limited expertise to raise funds and prioritize investment in capital-intensive infrastructure development. There are also critical human skills shortages in areas of infrastructure development. Strategies to address these challenges can include investments in affordable and sustainable energy as well as public-private partnerships for infrastructural development.

Agricultural Productivity

Another priority identified though diagnostics and consultations in Malawi is increasing agricultural productivity. Agriculture accounts for almost 30 percent of Malawi's GDP, and there are opportunities for higher productivity as current crop yields are low. About 75 percent of crop production comes from smallholder farmers with small farms and low crop yield, thus limiting food supply for sustainable and healthy diets. ASF supply has increased by 55 percent since 2010 but remains below the African and global averages. The limited production is exacerbated by high food waste and loss levels that increase food insecurity.

Increasing Malawi's agricultural productivity is beneficial because it will increase food availability and affordability, leading to increased food security and nutrition. It will also increase farmers' income and reduce need for agriculture deforestation as available farmland could yield enough to meet nutrient need. Nevertheless, addressing this priority area has challenges and trade-offs that need to be considered. Increased mechanized farming and fertilizer usage, for instance, may increase GHG emissions that hasten climate change, thus making Malawi more vulnerable to floods and droughts. Similarly, increased commercial agriculture may increase vulnerability to infestations (such as fall armyworm), while large scale production of focus crops increases yield but could lower production diversity.

At the policy level, generalized input subsidies do not address unique soil needs, thus limiting yield potential. In addition, the focus on increasing cereal production with little attention to other nutritious foods such as legumes can undermine food system outcomes. Farmer training and timely supply of inputs to ensure proper fertilizer application and harvest are not yet addressed, and the need to prioritize farmers to subsidize for maximum yield while protecting the most vulnerable remains a key challenge. There is also pervasive poor market structure, which limits trade and income opportunities from increased production. Land consolidation can facilitate large-scale farming but would need to be beneficial to landowners, especially since rapid population growth puts pressure on limited land. To resolve these challenges, a concerted approach is needed to increase resources for farmers, including access to inputs, financial services, and training.

Livelihoods Equity

Agriculture supports 85 percent of Malawi's population. Subsistence farming characterized by low productivity and limited value-addition results in farmers having a high-risk profile, which limits credit access and income growth opportunities. Consequently, Malawi is the third-poorest country in the world by GDP per capita. It is easier for cash crop farmers (mainly men) to access credit than for food crop farmers (mainly women) because cash crop farmers earn more and are thus able to afford high credit costs. Women-managed farms are also smaller than those managed by men, which limits their production and contributes to higher poverty among female-led households.

One benefit of addressing this priority area is that unlocking Malawian's income potential is a crucial and sustainable way to empower them to live high-quality lives and reduce the country's poverty burden. It could also reduce the amount of money dedicated to social protection programs, thereby making more funds available for other key projects.

Focusing on this priority area has challenges and trade-offs. Income growth could lead to inflation, which makes food more costly for the poor population, while large-scale production of focus crops increases yield but could lower production diversity. On the other hand, promotion of better-paying nonfarm jobs increases income but could reduce food supply due to reduced farm labor. Systems approaches have limited capacity to improve livelihoods; for example, input subsidies and training have limited effect without market access, while funding shortages often mean that social assistance programs are not implemented. Other constraints include the cost of de-risking farmers to facilitate credit access. It is also difficult to reach the most vulnerable population, and there is generally more interest in suboptimal quick fixes rather than optimal long-term investments. Public investments in financial de-risking initiatives and agricultural commercialization and extension services are among potential strategies to address these challenges.

Policy Mapping and Identification of Gaps

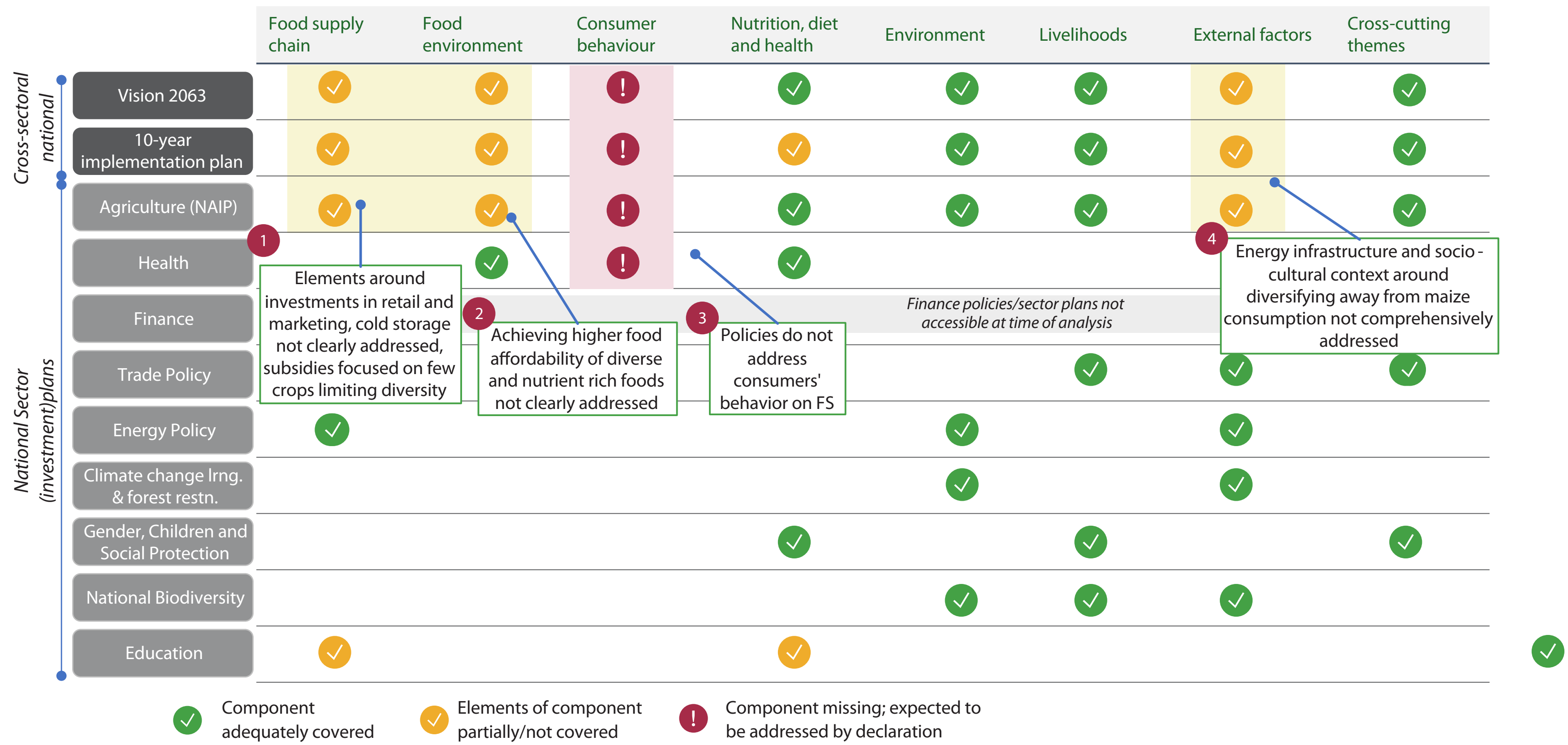
The next component of the food system diagnostic analysis involved conducting policy mapping to assess coverage of major food system components as well as the key challenges outlined above. Policy mapping also took into account cross-cutting themes of gender, youth, and human rights. In order to examine outcomes from the food system, the analysis also included the ability of policies to support nutrition, diet, health, livelihoods, and environmental health.

Figure 3.3 shows the results summarized pictorially. It is clear that national policies in Malawi do not currently support consumer behavior, including food acquisition, preparation, meal practices, and storage. In addition, for several other elements of the food system, the national policies in Malawi are not comprehensive. Tables 3.3 also summarize the current policies related to food system challenges, highlight potential gaps or conflicting policies, and identify potential policy implications.

Malawi's food systems policy landscape is guided by global and regional declarations as well as the national vision and development plans. The national development plans and policies generally have strong coverage of most elements of the food system, focusing heavily on resilience, food security, and nutrition given current poverty levels and increasing frequency of droughts. However, the key challenge lies with ensuring availability of sufficient financing and the right prioritization of programs and actions to deliver the highest multiplier effect.

Within the current policy landscape, there are opportunities for more alignment to deal with potential trade-offs as well as to realize synergies on some of Malawi's key challenges in its food system. There are also opportunities to realize more synergies between programs by streamlining financing, including funding from development partners.

FIGURE 3.3—NATIONAL POLICY GAPS RELEVANT FOR FOOD SYSTEMS IN MALAWI



Source: Rockefeller Foundation et al. (2021a).

Note: National plans broadly cover all components of food systems, with some elements around food supply chains and environments not addressed.

TABLE 3.3—CURRENT POLICIES, GAPS, AND IMPLICATIONS

Key challenges	Current policies related to challenge	Potential gaps or conflicting policies	Potential implications
Diet quality and nutrition security Limited consumption of nutrient rich foods such as legumes, fruits, vegetables, and animal-source foods, resulting in high rate of undernourishment	• NAIP: Input subsidies focused on maize and vegetable seeds • NAIP and Energy: Investment in cold chain for nutrient rich foods • Nutrition and NAIP: Nutrition-sensitive interventions, promoting dietary diversity, micronutrient supplementation • National export strategy: Export of nutrient-rich fruits and vegetables • Education: Promotion of school feeding • Trade: Promotion of commercial agriculture for export of food	• Subsidies with focus on maize enable continuity of current system dynamics • Limited prioritization of investments resulting in incomplete implementation of programs, despite NAIP, • Limited consumer behavior change limiting local consumption and increasing focus on exports	• Tailor input subsidy programs to increase diversity and availability of nutrient-rich foods • Prioritize investments based on return on investment • Ramp up education of nutrition-sensitive consumption and trade • Explore means to reduce cost of nutritious diet and create markets for nutrient rich foods • Increase value-addition/ processing of nutrient-rich foods (based on local demand)
Livelihood equity Majority of population living below poverty line, women-led households typically worse off, resulting in high undernourishment rate and consumption of cheaper, less nutritious meals	Resilience: • Cash transfer programs for lowest income category • Training, employment, and land ownership for women and youth • Gender and social welfare: Access to microfinance • NAIP: Access to market price information	• Blanket cash transfer program that improves poor targeting • Limited systems approach to improve livelihoods (e.g., input subsidies and training have limited effect without access to market) • Funding shortages often mean social assistance programs are not implemented	• Target cash transfer program to those that most need it • Scale up programs such as school feeding to cover entire population • Strengthen existing co-ops and enable development of market linkages, financing access, and so forth
Environmental resilience Frequent exposure to droughts and reliance on maize, a highly drought susceptible crops, resulting in high levels of food insecurity	Resilience: • Encourage crop diversification • Sustainable irrigation development and water supply systems • Early warning and response systems • Climate change learning: • Ensure forest cover of 10% on 80% of cropland	• Provide input subsidies without access to water (storage infrastructure) during drought period • Increased input utilization may risk ability to ensure sustainable production	• Invest in drought- and flood-resistant varieties and crops • Adopt predictive modeling and early warning system to prepare long-term • Explore cloud seeding to reduce rainfall extremes • Explore adoption of agro-forestry • Construct check dams, gully plugs, and terracing to avoid run-off
Infrastructure capacity Underdeveloped supply chain infrastructure with limited private-sector investment, particularly for nutrient rich foods, driving high food loss and waste	• NAIP: Improve domestic infrastructure including feeder roads • NAIP: Rural cold storage facilities • Energy: Rural electrification • NAIP: Post-harvest management • Trade: Improve market linkages	• Facilitate private sector investment/PPPs not addressed • Limited rural grid electricity development • Focus on external markets linkages over more local supply chains may impact local availability	• Explore reduction in tariff and non-tariff barriers • Explore development of (renewable energy) mini-grids for post-harvest management and cold chain management • Opportunity to leverage existing skills to build out agribusiness
Agricultural productivity Relatively low yield of crops, due to reliance on rain-fed agriculture, simple farming techniques on small-holder plots, and limited access to credit and insurance	• NAIP: Provision of subsidized inputs (e.g., fertilizer) • NAIP: Irrigated agriculture and water storage investment and mechanization • Reforestation strategy: Ensure forest cover of 10% on 80% of cropland	• Provision of subsidies without training on application of inputs and local conditions may not improve yields • Limited punitive measures to ensure quality of inputs • Timely supply of inputs to ensure successful harvest not addressed	• Provide localized understanding of soil and seasonal and climatic conditions • Explore farmer education on input application • Focus subsidies and investments on most productive farmers • Explore opportunity to provide consistent water supply to farms

Source: Rockefeller Foundation et al. (2021a).
Note: NAIP= national agriculture investment plans; PPP= public-private partnership.

Conclusions and Policy Implications

The food system diagnostics analysis underlined a number of key concerns and challenges for Malawi's food system. Policies have tended to emphasize food availability (production) without directing equal effort toward supporting other food system components. The alignment of national policies and strategies to international protocols, declarations, and visions is important for the achievement of national targets. This enhances the country's capacity to mobilize resources from development partners.

The subsidy program is critical but does not guarantee the availability and affordability of food to ensure dietary diversity. The existing AIP subsidy program primarily focuses on maize, with less emphasis on legumes and livestock production on smallholder farms. Given the small plots and the high levels of land degradation, it is doubtful that Malawi can be assured of production and dietary diversity under these circumstances.

Informal markets have no standards for quality and safety, leading to the consumption of unhealthy foods. Food waste—especially for fruits and vegetables—is high in Malawi and other African countries south of the Sahara. At the same time, the production and productivity of most crops are low. In addition, there is low processing of agricultural products in Malawi. Better and structured markets would promote the growth of agro-processing and the development of efficient and inclusive agricultural value chains that ensure competitive and fair pricing of agricultural products.

Based on the food system diagnostics undertaken for Malawi, recommended possible policy interventions include the following:

Pursue a food systems approach in policymaking

- Restructure to create an integrated food system with clear delineation of initiatives, policies, and other activities among all ministries, subdirectorates, and departments. Strong cooperation and coordination across ministries around food systems is crucial to ensuring ownership and increasing efficiency and effectiveness.

Invest in improved food safety

- Increase research, infrastructure, staffing, and other resources to increase capacity to proactively identify and prevent incidence of foodborne diseases.
- Adopt a risk-based approach to food safety, especially in the short term as capacity is being increased. This could involve prioritizing high-risk areas contributing to foodborne disease and determining frequency of inspection based on health risk.
- Increase commercial farming and ensure safety measures are installed to reduce disease vulnerability.

Reduce food loss and waste

- Invest in safe community food storage facilities; electricity, processing, and other infrastructure; and structured markets to limit food contamination, loss, and waste.
- Provide messaging on how to store and prepare produce to extend its shelf-life at home and in restaurants; invest in standards for avoiding food loss and waste for the retail sector.

Improve nutrition and food security

- Ensure adequate access to macro- and micronutrients by encouraging production of nutrient-rich and biofortified foods for the domestic market (such as by providing or increasing farming input subsidies for livestock, legumes, fruits, and other products through AIP).
- Invest in electricity, logistics, and other infrastructure to increase production, storage, and distribution of perishable food; develop alternative sources of proteins that have limited impacts on the environment (such as fish from Lake Malawi and Lake Chilwa).
- Encourage consumption of nutrient-rich food through nutrition education/awareness campaigns and provision of nutrient-rich foods to vulnerable populations through alternative channels such as school feeding programs.
- Promote healthy diets through potential increases in taxes on unhealthy foods such as sugar-sweetened beverages and salty snacks; sponsor information campaigns promoting healthy diets and physical activity for urban populations; and strengthen guidelines on food marketing and messaging.
- Place as much emphasis on food affordability and access as on food availability. Move toward a market-oriented and specialized agricultural sector that can meet the healthy food needs of the population outside of the agricultural sector.

- Promote integrated soil fertility management to improve soil health and mitigate negative impacts of land degradation on the affordability and availability of healthy foods.

Promote regional market integration

- Enact policies supporting integration of traders into regional and international markets to raise local standards for quality and safety of foods as well as to improve farmer incomes.

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CHAPTER 4

Committing to Transform Food Systems: Responsiveness of Food Systems Transformation Pledges by African Governments to the WHO Priority Food Systems Policies and Food-Related CAADP Biennial Review Performance Categories

Silver Nanema, Gideon Senyo Amevinya, and Amos Laar

Chapter Preview

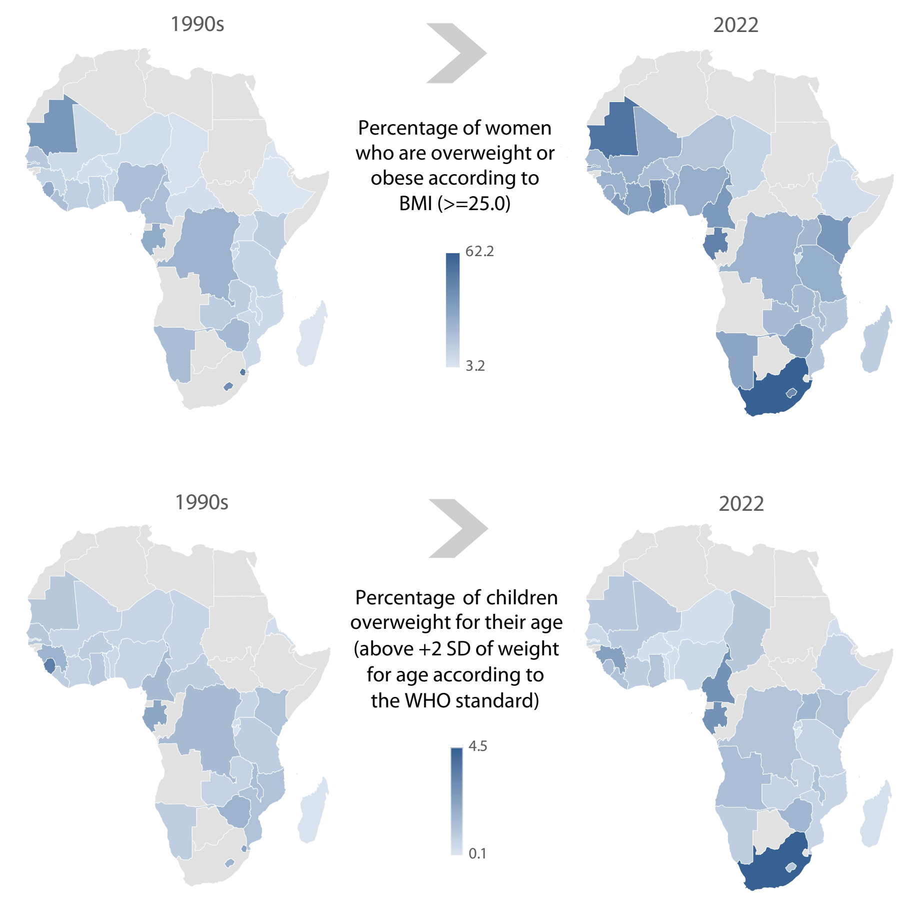
For several decades, Africa's food security situation has been dire. However, that dire state has recently been complicated by rising rates of overweight and obesity and other diet-related noncommunicable diseases. By 2030, noncommunicable diseases are predicted to become the leading cause of death on the continent amid other pandemic and economic challenges. Several interventions have been deployed to address the emerging challenges. African heads of state and government have been committing, declaring, pledging, and developing national and regional nutrition strategies, and they have envisioned the Africa they would want by 2063—the African Union's Agenda 2063. Other actions include commitments made as part of the 2021 United Nations Food Systems Summit. With less than a decade to go to meet the 2030 agenda for transforming food systems in a sustainable way, we must ask whether these new commitments and recommitments can fulfill that promise. In this chapter, we assess the responsiveness of some African nations' commitments to (1) the World Health Organization's food priority policy actions, and (2) select Comprehensive Africa Agriculture Development Programme Biennial Review performance categories. Both actions are touted as game changers—actions that have the potential to pave the way for the needed changes in Africa's food systems.

Introduction

Global Crises and Food and Nutrition Security in Africa

Food systems in Africa and worldwide face economic, pandemic, climate change, and related crises that disrupt food production, food distribution, and diets. Since 2019, global hunger rates have increased significantly, affecting about 7.9 percent of the world's population in 2019 and 9.2 percent in 2022 (FAO et al. 2023). By 2030, it is estimated that almost 600 million people worldwide will go to bed hungry (FAO et al. 2023). Regardless of the pandemic and the multiple manmade crises, between 23 and 119 million more people are expected to be affected by hunger by 2023, while in 2021 more than 3.1 billion people, women included, could not afford a healthy diet, representing an increase of 134 million people since 2019 (FAO et al. 2023). Along with high hunger rates, Africa also grapples with obesity and diet-related noncommunicable diseases (NCDs) (GBD 2015 Obesity Collaborators 2017). Figure 4.1 shows the changes in overweight/obesity prevalence among children and women across Africa from the 1990s to 2022 using Demographic and Health Surveys Program data from 36 African countries (USAID 2023). Overall, in a little over two decades, most parts of Africa (West,

FIGURE 4.1—CHANGE IN OVERWEIGHT/OBESITY PREVALENCE AMONG KEY POPULATIONS (WOMEN AND CHILDREN) IN AFRICA SOUTH OF THE SAHARA FROM THE 1990s TO 2022



Source: Compilation of Demographic and Health Surveys Program data from 36 African countries obtained from USAID (2023).

Note: BMI = body mass index; SD = standard deviation; WHO = World Health Organization.

East, Middle, and Southern) reported considerable increases in the prevalence of overweight/obesity among both women and children. The agrifood, health, and economic systems face various factors that make it difficult to provide nutritious, safe, and affordable diets to everyone. To address such challenges and ensure food security and healthy diets for Africans, the continent needs regional policies and practices that countries must adhere to.

Commitment to Transform Africa's Food Systems

Faced with the challenge of failing food systems, governments in Africa have pledged to ensure that affordable and healthy diets are accessible to all. Salient efforts to address this issue include, among others, the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods adopted by the heads of state and government of the African Union during the Twenty-third Ordinary Session of the African Union Assembly in Malabo, Equatorial Guinea, June 26–27, 2014 (African Union 2014). Such efforts have provided new impetus and a renewed effort to eradicate hunger and reduce poverty through the agricultural sector (FAO 2020). The following are the seven broad commitments from the Malabo Declaration:

1. Recommit to and uphold the principles and values of the Comprehensive Africa Agriculture Development Programme (CAADP).
2. Enhance investment finance in agriculture, directing at least 10 percent of national budgetary resources to agriculture and rural development policy implementation.
3. End hunger in Africa by 2025.
4. Reduce poverty by half by 2025 through inclusive agricultural growth and transformation.
5. Boost intra-African trade in agricultural commodities and services.
6. Enhance the resilience of livelihoods and production systems to climate variability and other related risks.
7. Ensure mutual accountability for actions and results by conducting a continentwide Biennial Review to monitor progress in achieving the seven commitments.

One year after the Malabo Declaration, world leaders adopted the Sustainable Development Goals (SDGs) as part of the United Nations' Sustainable Development Agenda to be achieved by 2030. This new global recommitment is consistent with the Malabo Declaration, particularly SDGs 1 and 2, that is, ending poverty in all its forms everywhere (SDG 1) and ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture by 2030 (SDG 2). The convergence of the Malabo Declaration and the SDGs was further reiterated by the overlap among most indicators to measure progress in implementing the Malabo Declaration and the SDGs (FAO 2020).

More recently, in 2021, the United Nations Food Systems Summit (UNFSS or "the Summit") and its associated dialogues galvanized diverse food system actors and stakeholders to take action on transforming food systems through five action areas (UN 2021):

1. *Nourish all people.* This includes ensuring access to safe and nutritious food for all, promoting and creating demand for healthy and sustainable diets, and reducing waste.
2. *Boost nature-based solutions.* Steps include acting on climate change, reducing emissions and increasing carbon capture, regenerating and protecting critical ecosystems, and reducing food loss and energy usage, without undermining health or nutritious diets.
3. *Advance equitable livelihoods, decent work, and empowered communities.* This entails raising incomes, distributing risk, expanding inclusion, creating jobs, and adding value.
4. *Build resilience to vulnerabilities, shocks, and stresses.* One way this is done is by ensuring the continued functionality of healthy and sustainable food systems.
5. *Accelerate the means of implementation.* Such means of implementation include finance, science and innovation, data, governance, and trade.

As part of the UNFSS process, African governments and the broader regional bloc, the African Union, expressed their commitments to transform their food systems to deliver nourishment to the African population in an equitable manner and within planetary boundaries.

Progress on Food Systems Transformation

To monitor progress on the Malabo commitments, the heads of state and government of the African Union made decisions about clearly defining targets and indicators to be measured and reported in a Biennial Review Report, the latest of which was published in March 2022 (AUDA-NEPAD 2022a). Mechanisms were also adopted to monitor progress on the SDGs at both national and global levels. The equivalent of the Biennial Review for the SDGs is known as a voluntary national review, and both the voluntary national reviews and the Biennial Reviews serve to facilitate the sharing of experiences by member states, the reporting of successes stories and challenges and lessons learned, and also the strengthening of policies and mobilizing of support and partnerships for the SDGs (FAO 2020).

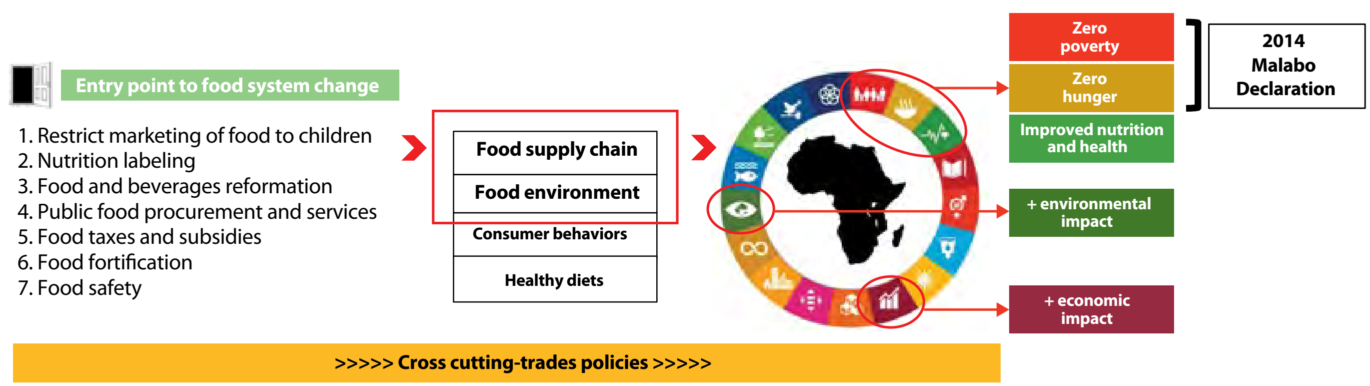
According to the latest Biennial Review Report (AUDA-NEPAD 2022a), 51 out of 55 countries reported their performance against 46 indicators and only a third of the countries were rated as doing well, of which Rwanda was the only country on track to achieve four out of seven Malabo commitments (1, 4, 6, and 7). Overall, most countries were not on track to achieve the seven Malabo commitments. An exhaustive list of countries and their respective commitments that they are on track to achieve can be found in the 3rd Biennial Review Report (AUDA-NEPAD 2022a).

The Sustainable Development Goals Report 2023: Special Edition (UN 2023) highlights the fragility and slow progress in achieving the SDGs. The COVID-19 pandemic, the Russia–Ukraine war, and climate-related disasters have exacerbated the slow progress. Shockingly, 30 percent of countries have either made no movement or regressed below the baseline, while estimates suggest that more than 500 million people will still be living in extreme poverty by 2030. Additionally, food prices remain high in many countries, and carbon dioxide levels continue to rise. It is evident that developing countries and the world's poorest and most vulnerable people are bearing the brunt of our collective failure (UN 2023). Policy incoherence across sectors and the misalignment of food security and nutrition policies are also both significant problems that lead to fragmentation throughout the regulatory system in Africa (AU, NEPAD, and CAADP 2019). Ensuring that food security is part of a prioritized policy agenda and a policy framework that align with both the Malabo targets and national development objectives, including climate change, remains the greatest challenge to Africa (Laar, Tagwireyi, and Hassan-Wassef 2023).

Opportunities for Change

This chapter warns that improving agriculture, enhancing food systems, and establishing effective platforms to boost food system capabilities are crucial. These actions will ensure that nutritious and healthy diets are available for everyone, household incomes are raised, and extreme poverty is reduced. Immediate action is necessary to achieve these objectives. Policies that advance all three pillars of sustainable development—economic, social, and environmental—must fully reflect these goals (FAO 2020).

FIGURE 4.2—POLICY OPPORTUNITY TO FOOD SYSTEM TRANSFORMATION



Source: Adapted from WHO (2021b).

However, until recently, health and development policies and strategies in Africa have focused mainly on addressing undernutrition, communicable diseases, and maternal and child health challenges. The high-level continental agriculture, nutrition, health, and development policy and strategy frameworks that we referred to—including the 2003 Maputo commitments, the 2014 Malabo Declaration, the Africa Regional Nutrition Strategy 2015–2025, and the African Union's Agenda 2063—to a large extent prioritize ridding the continent of hunger and food insecurity (Laar, Tagwireyi, and Hassan-Wassef 2023). Africa must seize the opportunity not only to align existing efforts but also to adopt the policy opportunities and entry points to sustainable food systems transformation that are currently valorized at the global level (Figure 4.2).

The World Health Organization (WHO) in 2021 issued an urgent call for the adoption of seven policy approaches that address health and promote sustainability across economic, social, and environmental domains. The approaches, called policy actions for better nutrition, include specific and cross-cutting actions that can transform food systems and support the 2030 Agenda for Sustainable Development. Implementing the policies can help end hunger, food insecurity, and malnutrition in all forms, while also making nutritious foods more affordable and reducing costs across agriculture, food, health, and environment systems (WHO 2021b). The WHO's "Food Systems for Health" narrative emphasizes the various ways that food systems affect health and recognizes the interconnectedness of humans, animals, and the planet (WHO 2021a).

The WHO's priority policy actions for food systems are as follows:

1. *Regulating the marketing of food and beverages to children of all ages.* Such regulation aims to reduce children's exposure and protect them from the harmful impacts of marketing.
2. *Nutrition labeling.* This policy action aims to ensure clear and accurate front-of-pack nutrition labeling to help inform consumers to make healthier food purchases and to encourage food companies to make positive changes to the nutritional composition of their products.
3. *Reformulation of food and drink products.* Such action would improve the nutritional quality of the food supply, reducing the content of salt, sugars, and harmful fats as needed.
4. *Fiscal policies—food taxes and subsidies:* Levying taxes on unhealthy food options (such as foods that are high in fats, sugars, and/or salt) would increase their price and discourage their purchase and consumption. Subsidies to reduce the price of healthy options (for example, fruits and vegetables) are designed to encourage their consumption.
5. *Food procurement.* Setting criteria for food served or sold in public settings and/or purchased with government funds that enable healthy diets.
6. *Food fortification.* Fortifying foods by adding extra vitamins and minerals can supply essential micronutrients to entire populations to combat micronutrient deficiencies.
7. *Food safety.* Countries can take action to ensure that foods are safe by building the capacity to detect, monitor, and respond to foodborne diseases caused by both microbiological and chemical risks.

In addition to these priority policy actions, the WHO proposed a cross-cutting focus on ensuring coherence of trade policies with nutrition and food safety. A commitment to ensuring coherence between trade and nutrition policy objectives is necessary if international trade is to promote rather than undermine affordable/sustainable healthy diets. (This trade-related cross-cutting theme is not included in the current analysis.)

The above actions, if implemented in combination, are referred to as "multiple-duty actions" as they can address multiple forms of malnutrition simultaneously (Hawkes et al. 2020).

In this chapter, we evaluate the promises African heads of state made at the 2021 UNFSS. Our analysis focuses on how well those commitments align with the WHO's recommended actions for food systems (such as nutrition labeling, marketing regulations, and food safety measures). Additionally, we examine how closely their promises align with select Comprehensive Africa Agriculture Development Programme (CAADP) Biennial Review performance categories, which aim to end hunger by improving access to agriculture inputs and technologies, increasing productivity, reducing postharvest loss, providing social protection, ensuring food security and nutrition, and enhancing food safety.

Approaches

For this chapter, we draw on multiple sources of evidence associated with both the UNFSS and the African Union CAADP Biennial Review performance categories. Thus, the sources include the official statements made by African heads of state and by the African Union at the 2021 UNFSS. We also make use of recent literature—published and gray—covering such subjects as the UNFSS, the CAADP Biennial Review Reports, and the WHO food systems priority policy areas. We draw substantially from the approaches used by Laar, Tagwireyi, and Hassan-Wassef (2023), which we summarize in the following paragraphs.

Both this chapter and Laar and colleagues' 2023 study make use of data from African countries that have submitted pledges on the UNFSS website. The website is publicly available and can be accessed at https://www.un.org/en/food-systems-summit/documentation. Thirty-six of the 149 countries that lodged their statements on the portal were African. We were able to access 26 national statements from these 36 African countries, which we include in our analysis. We analyzed all the commitments mentioned in these governmental and presidential statements. For non-English statements, we used Google Translate before analyzing them. Additionally, we analyzed the Africa Common Position on Food Systems (AUDA-NEPAD 2021), the African Union's regional submission to the UNFSS (see Table 4.1 for details).

Following the compilation and collation of the commitments, the analysis of the pledges (n = 219 statements) entailed assessing the responsiveness of the commitments. We operationally define responsiveness as alignment or relatedness of the commitments to the WHO priority policies and the CAADP Biennial Review performance categories (performance categories 3.1 through 3.6). We did this by comparing each commitment with the seven WHO food systems priority policy actions (nutrition labeling, marketing regulation, public food procurement, fiscal policies, food fortification, food and drink reformulation, and food safety) and with the six CAADP Biennial Review performance categories (access to agriculture inputs and technologies, agriculture productivity, postharvest loss, social protection, food security and nutrition, and food safety). The performance categories 3.1 through 3.6 were the most explicit and directly related efforts aimed at improving food and diet quality in Africa—hence their selection. The rating was done by two independent coders using a study-specific data-charting spreadsheet. The coders rated and categorized each commitment as fully responsive, partially responsive, or not at all responsive to each of the 13 domains. This process generated the results shown in Table 4.1, which were then validated. Validation consisted of comparing data charted by the coders for concordance or lack thereof. Where discrepancies were identified, the input of a third individual was invited.

Findings

Africa's Commitment to Ending Hunger by 2025

African countries vary in terms of economic and social development, demographics, culture, religious beliefs, and political governance. Additionally, differences exist in availability of natural resources, stages of nutrition transition, and level of food system challenges. Despite these differences, all African countries are facing a common challenge. They are currently struggling with a surge in obesity and other diet-related noncommunicable diseases, at the same time that undernutrition and micronutrient deficiencies persist. This has led to a double burden (in some cases, multiple burdens) of malnutrition that all African countries are battling.

For several decades, national and regional efforts in Africa have focused on addressing undernutrition, communicable diseases, and maternal and child health challenges. Efforts by African governments to address NCDs are nascent and limited in scope and depth (Asiki et al. 2020; Booth et al. 2021; Laar et al. 2020). For example, until recently, high-level continental agriculture, nutrition, health, and development policies/strategies such as the 2003 Maputo commitments (African Union 2003), the 2014 Malabo Declaration (African Union 2014), the Africa Region Nutrition Strategy 2015–2025 (African Union 2015a), and the African Union's Agenda 2063 (African Union 2015b) have all focused more on ridding the continent of hunger and food insecurity.

NCDs are predicted to become the leading cause of death in Africa by 2023 (GBD 2015 Obesity Collaborators 2017). The rate at which they are increasing in Africa is alarming. An analysis spanning 1975 to 2016 showed that six of 60 nations in the world with the fastest-rising rates of adult obesity are in Africa (NCD Risk Factor Collaboration 2016). While efforts to end hunger in Africa must continue, Africa needs transformative food system policies that regional, national, and local actors can use to promote sustainable, healthy diets (Laar et al. 2022) within a comprehensive vision of integrated sustainable human development. As a mantra, ending hunger in Africa is not new. At the 1996 World Food Summit, leaders from 186 countries pledged to reduce the number of hungry people in the world by half no later than 2015. Reinforcing that was the first Millennium Development Goal (MDG 1) that specifically set the goal of reducing by half the proportion of people living on less than a dollar a day and the proportion of people suffering from hunger by 2015. Africa, excluding North Africa, did not meet MDG 1's target. From 1990 to 2015, the proportion (percentage) of people living on less than $1.25 a day reduced from 57 percent to 41 percent (UN 2015).

Following that, the African Union set a target to "eliminate hunger and food insecurity by 2025" (AUDA-NEPAD 2022b). Both Agenda 2063 and the 2014 African Union Summit's Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods have reaffirmed this commitment. Unfortunately, Africa is not on track to meet its targets (AUDA-NEPAD 2022b). Immediate, mutually reinforcing interventions that focus on feeding and nourishing are required to bring the continent closer to eliminating hunger and food insecurity.

We've organized the remainder of this section into three subsections:

- Africa's commitments to transforming its food systems by 2030
- Responsiveness of Africa's commitments to select CAADP Biennial Review performance categories
- Responsiveness of Africa's commitments to the WHO's priority policy actions for food systems

Africa's Commitment to Transforming Its Food Systems by 2030 Is a Commitment to Achieving the SDGs

Considering the many challenges we discuss in this chapter, there is a growing need for partnerships and collaborative efforts to find solutions. To address this, UN Secretary-General António Guterres organized the Food Systems Summit in September 2021 as part of the Decade of Action, with the goal of achieving the SDGs by 2030. The UNFSS introduced new actions to make progress on all 17 SDGs, all of which depend on having healthier, more sustainable, and equitable food systems. Through the Summit and its related discussions, countries and food system participants were able to accelerate their journey toward transforming food systems to achieve sustainable and healthy diets for all, and ultimately the SDGs.

Discourses on the subject prior to, during, and after the Summit, generally agree that transforming food systems can accelerate the achievement of the SDGs. Caron and colleagues (2018) proposed a four-part food systems transformation plan consisting of four stages of implementation and three prerequisites for successful execution. The plan's first step focuses on food consumption patterns and aims to provide all individuals with access to nutritious and healthy food. The second step aims to promote sustainable agriculture production and food value chains, while the third step seeks to mitigate climate change and promote resilience. The final step of the plan aims to encourage a renaissance of rural territories.

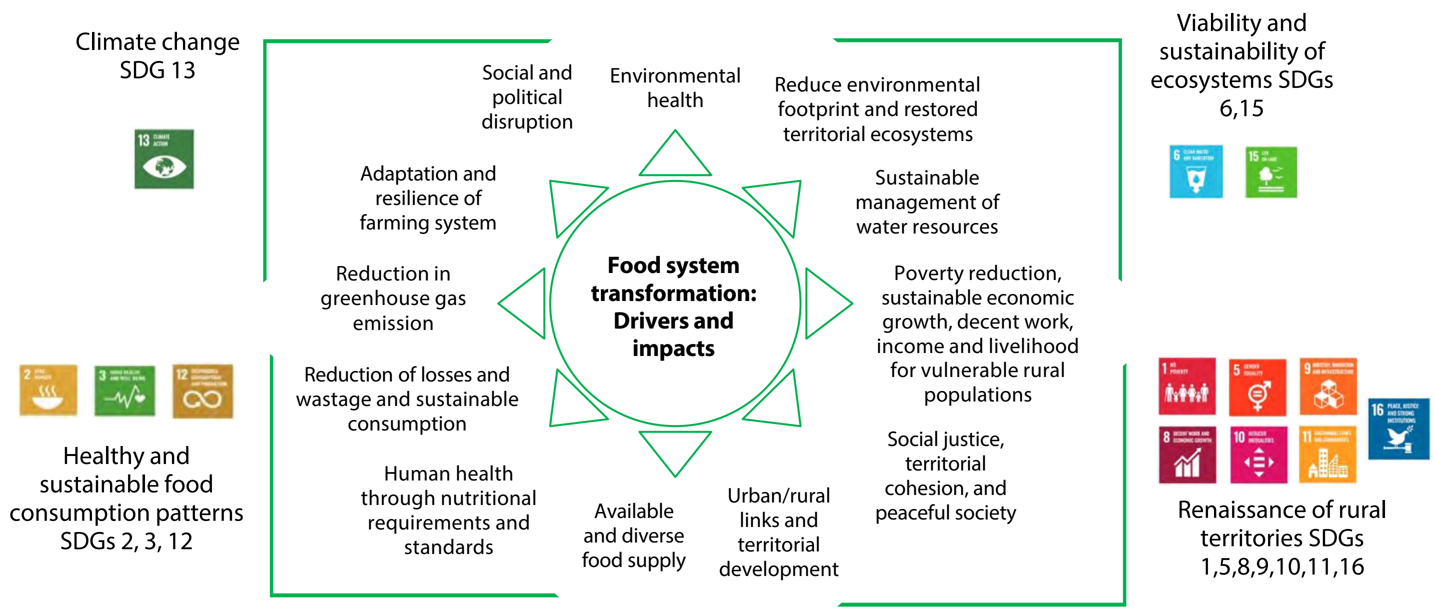
Of note, the transformation will not occur automatically and requires careful planning, design, implementation, and monitoring by local stakeholders. The implementation process must follow agreed-upon sustainable development parameters at both the national and global levels. The successful implementation of the four-part transformation, as Caron and colleagues (2018) note, requires three prerequisites: suitable metrics for decision-making, policies that align local and global priorities, and development approaches that focus on territories.

How can we determine whether efforts to transform food systems are having a positive impact on the SDGs? Caron and colleagues (2018) proposed a framework that considers two main aspects. First, it considers the relationship between food and nutrition security, environmental health, climate, and social justice. Second, it examines how the nexus is affected by changes in food systems (Figure 4.3).

Other researchers have also developed several frameworks for the assessment of food systems transformation—see, for example, van Berkum and Ruben (2021) and Fanzo et al. (2021)—each with their unique strengths and weaknesses. Other frameworks have been inspired by the work of the Committee on World Food Security's High-Level Panel of Experts on Food Security and Nutrition (HLPE 2017). Distilling and enunciating the pros and cons of these frameworks is beyond the scope of this chapter.

It is essential to have inclusive and sustainable food systems to achieve SDG 2 and contribute to the 2030 Agenda for Sustainable Development. Sustainable

FIGURE 4.3—A PROPOSED FRAMEWORK FOR FOOD SYSTEMS TRANSFORMATION



Source: Caron et al. (2018).

food systems can lead to four outcomes: nutritious and healthy diets for everyone; regenerated ecosystems; climate change mitigation; and promotion of social justice by focusing on the well-being of poorer rural communities and all 17 SDGs. Therefore, when transforming our food systems, we must also prioritize enhancing livelihood, economic development, and ensuring a healthy planet in line with the four Ps—people, planet, prosperity, and peace/partnerships.

In our observation, African countries and their governments showed significant involvement in UNFSS-related dialogues and summit-related processes. They demonstrated a strong commitment to transforming their food systems. But it is unclear whether the commitments are aligned with prevailing health-promoting policies. After analyzing the political commitments made by the African heads of state and government, we found that they primarily focused on addressing hunger and food security, promoting sustainable production systems, and building resilience to climate change and other shocks (Table 4.1). In particular, commitments were in alignment with the five action areas outlined at the UNFSS; this finding compares with recent reports. For instance, Kalibata (2022) observed that several African countries had committed to participating in the coalitions on zero hunger (14 countries), school feeding (10 countries), and healthy diets for children and all (16 countries). According to Kalibata, a number of other countries had made commitments to nourish all people (zero hunger, healthy diets for children and all, school feeding) and boost nature-based solutions, especially in the areas of sustainable production, resilience, and attention to climate change.

TABLE 4.1—RESPONSIVENESS OF COMMITMENTS PLEDGED BY AFRICAN HEADS OF STATE TO SELECT CAADP BIENNIAL REVIEW PERFORMANCE CATEGORIES AND TO THE WHO'S PRIORITY POLICY ACTIONS FOR FOOD SYSTEMS

Country	Commitments	CAADP Biennial Review performance categories (PCs)						WHO food systems for health priority policy actions						
		PC 3.1 Access to agric. inputs and technologies	PC 3.2 Agric. productivity	PC 3.3 Postharvest loss	PC 3.4 Social protection	PC 3.5 Food security & nutrition	PC 3.6 Food safety	Nutrition labeling	Marketing regulation	Public food procurement	Fiscal policies	Fortification	Reformulation	Food safety
Benin	1. Improve national integrated school feeding program.	Orange	Orange	Orange	Green	Green	Red	Red	Red	Orange	Red	Red	Red	Red
	2. Strengthen food and nutrition security for all.	Orange	Orange	Orange		Green	Orange	Red	Red	Red	Red	Red	Red	Orange
	3. Play a leading role in the global School Meals Coalition under the aegis of the World Food Programme.	Red	Red	Red	Orange	Orange	Red	Red	Red	Orange	Red	Red	Red	Red
	4. Mobilize resources to ensure the financing of food systems transformation.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Botswana	5. Increase sustainable climate-resilient food production.	Orange	Orange	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	6. Increase sustainable value creation and private sector development.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	7. Promote regional and international trade in agriculture commodities.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	8. Improve nutrition and sustainable consumption.	Red	Red	Red	Red	Green	Red	Red	Red	Red	Red	Red	Red	Red
	9. Promote decent employment in agriculture.	Red	Green	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	10. Develop and deploy new technologies that help agriculture adapt to changing environmental conditions.	Green	Green	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	11. Strengthen institutional capacity for food system governance.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	12. Control food losses from production to consumption.	Orange	Orange	Green	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	13. Include indigenous foods in the local food system.	Red	Red	Red	Red	Green	Red	Red	Red	Red	Red	Red	Red	Red
	14. Intensify collaborations with other nations for mutual benefit.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Democratic Republic of the Congo (DRC)	15. Invest in research and innovation to help double food production by sustainably increasing productivity through the adoption of high-yielding agricultural varieties.	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	16. Valorize inter-Africa trade and with the rest of the world in a mutually beneficial way.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	17. Invest in infrastructure and improve food safety compliance and standards.	Red	Red	Red	Red	Orange	Green	Red	Red	Red	Red	Red	Red	Green

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	18. Reduce endemic nontariff barriers at the border in order to stimulate trade.	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	19. Adopt multisectoral approach to transform food systems.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	20. Advocate for the establishment, under the initiative of the African Development Bank, of a financing mechanism for food and nutrition security in Africa.	🟠	🟠	🔴	🟠	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	21. Advocate for Africa/regional monitoring system to measure progress and hold each other accountable for the outcome of the UNFSS.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	22. Integrate the food systems approach into monitoring progress toward 2030, and to share DRC lessons and experiences with the rest of the world.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	23. Join coalitions being created to advance solutions favorable to the Africa Common Position on Food Systems and national interests.	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠	🟠
Egypt	24. Formulate a practical and implementable national system for transforming Egypt's food systems into sustainable ones.	🟠	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	25. Integrate and use international visions and solutions toward Egyptian food systems transformation.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	26. Develop a creative financing mechanism that helps developing countries achieve sustainable development and adapt to climate change.	🟠	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	27. Advocate for greater investment in capacity building and technology transfer to least-developed countries.	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	28. Establish a follow-up mechanism at the national level based on clear and measurable criteria and indicators that contains tools to modify and develop existing implementation plans and programs as needed.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	29. Establish a national council for food systems.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	30. Create awareness on the need to reduce food losses.	🔴	🔴	🟢	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	31. Promote healthy nutrition.	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	32. Develop food transport chains.	🔴	🟠	🟠	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴

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Ethiopia	33. Improve nutrient-dense food production, food safety, and fortification.	Orange	Green	Red	Red	Green	Green	Red	Red	Red	Red	Green	Red	Green
	34. Enhance rural electrification and appropriate climate-smart technologies.	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	35. Develop the supply and value chains.	Green	Green	Green	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	36. Develop and implement national food-based dietary guidelines, and use for nutrition literacy and awareness creation.	Red	Red	Red	Red	Green	Orange	Orange	Red	Red	Red	Red	Red	Orange
	37. Integrate policymaking, land reform, and improved government finance provision for agricultural and rural transformation.	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	38. Invest in agricultural technologies, innovation, and input supplies.	Green	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	39. Ensure access to markets, market information, infrastructure, and specialization.	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	40. Manage and mainstream risk and protect the poor.	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red
Gabon	41.Intensify the process of diversification of Gabon's economy, based on the inclusion of women and young people and on the preservation of the environment.	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	42. Place the agricultural sector at the heart of the priorities of a new development model.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	43. Provide the greatest number of agricultural lands whose land titles are secured.	Orange	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	44. Facilitate access to inputs or quality technical support, both for small producers and foreign investors.	Green	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	45. Gabon will continue its policy of combating climate change. To further preserve our environment, Gabon will adopt at the legal level an ordinance on climate change.	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	46. Gabon will transform the human–wildlife conflict into peaceful and harmonious cohabitation between man and fauna.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	47. Develop and promote short supply chains to ensure that national production systems are resilient to shocks.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	48. Offer national producers decent remuneration.	Orange	Orange	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red

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	49. Put requirements in place in terms of nutritional quality, quantitative production needs, and preservation of animal health.	Red	Green	Red	Red	Green	Green	Red	Red	Red	Red	Red	Red	Green
	50. Limit the environmental impact of productive activities.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	51. Consolidate the legal and financial framework to support the private sector.	Yellow	Yellow	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Red	Red
Gambia	52. Increase access to agriculture land, financing, and other productive resources for women, youth, and differently abled persons.	Yellow	Green	Red	Yellow	Red	Red	Red	Red	Red	Red	Red	Red	Red
	53. Increase the efficiency and effectiveness of the health delivery system.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	54. Exploit sustainably the country's natural resource base.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	55. Double Gambians' food production.	Yellow	Green	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Red	Red
	56. Coordinate a harmonized policy environment that affects food systems.	Red	Red	Red	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Yellow
	57. Contribute to better understanding and communication within government circles to eliminate the conflicts among policies (policy coherence).	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	58. Increase private sector investment in food systems.	Yellow	Yellow	Yellow	Red	Yellow	Red	Red	Red	Red	Red	Red	Red	Red
	59. Contribute to developing livelihoods and reducing the gaps between regions and different strata of society by creating employment opportunities and developing infrastructure.	Red	Red	Red	Yellow	Red	Red	Red	Red	Red	Red	Red	Red	Red
	60. Respect regional and international fiscal obligations.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Red	Red	Red
	61. Contribute to building partnerships, particularly, the commitment to the CAADP process of allocating 10% of the national budget to agriculture as contained in the Malabo Declaration of 2014, and to our UN and regional partners.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	62. Contribute access to safe and nutritious food, improve consumption patterns, and reduce malnutrition.	Red	Red	Red	Red	Green	Green	Red	Red	Red	Red	Red	Red	Red
	63. Protect the environment.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	64. Build resilience through smart agriculture.	Yellow	Yellow	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

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	65. Improve quality education.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	66. Improve gender equality.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	67. Create jobs.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	68. Enhance the sustainable use of the blue and green economies.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	69. Gambia is committed to the importance of the school feeding program in providing safe and nutritious food to our children and will therefore support the School Meals Coalition and commit ourselves to achieving the goals.	🔴	🟡	🔴	🟡	🟢	🟢	🔴	🔴	🟡	🔴	🔴	🔴	🟢
Ghana	70. Increase by 40% the production of climate-resilient varieties of diverse vegetables and legumes, fruits, and biofortified staple crops using sustainable agricultural practices.	🟡	🟢	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🟢	🔴	🔴
	71. Develop and implement food-based dietary guidelines by 2022.	🔴	🔴	🔴	🔴	🟢	🟡	🟡	🔴	🔴	🔴	🔴	🔴	🟡
	72. Update and consolidate local food composition databases.	🔴	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	73. Develop a nutrient profiling system to facilitate implementation of food-based policies.	🔴	🔴	🔴	🔴	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡
	74. Develop and implement well-structured training programs for agricultural extension workers in nutrition and sustainable agronomic practices.	🟡	🟡	🟡	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	75. Increase women's empowerment in agriculture index by 20%.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	76. Support increased production of fruits and vegetables by expanding the proportion of land area under irrigated agriculture from 24% to 30%.	🟡	🟢	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	77. Promote seed security, breed security, and land security for Ghanaian farmers, especially women and youth in agriculture.	🟡	🟢	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	78. Strengthen the integration of essential nutrition actions into the primary healthcare system.	🔴	🔴	🔴	🔴	🟢	🟡	🟡	🟡	🟡	🟡	🟡	🟡	🟡
Kenya	79. Ensure 100% food and nutrition security in Kenya.	🟡	🟡	🟡	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	80. Develop data-driven, inclusive, and innovative Kenyan food systems that provide a rich and diverse diet and build climate-resilient livelihoods.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴

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	81. Avail relevant information to farmers and traders through an existing national e voucher program, market information systems, and commodity exchanges.	🟠	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	82. Engage youth in agriculture.	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	83. Increase access to nutritious food and diversify the diet by bringing back forgotten and neglected traditional foods.	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	84. Invest in fisheries, aquaculture, livestock, fruits, and vegetable farming.	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	85. Enhance existing school feeding and school milk program, and take a leadership role in the School Meals Coalition.	🔴	🟠	🔴	🟠	🟢	🔴	🔴	🔴	🟠	🔴	🔴	🔴	🔴
	86. Harness the power of innovation and digital technologies in agriculture and foster an environment that allows our innovators to thrive and contribute to agricultural transformation.	🟠	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	87. Develop climate-smart agriculture programs, expedite ecosystems restoration efforts through agroforestry and reforestation, and ensure sustainable use of our natural resources.	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	88. Challenge global financial institutions to innovate and design appropriate de risking and financing instruments for increased investment in agriculture.	🟢	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Liberia	89. Ensure that women, who are widely considered a driving force of local food production, have direct access to basic support and resources—access to arable land through titled ownership, financial loans and grants, market links, technology, and training and extension services to ensure viable food systems.	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	90. Encourage youth to get more involved in food systems to reduce unemployment and enhance well-being.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	91. Have smallholder farmers and agribusinesses supported with machinery and financial grants needed to expand food production and processing.	🟢	🟢	🟠	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	92. Commit to enlist and advance the following UNFSS Coalitions of Action: youth employment; making food systems work for women and girls; school meals: nutrition, health, and education for every child; and resilient food supply chains.	🔴	🔴	🔴	🔴	🟢	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🟠

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Madagascar	93. Promote access to a diversified, healthy and nutritious diet with the involvement of the private sector and civil society.	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	94. Promote governance that promotes equitable and resilient livelihoods.	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	95. Promote youth and women's entrepreneurship.	🔴	🟡	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	96. Promote climate-resilient production with local transformation, agribusiness, the landscape approach, and the use of renewable energies.	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	97. Accelerate the process of effective decentralization in order to establish a territorial balance and guarantee equity in the distribution of public resources.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	98. Develop agricultural infrastructure and scale up innovative mechanisms to improve access to local agricultural services in terms of advice, extension, training, technical supervision, and funding.	🟢	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	99. Madagascar has already joined three coalitions, including zero hunger, resilient food supply chain, and transformation through agroecology.	🔴	🟡	🔴	🔴	🟢	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴
Malawi	100. Improve road infrastructure that makes the transportation of food difficult, raises food prices, and reduces food quality.	🔴	🟡	🟡	🔴	🟡	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🟡
	101. Address postharvest losses that expose households to food insecurity.	🔴	🔴	🟢	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	102. Diversify the Affordable Inputs Programme and scale up investments in integrated nutritious value chains.	🟢	🟢	🔴	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	103. Invest in medium- and large-scale farm mechanization nationwide.	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	104. Promote nutrient-rich foods and invest in frontline nutrition workers.	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	105. Adopt technologies and innovations for value addition and food preservation.	🔴	🟡	🟢	🔴	🟡	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🟡
	106. Invest in digitized and localized early warning systems.	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	107. Construct disaster preparedness infrastructure and review disaster risk management laws.	🔴	🔴	🔴	🟡	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴

TABLE 4.1—RESPONSIVENESS OF COMMITMENTS PLEDGED BY AFRICAN HEADS OF STATE TO SELECT CAADP BIENNIAL REVIEW PERFORMANCE CATEGORIES AND TO THE WHO'S PRIORITY POLICY ACTIONS FOR FOOD SYSTEMS

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	108. Pursue a multisectoral approach in the transformation of food systems.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	109. Various stakeholders pledge technical and financial support toward this vision of transforming Malawi's food systems—e.g., the Donor Committee of Agriculture and Food Security, the UN System, academia, the Malawi Bureau of Standards, and civil society organizations	🟠	🟠	🟠	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Mauritania	110. Invest and prioritize improvement of agricultural production, animal resources, and the rationalization of the management of our fisheries.	🟠	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	111. Create the conditions for the development of small-scale farming.	🟠	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	112. Promote a national industrial fabric to add value to local food production and its derivatives in order to reduce dependence on imports and lay the groundwork for meaningful economic and social development.	🟠	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Mauritius	113. Support the call for coordinated action for resilient, fair, sustainable, and more inclusive economies.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	114. Through a resilient agrifood system, increase productivity sustainably and decrease adverse effects on the environment—by addressing malnutrition and mitigating climate change	🔴	🟢	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	115. Make a new partnership for sustainable agriculture.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	116. Come together with renewed vigor with the solemn aim of finding nature-based solutions to man-made calamities.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	117. Look at the country's food systems through the farmers' eyes.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Morocco	118. Morocco has been able to put in place an integrated approach, which aims to guarantee food availability and promote sustainable agricultural and rural development.	🔴	🟠	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	119. Give priority to the protection of natural resources and adapt to climate change.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	120. Invest in the new agricultural strategy—Generation Green 2020–2030—to improve the resilience and sustainability of food systems in Morocco.	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴

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	121. Commit to three international coalitions: the School Meals Coalition, the Coalition for Food, and the Coalition on Agroecology.	🔴	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Namibia	122. Protect local environments, including oceans, by enhancing the conservation and sustainable use of oceans and their resources.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	123. Implement international law as reflected in the UN Convention on the Law of the Sea.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	124. Mobilize resources from a variety of sources including through enhanced development cooperation in order to provide adequate and predictable means of financial support.	🔴	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	125. Design and implement resilient agricultural practices to increase productivity .	🔴	🟢	🟠	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	126. Restore degraded land and combat desertification.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	127. The Namibian government will continue to prioritize land redistribution.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	128. Prioritize capacity building, financial support, and opportunities for value addition to realize agricultural potential.	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Niger	129. Ensure that the efforts undertaken in the transformation of local food systems lead to greater resilience to mitigate threats and crises, and on the other hand contribute to reducing the pressure on natural resources and better social inclusion.	🔴	🔴	🔴	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	130. Ensure the modernization of the agricultural sector to obtain more significant results in increasing and diversifying production and in creating trade and job opportunities, especially for youth and women.	🟠	🟢	🔴	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	131. Ensure social protection measures for vulnerable households, which will help to strengthen peace and social cohesion.	🔴	🔴	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	132. Enshrine the right to food in the constitution of the republic of Niger.	🔴	🔴	🔴	🔴	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🟠
	133. Mobilize of substantial financial resources for food systems transformation.	🟠	🟠	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	134. Commit to various coalitions for the implementation of numerous and better investments.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴

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Nigeria	135. Set up a food system focused on addressing existing gaps while prioritizing healthy diets and affordable nutrition so as to improve lives and livelihoods of the over 200 million Nigerians.	Red	Red	Red	Red	Orange	Orange	Red	Red	Red	Red	Red	Red	Orange
	136. Have an efficient, inclusive food system, which is vital especially taking into account the impact of climate change.	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	137. Follow the recommendations from the dialogues and Nigeria's plan to lift 100 million Nigerians out of poverty within a decade.	Red	Red	Red	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	138. Invest in food security and nutrition knowledge dissemination, skills' development, and information management systems to enhance agricultural productivity.	Red	Green	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	139. Build sustainable, responsive, and inclusive food systems.	Red	Orange	Orange	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	140. Enhance the productivity of smallholder farmers, and empower women and youth for greater access to food production and processing.	Orange	Green	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	141. Make greater investment in digital technologies, biotechnology, accessible financial services, and other proven innovations.	Green	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	142. Adopt nutritious food policies, establish food reserves, and expand school feeding programs.	Red	Red	Red	Green	Orange	Orange	Red	Red	Orange	Red	Red	Red	Orange
	143. Support local markets and food supply chains, and expand trade within Africa.	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	144. Work to increase agricultural financing to 10% of public expenditure.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	145. Facilitate smallholder farmers and ensure women's access to productive resources.	Green	Green	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	146. Expand social safety nets and climate data systems.	Red	Red	Red	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red
	147. Support broad global partnerships in order to transform food systems, and meet the SDGs.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	148. Promote accountability for advancing these actions, including regular reviews under the African Union's CAADP. Rwanda supports the Africa Common Position on Food Systems.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

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Senegal	149. Senegal's commitments for sustainable food systems is in line with the Plan Sénégal Emergent.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	150. Ensure that access to safe and nutritious food for all is fully guaranteed.	🔴	🔴	🔴	🔴	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🟢
	151. The functioning of consumption patterns remains to be perfected.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	152. Improve the production, processing, marketing, and consumption of agro-sylvo-pastoral and fisheries products.	🔴	🟢	🔴	🔴	🟠	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴
	153. Strengthen the legislative and regulatory framework for food systems.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	154. Strengthen the resilience of food systems.	🔴	🔴	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	155. Senegal pledges to join the Agroecology Coalition.							🔴	🔴	🔴	🔴	🔴	🔴	🔴
Seychelles	156. To the global call to reform the food systems, we will build on the outcomes of the dialogues, articulate the findings, and project ideas in the country's food system transformation strategy.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	157. Invest within the possibilities of our economic resources to bring to life the vision for a domestic food system less dependent on imports.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	158. Continued partnership to harness our collective resources and know-how to build a network of coalitions in the spirit of a win-win strategy and greater synergy to address the challenges of food systems transformation.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Somalia	159. Investment in agribusiness and food systems by promoting infrastructure, irrigation technology, and mechanization of all stages of production.	🟢	🟢	🟠	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	160. Commit to promote durable solutions to prevent the negative impacts of migration and displacement on food systems.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	161. Intensify efforts to combat climate change effects such as famine, floods, and pests, and promote disaster risk reduction (approaches) that are context specific to Somalia.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	162. Scale up early warning systems, which will support early decision-making and risk mitigation and reduce magnitude of displacement.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴

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	163. Commit to minimize the impact of shocks and scale up social protection programming within the country.	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red
	164. Advocate for the adoption and scaling up of nutrition-sensitive, government-led social protection programs to ensure no one is left behind.	Red	Red	Red	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red
	165. Stimulate markets and provide livelihood opportunities and more local nutritious food options by increasing investments in diversified nutrition-sensitive value chains.	Red	Red	Red	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	166. Encourage and create an enabling environment to support women's access to productive resources such as land, technology, active engagement, and involvement in leadership positions.	Green	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	167. Engage the youth in designing and developing digital innovative solutions while creating youth-centric opportunities, meaningful engagement, participation, and access to resources so as to enhance and scale up digital practices and innovations.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Sudan	168. Ensure food safety by modernizing laboratories and traceability system.	Red	Red	Red	Red	Red	Green	Red	Red	Red	Red	Red	Red	Green
	169. Standardize channels and implement quality indicators.	Red	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Orange
	170. Enhance agricultural diversity, support biodiversity, and support biofortification and food fortification (e.g., school feeding and home gardens).	Red	Red	Red	Red	Orange	Red	Red	Red	Orange	Red	Red	Red	Red
	171. Improve consumption and good food cultural practices and positively change consumption patterns.	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	172. Improve productivity and production by applying innovations and technology transfer.	Green	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	173. Reduce food loss and waste.	Red	Red	Green	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	174. Raise the efficiency of producers' organizations and encourage adaptive agriculture to climate change.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

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	175. Improve and develop food processing, quality control, and benefits from the value-added by product export.	Orange	Orange	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Orange
	176. Commit to fair and equitable livelihoods in terms of assets and strategies, mainly for segments of women, youth, and vulnerable groups.	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red
	177. Involve rural communities in food systems transformation.	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	178. Build resilience for communities, improving access to adequate income and managing disasters to build communities' capacities to address them.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	179. Pledges to join coalitions that promote the transformation of food systems.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
Tunisia	180. Adopt effective, fair, and multidimensional global governance that takes into account the specificities of developing countries and the challenges they face at the developmental and financial levels.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	181. Implement Resolution 2532 (2000), adopted by the Security Council at the initiative of Tunisia and France, which calls for a cessation of military operations in order to secure the delivery of humanitarian aid in the areas of crisis and conflicts.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	182. Mitigate several challenges, especially monopoly, speculation, inflation, and the rise in food cost.	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	183. Ensure access to all safe foods for all, in a sustainable manner and at appropriate cost.	Red	Red	Red	Red	Green	Green	Red	Red	Red	Red	Red	Red	Green
Uganda	184. Improve supportive infrastructure across the country including improvement of the road network and irrigation infrastructure, increased rural electrification, development of subnational and cross-border markets, and supporting digitalization and e commerce.	Orange	Orange	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	185. Ensure existence of an enabling policy environment and that the SDGs have been fully integrated in national development.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	186. Increase investment in research as a critical enabler to resilient, sustainable food systems development.	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red

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	187. Commit to taking bold and accelerated steps to fast-track the implementation of resolutions and plan of actions from the Summit.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
Zimbabwe	188. Develop more sustainable ways of producing, processing, accessing, and utilizing food.	🟠	🟠	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	189. Implement a food systems approach that aims to achieve safe and nutritious food and consumption patterns for all in Zimbabwe's quest to meet the SDGs.	🔴	🔴	🔴	🔴	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🟢
	190. The government of Zimbabwe is implementing the agricultural and food systems transformation strategy toward reviving, restructuring, and transforming agriculture.	🟠	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	191. Zimbabwe seeks to improve climate resilience through accelerated irrigation development, farm mechanization, and technology-based crop, livestock, land, and water management systems.	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	192. Accelerate rural development as well as achieve equitable access to safe and nutritious food for all.	🔴	🔴	🔴	🔴	🟢	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🟢
	193. Build resilience to vulnerabilities and shocks.	🔴	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	194. Reduce greenhouse gas emissions, in line with the country's nationally determined contributions under the Paris Agreement.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	195. Increase production and productivity by smallholder and communal farmers, inclusive of women and the youth.	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	196. Promote sustainable utilization of land and improved incomes for rural communities.	🔴	🟠	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	197. Zimbabwe places urgent emphasis on the nexus between food and the health of our planet, given that climate change is both a driver and a consequence of hunger.	🔴	🔴	🔴	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	198. Concerted efforts must be made to enhance the resilience and sustainability of agricultural and food production systems.	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	199. Partnerships remain critical as we reach out and draw from the various competencies in our respective countries.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴

TABLE 4.1—RESPONSIVENESS OF COMMITMENTS PLEDGED BY AFRICAN HEADS OF STATE TO SELECT CAADP BIENNIAL REVIEW PERFORMANCE CATEGORIES AND TO THE WHO'S PRIORITY POLICY ACTIONS FOR FOOD SYSTEMS

Country	Commitments	CAADP Biennial Review performance categories (PCs)						WHO food systems for health priority policy actions						
		PC 3.1 Access to agric. inputs and technologies	PC 3.2 Agric. productivity	PC 3.3 Postharvest loss	PC 3.4 Social protection	PC 3.5 Food security & nutrition	PC 3.6 Food safety	Nutrition labeling	Marketing regulation	Public food procurement	Fiscal policies	Fortification	Reformulation	Food safety
Africa Common Position on Food Systems	**To catalyze rapid expansion in agricultural and food productivity and production**													
	200. Paragraph 54: Access to basic means of production especially by frontline players in the food systems value chain—most of whom are SMEs, women, and operating informally.	🟠	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	201. Paragraph 55. Boosting nature-positive production and processing-value addition, at scale: Under this area, Africa is committed to	🔴	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	Boosting investment financing for Africa's food systems transformation agenda													
	202. Paragraph 56. AU's ambition to increase domestic public–private investment financing for Africa's economic growth and development agenda. Foreign finance should progressively move toward direct investments taking the form of financing for capital infrastructure, technology transfer, and market share.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	Ensuring access to safe and nutritious food for all: Under this area, Africa is committed to:													
	203. Paragraph 57. Promote biofortification of staple foods and industrial fortification of complementary foods to deliver better diets for all.	🔴	🔴	🔴	🔴	🟢	🔴	🔴	🔴	🔴	🔴	🟢	🔴	🔴
	204. Paragraph 58. Facilitate the expansion of cash transfer programs and use expanding cash transfer platforms to reach families with nutrition services and programs that focus on producing nutritious foods.	🔴	🔴	🔴	🟢	🟠	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	205. Paragraph 59. Promote and enforce food safety standards in both formal and informal food markets to protect consumers.	🔴	🔴	🔴	🔴	🟠	🟢	🔴	🔴	🔴	🔴	🔴	🔴	🟢
	206. Paragraph 60. Expand domesticated school feeding programs to improve nutrition for schoolchildren and create markets for locally produced foods. to increase farmer incomes.	🔴	🔴	🔴	🟢	🟠	🔴	🔴	🔴	🟠	🔴	🔴	🔴	🔴

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	207. Paragraph 61. Design and implement innovative Social and Behavior Change Communication campaigns and nutrition education to improve food and feeding practices for children and society at large and to influence food supply and food environments.	Red	Red	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red
	208. Paragraph 62. Adopt and implement coherent nutritious food policies and strategies that are evidence based, along with enhanced institutional capacities and capabilities for accelerated transformation of sustainable food and nutrition systems.	Red	Red	Red	Red	Orange	Red	Red	Red	Red	Red	Red	Red	Red
	209. Paragraph 63. Identify, renew, and implement longer-term actions across multiple systems—food, health, water and sanitation, education and social protection—in the food system to facilitate sustained access to affordable and nutritious foods, essential nutrition services, and positive nutrition practices in all contexts, and to promote diversification, including in nutritious indigenous foods.	Red	Red	Red	Red		Red	Red	Red	Red	Red	Red	Red	Red
	210. Paragraph 64. Adopt policy and fiscal measures across government ministries to support food affordability (i.e., subsidies for healthy and sustainable foods, expansion of social protection programs, taxation for unhealthy foods, and procurement policies for healthy school meals).	Red	Red	Red	Green	Red	Red	Red	Red	Green	Green	Red	Red	Red
	211. Paragraph 65. Implement long-term inclusive strategies that foster multifaceted investment in agriculture, agribusiness, and agro-industries; and ensure food safety, micronutrient content, and sustained food quality and standards that enable micro and medium agro-SMEs to compete in domestic, regional, and international value-added food markets.	Red	Red	Red	Red	Orange	Green	Red	Red	Red	Red	Red	Red	Green
	212. Paragraph 66. Promotion of national, regional, and continental food information systems to share information on the availability of food and food prices at all levels, and how it could be accessed.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
	213. Paragraph 67. Ensure adequate regional strategic emergency food reserves and storage facilities.	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red

TABLE 4.1—RESPONSIVENESS OF COMMITMENTS PLEDGED BY AFRICAN HEADS OF STATE TO SELECT CAADP BIENNIAL REVIEW PERFORMANCE CATEGORIES AND TO THE WHO'S PRIORITY POLICY ACTIONS FOR FOOD SYSTEMS

Country	Commitments	CAADP Biennial Review performance categories (PCs)						WHO food systems for health priority policy actions						
		PC 3.1 Access to agric. inputs and technologies	PC 3.2 Agric. productivity	PC 3.3 Postharvest loss	PC 3.4 Social protection	PC 3.5 Food security & nutrition	PC 3.6 Food safety	Nutrition labeling	Marketing regulation	Public food procurement	Fiscal policies	Fortification	Reformulation	Food safety
	214. Paragraph 68. Incentivize national and transnational trade corridors for food commodities and services and ensure dedicated attention to regional food markets and trade in all AfCFTA provisions and protocols.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	Strengthening and harnessing Africa's growing local food markets													
	215. Paragraph 69. Shifting to sustainable consumption patterns.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	216. Paragraph 70. Advancing equitable livelihoods and value distribution.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴
	217. Paragraph 71. Building resilience to shock and stress	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🟢
	218. Paragraph 72. Facilitating and building local implementation capacities at all levels with focus on frontline players and decentralized structures.	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🔴	🟢	🔴	🔴

Legend:
- 🟢 Fully responsive (meaning commitment is aligned with the WHO priority policy or the CAADP Biennial Review performance categories).
- 🟠 Partially responsive (meaning commitment is somewhat aligned with the WHO priority policy or the CAADP Biennial Review performance categories).
- 🔴 Not responsive (meaning commitment is not aligned at all with the WHO priority policy or the CAADP Biennial Review performance categories).

Source: Authors, based on Laar et al. (2023).

Note: AfCFTA = African Continental Free Trade Area; AU = African Union; CAADP = Comprehensive Africa Agriculture Development Programme; SDGs = Sustainable Development Goals; SMEs = small and medium enterprises; UN = United Nations; UNFSS or the Summit = United Nations Food Systems Summit; WHO = World Health Organization.

Responsiveness of Africa's Commitments to Select CAADP Biennial Review Performance Categories

As Table 4.1 shows, our analysis also assessed the responsiveness of each country's pledges to the commitments in the CAADP domain "Ending Hunger in Africa by 2025"—specifically, access to agriculture inputs and technologies; agricultural productivity; postharvest loss; social protection; food security and nutrition; and food safety. Table 4.2 summarizes our sample's responsiveness to the commitments by number of countries and number of commitments. Of the 26 countries we included in the analysis, the total number that are fully responsive to the CAADP Biennial Review performance categories ranges from four countries (for social protection) to 17 countries (for agriculture productivity). Out of 219 commitments that we analyzed, the total number of commitments that are fully responsive to the CAADP Biennial Review performance categories ranges from six (for postharvest loss) to 29 (for both agriculture productivity and food/nutrition security).

In Table 4.1, we provide details of the national commitments that are fully responsive to the CAADP Biennial Review performance categories. For instance, with regard to promoting access to agriculture inputs and technologies:

- Botswana pledges to develop and deploy new technologies that help agriculture adapt to changing environmental conditions.
- The Democratic Republic of the Congo pledges to invest in research and innovation to help double food production by sustainably increasing productivity through the adoption of high-yielding agricultural varieties.
- Ethiopia commits to investing in agricultural technologies, innovation, and input supplies.
- Gabon commits to facilitating access to inputs or quality technical support, for both small producers and foreign investors.
- Ghana pledges to ensure seed security, breed security, and land security for vulnerable famers.
- Kenya is challenging global financial institutions to innovate and to design appropriate de-risking and financing instruments for increased investment in agriculture.
- Liberia commits to ensuring that women have direct access to basic supports and resources—access to arable land through titled ownerships, financial loans and grants, market links, technology, training, and extension services to ensure viable food systems.

TABLE 4.2—RESPONSIVENESS OF AFRICA'S COMMITMENTS TO SELECT CAADP BIENNIAL REVIEW PERFORMANCE CATEGORIES

	Biennial Review indicators					
	PC 3.1 Access to agriculture inputs and technologies	PC 3.2 Agriculture productivity	PC 3.3 Postharvest loss	PC 3.4 Social protection	PC 3.5 Food security and nutrition	PC 3.6 Food safety
			N (%)			
Number of countries with commitments somewhat responsive to the CAADP BR performance categories	19 (73)	21 (81)	14 (54)	15 (58)	23 (88)	13 (50)
Number of countries fully responsive	11 (42)	17 (65)	5 (19)	4 (15)	15 (58)	8 (31)
			N (%)			
Total number of commitments that are somewhat responsive to the CAADP BR performance categories	52 (24)	64 (29)	20 (9)	23 (11)	51 (23)	16 (7)
Total number of commitments that are fully responsive to the CAADP BR performance categories	17 (8)	29 (13)	6 (3)	8 (4)	29 (13)	12 (5)

Source: Authors.
Note: BR = Biennial Review; CAADP = Comprehensive Africa Agriculture Development Programme; PC = performance category

- Madagascar plans to develop agricultural infrastructure and scale up innovative mechanisms to improve access to local agricultural services, such as, for example, advice, extension, training, technical supervision, and funding.
- Malawi will diversify its Affordable Inputs Programme and scale up investments in integrated nutritious value chains.
- Rwanda pledges to support smallholder farmers and ensure women's access to productive resources.
- Somalia pledges to encourage and create an enabling environment to support women's access to productive resources such as land, technology, active engagement, and involvement in leadership positions.
- Sudan commits to improve productivity and production by applying innovations and technology transfer.

With regard to reducing postharvest loss:

- Botswana pledges to control food losses from production to consumption.
- Egypt commits to create awareness about the need to reduce food losses.
- Ethiopia commits to supply and value chain development.
- Malawi commits to adopt technologies and innovations for value addition and food preservation.
- Sudan pledges to reduce food loss and waste.

Responsiveness of Africa's Commitments to the WHO Food Systems Priority Policy Actions

Regarding responsiveness to the WHO's priority policies, Table 4.1 shows that even fewer countries committed to them. For example, in terms of food safety:

- The Democratic Republic of the Congo commits to invest in infrastructure and improve food safety compliance and standards.
- Ethiopia pledges to improve nutrient-dense food production, food safety, and fortification.
- Gabon pledges to put requirements in place in terms of nutritional quality, quantitative production needs, and preservation of animal health.
- Gambia commits to contribute to access to safe and nutritious food.
- Senegal pledges to fully guarantee access to safe and nutritious food for all.
- Sudan commits to ensure food safety by modernizing laboratories and a traceability system.
- Tunisia pledges to ensure access to safe foods for all in a sustainable manner and at appropriate cost.
- Zimbabwe commits to implement a food systems approach that aims to achieve safe and nutritious food and consumption patterns for all in its quest to meet the SDGs.

At the continental level, in the Africa Common Position on Food Systems, the African Union responded to some of the WHO's priority policy actions. Among the priorities of African Union member states are the following:

- Promoting biofortification of staple foods and industrial fortification of complementary foods to deliver better diets for all
- Expansion of cash transfer programs and of the reach to families with nutrition services and programs that focus on producing nutritious foods
- Expanding domesticated school feeding programs to improve nutrition for school children and create markets for locally produced foods to increase farmer incomes
- Promoting and enforcing food safety standards in both formal and informal food markets to protect consumers
- Adopting policy and fiscal measures (i.e., subsidies for healthy and sustainable foods, expansion of social protection programs, taxation for unhealthy foods, and procurement policies for healthy school meals)

Discussion

This chapter assesses the responsiveness of the commitments made by African countries at the UNFSS to the WHO's food systems priority policy actions and select CAADP Biennial Review indicators, and contextualizes the findings using available literature on the subject. Our findings indicate that about half of all African countries (26 out of 55) formulated and submitted via the UNFSS portal their national commitments or pledges to transforming their food systems by 2030. This work recognizes the continuing and crucial efforts being made by African governments to strengthen the continent's food security and other dimensions of food systems. The 2021 UNFSS offered African leaders yet another opportunity to renew their engagement to build a robust food system and identify actions that the continent can leverage in the form of commitments. At the Summit, African countries announced to the world the priority initiatives that they would pursue to transform their countries' food systems. In parallel, the WHO, cognizant of the revelations and insights from the UNFSS, identified food systems as a critical determinant of health and has outlined several priority actions to address the challenges such systems face. Likewise, CAADP aims to eliminate hunger and reduce poverty through agriculture-led development in African countries.

Responsiveness to the WHO Food Systems Priority Policy Actions and to the CAADP Biennial Review Performance Categories

African countries have not fully aligned their commitments with the WHO's priority food systems policies or the select CAADP Biennial Review indicators. Some countries have been more responsive than others, showing varying degrees of commitment. Most countries have focused their commitments on the CAADP Biennial Review indicators, which aim to end hunger and food insecurity by improving agricultural production and increasing farm yields through innovations and the use of appropriate inputs and technologies. However, whereas such an approach may lead to the increased production of food, it will not necessarily lead to a sufficient quantity of healthy food.

A few countries mentioned improving the nutritional quality of food along the food supply chain and creating healthier food environments—policies that align most with the WHO's priority food systems for health policy actions. Among the few commitments were broad statements about nutrition such as "improving national school feeding program," "strengthening nutrition security," and "improving nutrition," but there were also specific statements such as "inclusion of indigenous foods in local food system," "promot[ing] healthy nutrition," "develop and implement food-based dietary guidelines by 2022," "develop a nutrient profiling system to facilitate [the] implementation of food-based policies," "diversifying the diet by bringing back forgotten and neglected traditional foods," and "promote biofortification of staple foods and industrial fortification of complementary foods to deliver better diets for all."

In comparison with the CAADP Biennial Review performance categories, there was little mention of the WHO recommendations for countries to improve their food systems. The deficiencies we observed in our analysis converged with Laar and colleagues' (2023) observations. In their analysis, Laar and colleagues highlight that very few countries featured the health and nutrition, environmental, and socioeconomic dimensions of sustainability in their commitments and that even fewer countries were responsive to the WHO priority policy actions. Hence, they concluded that any food system unsupportive of public health cannot be said to be sustainable.

Although the commitment to multisectoral/stakeholder collaboration, the use of modern technologies, and mechanisms for monitoring the transformation were laudable, there were few commitments that addressed the data and indicators gap on the continent necessary for monitoring food systems transformation. The question of who would and how to finance such a transformation in Africa was hardly addressed. Proposals mentioned investments from the private sector and government, including committing 10 percent of public expenditure to agriculture as stipulated by the African Union (2014), but there was little mention of empowering the population to demand and make healthier food choices through labeling laws, and the environment and sustainability question remained underdeveloped. The commitments were also less responsive to food safety issues, the environment, and the sociocultural dimensions of sustainability. However, there were pledges to join the Africa Common Position on Food Systems coalition, support small and medium enterprises and other small-scale producers, and create employment, among others.

According to the Biennial Review and the SDG reports, the world is falling behind in achieving the SDGs—of which the Malabo target is a part—and the African nations are no exception. The continent is facing a disproportionately large number of challenges, including economic, health, sanitation, and structural issues. Despite progress made in food security over the past decade, the COVID-19 pandemic and ongoing armed conflicts have caused setbacks in this area. Additionally, efforts to make necessary changes in areas such as the environment, health, and sociocultural issues have only just begun. Despite these warning signs, African nations continue to pursue an ineffective and unsustainable model for change, potentially due to the pressures of population growth, urbanization, and high unemployment exacerbated by COVID-19 and recent climate-related disasters.

It is widely agreed that simply increasing food production will not be enough to achieve sustainable and healthy diets beyond 2030. The Malabo targets and the SDGs call for holistic changes in the food system, moving from feeding to nourishing. African countries struggle to catch up with this concept, which also includes caring for the planet and addressing social injustice. The effects of neglecting such changes will only be worsened by emerging development challenges such as climate change, environmental degradation, social inequalities, and conflicts. However, by integrating both quantitative and qualitative policies, the continent can effectively address these issues.

Conclusions and Recommendations

African heads of state made commitments at the UNFSS that were partly responsive to the CAADP indicators. Those commitments addressed the need to increase agricultural inputs and production on the continent, address economic challenges in society, and, ultimately, improve food security and nutrition. However, they were less responsive to the WHO's proposed priority policies for improving the food environment and curbing the spread of NCDs. To achieve the SDGs, African nations must commit to concrete, integrated, and targeted actions, including eradicating malnutrition in all forms, reducing inequality, caring for the planet, and strengthening national and subnational capacity, accountability, and public institutions. A fundamental shift is required to accelerate progress toward achieving the SDGs.

Numerous assessments have recognized that improving Africa's food systems requires a coherent combination of policies, investments, and legislation. This means reinforcing interconnected actions from sectors such as agriculture, food, trade, and health. Simply increasing agricultural production without considering sustainability and the health of humans will only provide food without leading to a healthy population as envisioned by the SDGs for 2030 and beyond. In light of rising food insecurity and malnutrition in Africa, game-changing actions must be taken to improve the food systems. Actors should shift their focus to food systems that provide quality and nutritious food instead of solely focusing on quantity or food security.

Africa's food systems need a collaborative effort from all African countries to implement and achieve the CAADP indicators and the WHO priority food system policies. Each country faces unique food system challenges, which require context-specific initiatives. However, managing these initiatives and ensuring coherence among countries is crucial to transforming Africa's food system. Policies with impacts on Africa's food systems must be implemented cohesively to achieve the desired transformation and provide healthy food to meet the nutritional requirements of the African population. Eliminating policy silos and shifting focus toward nutrition security is vital to combatting malnutrition in Africa.

The WHO's priority policy actions provide an avenue to the changes needed for sustainable food systems and diets in Africa. For example, health taxes provide a partial answer to how to finance food system transformation. Taxes can be levied on unhealthy food options (foods high in fats, sugars, and/or salt) to increase their price and discourage their purchase and consumption, while subsidies (collected from unhealthy foods) can be used to reduce the price of healthier options (fruits and vegetables) to encourage their consumption (WHO 2021b). Such intervention, if grounded in policies backed by law with a workable enforcement structure, can provide a financing mechanism for prompting qualitative changes in food systems. Although current efforts in Ghana and South Africa aim at repurposing the funds from levies on unhealthy commodities, evidence in South Africa indicates that taxing sugar-sweetened beverages (SSBs) is progressive for health. The daily purchased volume of taxed drinks in South Africa fell from 518.99 mL/capita per day (506.90–531.08) to 443.39 (430.10–456.56). Similarly, the *daily* purchased sugar and calories from taxable beverages fell from 16.25 g/capita per day (95% CI 15.80–16.70) to 10.63 (10.22–11.04) and 70.21 kcal/capita per day (68.31–72.11) to 46.45 (44.71–48.15) in the pre-announcement and the post-implementation period of the Health Promotion Levy, respectively (Stacey et al. 2021).

From a policymaking perspective, the near absence of low-agency and high-agency measures (for example, empowering the growing population to demand and make healthier food choices) in the commitments is worrisome. Consumers need to be informed about the importance of a healthy diet and the nutritional quality of foods so that they can make healthy choices. Simplified nutrition information on food packages can be a valuable guide for consumers to choose healthier foods and has been recommended to tackle the increase in NCDs (WHO 2017) and prevent childhood obesity (WHO 2016). Few African nations have these in place or have pledged to develop them.

CHAPTER 5

2023 ATOR: The Call for Nutrition-Smart Food Systems

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Introduction

A shift from agriculture to manufacturing was one of the hallmarks of job creation, poverty reduction, and rapid growth in low-income countries during the latter half of the 20th century. This experience in earlier decades of structural transformation was characterized by labor-absorbing, productivity-increasing manufacturing. Recent structural change in African countries has been markedly different—productivity gains are realized through reallocation of economic activity away from agriculture without the accompanying within-sector productivity growth in nonagriculture, and manufacturing in particular (Diao, McMillan, and Rodrik 2019; Diao et al., 2021; McMillan and Zeufack 2022). This chapter examines the extent to which agrifood processing follows these trends.

A nutrition-smart food system is one that effectively and sustainably addresses both hunger and malnutrition, from undernutrition to micronutrient deficiencies and overnutrition. Such a system ensures that food production, processing, distribution, consumption, and waste disposal are optimized for human health while being environmentally sustainable. It emphasizes a variety of crops rather than monocultures to increase dietary diversity, which is crucial for supplying all essential nutrients (Herforth and Harris 2014). It also addresses issues in storage, transportation, and consumption to minimize food waste, thereby ensuring that more nutrients are retained in the food system. A nutrition-smart food system ensures that the food available to consumers is not only sufficient in quantity but also in quality, emphasizing nutrient-rich foods (Hawkes et al. 2020). Additionally, nutrition education and public campaigns can influence healthier food choices. A nutrition-smart food system incorporates nutrition goals into agricultural policies and practices, which involves selecting specific crops for cultivation based on their nutritional profiles or improving soil health for better nutrient content in crops. A shift to nutrition-smart food systems can also help to mitigate adverse environmental impacts by promoting sustainable agricultural practices and reducing food waste (Willett et al. 2019) and can contribute to economic growth and efficiency (Bloom et al. 2011).

In Africa, gradual but steady improvements in food security and nutrition over the past two decades have recently faltered. The prevalence of overall population undernourishment and child malnutrition declined consistently from the early 2000s to the mid-2010s, but undernourishment subsequently increased in the second half of the 2010s (see chapter 13, this volume). The COVID-19 crisis beginning in 2020, followed by the Ukraine-Russia war and associated food price inflation in 2022 have provoked increases in hunger and malnutrition which could persist for years to come (FAO et al. 2023). In addition to undernutrition, Africa also faces growing prevalence of overnutrition, with increases in overweight and obesity that are associated with increased risk of noncommunicable diseases such as diabetes and heart disease (Global Nutrition Report 2023).

Africa also faces serious problems of micronutrient deficiencies (also referred to as "hidden hunger") resulting from inadequate intake of vitamins and minerals. Micronutrient deficiencies can coexist with both undernutrition and overnutrition (Kim et al. 2019), impeding healthy growth, development, and functioning and causing or contributing to serious illness and death (Bailey, West, and Black 2015). Comprehensive data on micronutrient deficiencies for large population groups are lacking, but available evidence suggests that deficiencies are severe and widespread in Africa. In their study of global death and disease burdens due to micronutrient deficiencies, Muthayya and others (2013) found high concentrations of burden in Africa south of the Sahara. Han and colleagues (2022) estimated that central and eastern Africa had the highest rates of vitamin A deficiency in the world in 2019, with age-standardized prevalence rates of more than 20 percent compared to the global rate of under 7 percent. Western Africa had one of the highest estimated rates of dietary iron deficiency (after South Asia) at more than 21 percent, compared to around 14 percent globally (based on 2019 data).

Although nutrition-smart food systems have the potential to address all forms of malnutrition, their promotion can be challenging due to political, economic, and cultural barriers and knowledge and infrastructure gaps. Often, nutrition does not receive the political priority it deserves, with initiatives for healthier food systems competing with other political priorities. The economic structure of many food systems is such that unhealthy, highly processed foods are often cheaper and more readily available than healthier alternatives, due to subsidy patterns, the difficulty of storing and transporting nutrient-dense foods, and other factors. Exposure to different types of food in the environment, food marketing, lack of nutrition knowledge, and misinformation on nutrition also shape consumer preferences and can contribute to poor dietary choices (Chandon and Wansink 2012; Hawkes et al. 2015).

This chapter focuses on the issue of micronutrient deficiencies, examining nutrient adequacy at multiple stages to identify priority strategies to enhance nutrition throughout food systems. To better understand the scale of challenges regarding micronutrient deficiencies in African countries, it is important to examine the availability of micronutrients at different segments in food systems. Nutrients can enter food at multiple stages—during food production, during processing through industrial fortification, and through at-home fortification—and can also leave at multiple stages, including processing, storage, and cooking. Addressing micronutrient deficiencies and strengthening the ability of food systems to provide adequate nutrition requires understanding the nutritional content of food at multiple stages in food systems and identifying key points at which interventions can stem nutrient loss or enhance nutrient conservation or gain.

In this chapter, we implement an approach to assess nutrient adequacy at multiple stages in food systems as a first step to identifying priority strategies to enhance nutrition. The evidence provided in this chapter can, within the framework of the Comprehensive Africa Agriculture Development Programme M&E system, help to better identify the challenges in terms of eradicating hunger and guide efforts to better integrate nutrition into the design of the post–Malabo Declaration agenda. We select two countries—Senegal in western Africa and Rwanda in eastern Africa— to highlight the needs for context specific strategies while rolling out nutrition-smart food systems strategies. Indeed, several factors can contribute to the differences in the nature of micronutrient deficiencies between the two countries, including differences in dietary habits, food availability, socioeconomic factors, cultural practices, agricultural systems, and public health interventions. For instance, regions that rely heavily on a single crop (monoculture) may lack diversity in their diet, leading to certain micronutrient deficiencies (Welch and Graham 2004). Countries that fortify staple foods with micronutrients might have lower prevalence of certain deficiencies (Bhutta, Salam, and Das 2013).

In this chapter, we use household survey data to examine nutrient consumption against nutritional requirements as well as agricultural production data to assess the production of nutrients. Comparing nutrient production adequacy with overall consumption adequacy as well as adequacy at the household level serves

BOX 5.1—ROLES OF KEY NUTRIENTS EXAMINED IN THE CHAPTER

The nutrients examined in this chapter are essential for healthy growth and functioning, and deficiencies are a major cause of reduced productivity, poor health, disability, and mortality in developing countries. Key roles of the nutrients examined are briefly summarized below:

- Proteins are essential components of the human body and are necessary for many bodily functions. Deficiencies can cause poor growth, loss of muscle, reduced immune function, and other issues.
- Calcium protects bone health and helps to prevent negative pregnancy outcomes, preterm birth, and neonatal mortality.
- Iron has major impacts on cognitive function and productivity; deficiencies contribute to maternal mortality and low birth weight.
- Vitamin A is necessary for immune system functioning; deficiencies cause increased maternal and childhood mortality and are a major cause of childhood blindness.
- Riboflavin deficiencies impede digestion of carbohydrates, protein, and fat as well as iron absorption and can cause growth delay and other developmental issues.
- Vitamin B12 is essential for cellular metabolism, red blood cell production, and neurological functioning.
- Zinc deficiency impairs overall growth and development and is associated with increased maternal and infant mortality.
- Folate deficiency can cause anemia and contribute to birth defects and other negative outcomes.
- Vitamin C helps the body to fight infections and heal from injuries and is necessary for the production of collagen and some hormones.
- Niacin aids enzymatic reactions, repairs DNA, plays a role in converting nutrients found in food into energy, and may help to maintain brain health.
- Thiamin is essential for cellular growth and function; deficiencies can cause heart failure, cognitive issues, and muscle loss.

Source: Authors analysis based on Bailey, West, and Black 2015; Conti et al. 2019; Green et al. 2017; Harvard 2023; Mahabadi, Bhusal, and Banks 2023; and WHO 2023.

as a first step to identifying areas where nutrients may be entering or exiting the system. This can help to guide efforts to address nutrient gaps, whether by enhancing production of nutrients through biofortification or crop selection, increasing availability of nutrients through imports or food fortification, or enhancing households' access to nutritious foods through price or income interventions. As both production and consumption adequacies can differ markedly within countries, we examine adequacy patterns both at the national and subnational levels (that is, departments for Senegal and districts for Rwanda). The chapter assesses adequacy for energy and protein as well as ten micronutrients (calcium, iron, zinc, folate, vitamin A, vitamin B12, vitamin C, riboflavin, niacin, and thiamine).[1] Box 1 provides a summary of the key functions of these nutrients.

The remainder of the chapter is structured as follows: Section two describes our analytical approach, methodology, and data sources; section three reports nutrient adequacy results and maps adequacy patterns at the subnational level; section four discusses policy implications and potential strategies to fill nutrient gaps; and the final section provides our conclusions.

Methodology and Data

Analytical Approach

Following the work of Marivoet and Ulimwengu (2022) and Marivoet and colleagues (2021), this chapter carries out analysis on three types of nutrient adequacy measures: nutrient production adequacy (NPA), nutrient market adequacy (NMA), and nutrient household adequacy (NHA). NPA expresses the ratio of the total quantity of a nutrient produced in an area to the total requirements of its population. On the consumption side, NMA shows the ratio of the total quantities of nutrients consumed in an area to total population requirements without accounting for unequal distribution between households, while NHA is the ratio of average household-level consumption to requirements. Thus, NPA provides an overview of the adequacy of production, NMA shows the adequacy of the availability of nutrients for consumption in markets, and NHA shows the adequacy of consumption at the household level (see Magne Domgho et al. 2023 for more details). While NPA, NMA, and NHA do not capture all food systems segments, they provide a simplified framework to assess nutrient adequacy at key milestones and serve as an entryway to identify possible areas of intervention to improve nutrition.

In order to carry out the analysis of NPA, NMA, and NHA, we first converted the quantities of food consumed by households into nutrient equivalents. The results obtained enabled us to identify the localities with high nutrient gaps and highlight the main foods consumed that contribute most to nutrient intake. Then, to provide information on the dynamics of household food consumption, we applied a Quadratic Almost Ideal Demand System (QUAIDS) model to derive elasticities of demand for nutrients with respect to income and to prices of different food groups (see Ulimwengu et al. 2023 for details).

Estimating Nutrient Production, Market, and Household Adequacy

To convert the quantities of food consumed into nutrient equivalents, we applied an edible conversion factor to each food item and matched it with the most suitable record within the appropriate food composition table (FCT): the Food and Agriculture Organization of the United Nations' (FAO's) West African FCT (Vincent et al. 2020) for Senegal, and Kenya's FCT for Rwanda (FAO, Kenya Ministry of Health, and Kenya Ministry of Agriculture and Irrigation 2018).[2] Finally, we estimated for each food consumption line the total quantity of energy, proteins, calcium, iron, zinc, folate, vitamin A, vitamin B12, vitamin C, riboflavin, niacin, and thiamine (as well as vitamin B6 for Senegal).

As a first step to estimating NHA, nutrient intake estimates for each household member were computed by applying the corresponding adult male equivalent (AME)[3] factors (FAO 2001) to account for differences in the age and gender composition of households. We assume that food is distributed to members in proportion to each member's share of energy requirements. After calculation, households that fall outside a plausible consumption range of 500–5000 kcal consumption per person per day (Voortman et al. 2017) were removed from the survey sample. Actual nutrient intakes were compared

1 We also include vitamin B6 for Senegal only due to data availability.

2 For Rwanda, the Kenya FCT was completed by information from food composition tables for Tanzania (Lukmanji et al. 2008) and Uganda (Hotz et al. 2012) as well as the West Africa FCT.

3 Adult male equivalents (AME) express energy requirements on the basis of gender, age, and physiological status as a proportion of the energy requirements of an average adult male (Weisell and Dop 2012).

to recommended daily nutrient intakes defined in WHO and FAO (2005) to determine nutrient adequacy ratios (NARs). As some households exceeded recommended intakes and others had deficits, household NARs were truncated at 100 percent before calculating average adequacy levels—referred to in our analysis as NHA—in order to avoid households with surplus intakes masking nutrient deficiencies. We calculated NMA based on overall consumption for an area divided by recommended intakes, without truncating, in order to express the adequacy of the total supply of nutrients available for consumption. For NPA, quantities produced of crops and animal products were similarly converted into nutrient equivalences using the same food composition tables listed above. Nutrients produced were compared to recommended daily intakes in WHO and FAO (2005) to calculate NPA.[4]

Several limitations of the analysis should be noted. Estimated nutrient adequacy levels take into account the varying demographic makeup of households; however, as food consumption data were collected at the household level, the analysis cannot account for potential disparities in shares of food allocated to different household members.[5] In addition, actual nutrient intake may differ from what is suggested by the data due to differences in cooking methods used by households that affect nutrient content of foods, as well as varying bioavailability of nutrients. When comparing NPA with NMA and NHA, it should be noted that some differences may be related to the different data sources used, as discussed in the next section.

Data Sources

The NPA analysis for Senegal is based on crop production data from the country's annual agriculture survey, *Enquête Agricole Annuelle,* carried out by the Directorate of Analysis, Forecasting and Agricultural Statistics (DAPSA) in 2017–2018. The DAPSA data are complemented by data from FAOSTAT, the Ministry of Fisheries and Maritime Production (MPEM), the Ministry of Livestock and Animal Production (MEPA) on palm oil, fishery, and livestock production, and the Directorate of Water, Forests, Hunting and Soil Conservation (DEFCCS) on nontimber forest products, respectively. Production data for most crops and animal products are available at the national and subnational levels; however, information on the production of palm oil and most fruits is only available at the national level. The NMA and NHA analysis for Senegal is based on household survey data collected in 2017–2018 as part of the Projet d'Appui aux Politiques Agricoles (PAPA) led by Senegal's Ministry of Agriculture and Rural Equipment, the International Food Policy Research Institute, and Michigan State University with funding from the USAID.

Nutrient production data for Rwanda uses the crop production module from the fifth Rwanda Integrated Household Living Conditions Survey (EICV 5), which was conducted by the National Institute of Statistics of Rwanda (NISR) between October 2016 and October 2017. The data is complemented by data from Ministry of Agriculture and Animal Resources (MINAGRI) and from the Rwanda Agriculture Board (RAB) on livestock and fishery production, respectively. The NMA and NHA analysis for Rwanda is based on the food consumption module of the EICV 5.

Results: Nutrient Production, Market, and Household Adequacy

In this section, we compare NPA, NMA, and NHA at the national level for Senegal and Rwanda for all nutrients. We also identify key foods contributing to the production and consumption of nutrients, compute price and income elasticities of demand for nutrients, and map the three adequacy measures at the subnational level for selected nutrients. Comparing NPA, NMA, and NHA can provide an entry point to identifying potential sources of nutrient loss in food systems. Differences between NPA and NMA reflect loss or entry of nutrients between the production and market stages. For example, nutrients can leave the food system after production due to postharvest losses or other uses of production besides human consumption (for example, as animal feed). Industrial fortification of food can add nutrients and contribute to greater market adequacy than production adequacy. Trade, both domestic and international, can also cause differing

4 Further methodological details are available from Magne Domgho et al. (2023).

5 Relatively little research has been carried out on intrahousehold food allocation due to the difficulty of collecting consumption data at the individual level. A study by De Vreyer and Lambert (2019) does not indicate evidence of disparities in food allocation within Senegalese households, but results from Fadare and colleagues (2018) suggest that men are more likely than women and children to benefit from relatively diverse diets in Nigerian households. In Rwanda, focus groups indicate that men receive larger quantities and more preferred foods such as meat (Rwanda, Ministry of Health 2005).

levels of NPA and NMA, as some nutrients produced in a region are transported outside of the region and others produced elsewhere are purchased and consumed in the region. Differences between NMA and NHA reflect unequal distribution of nutrients among households in a given locality. This can result from limited purchasing power or limited access to markets among some households.

Senegal

Table 5.1 and Figure 5.1 present NPA, NMA, and NHA for energy (Kcals), protein, and 11 micronutrients at the national level for Senegal. NPA is over 100 percent for most nutrients, suggesting that, on average, sufficient levels of nutrients are produced in Senegal to adequately feed the entire population. Adequacy levels of protein, folate, niacin, and thiamin are particularly high at over 200 percent. Despite this general pattern, production falls short of national requirements for calcium and riboflavin.

A very different pattern emerges in terms of consumption adequacy at national and average household levels, with NMA and NHA values significantly lower than NPA for most of the nutrients. For iron, zinc, vitamin B6, folate, niacin, and thiamin, NMA and NHA levels are less than half those of NPA. While some differences may be due to data and measurement issues, this also suggests that significant shares of the nutrients produced in Senegal do not make their way to households' tables, potentially due to limited purchasing power, food exports, postharvest crop losses, and other nutrient losses after production or during the cooking process. Exceptions to this pattern include calcium, with slightly higher NHA than NPA, and vitamin B12, for which NMA is slightly higher than production adequacy. Higher levels of NMA than NPA suggest that Senegal may have increased supplies of this nutrient through trade with other countries.

NHA is lower than NMA for most nutrients, indicating that national-level nutrient consumption is not distributed evenly among households. The difference between NMA and NHA is largest for vitamin A and vitamin B12, suggesting that there are significant disparities in households' access to foods rich in these nutrients (which include palm and other vegetable oils, and fish and meat, respectively).

Key Foods Contributing to Energy and Nutrient Consumption and Production for Senegal

Table 5.2 lists the top five food items that contribute to Senegalese households' intake of energy as well as selected nutrients and budget shares of each key food. Cereals, particularly rice and millet, represent households' principal sources of energy and key micronutrients including iron and calcium. Millet grain is especially rich in iron but accounts for a small share of budgets; the bulk of households' cereal budgets are allocated to broken and whole rice, followed

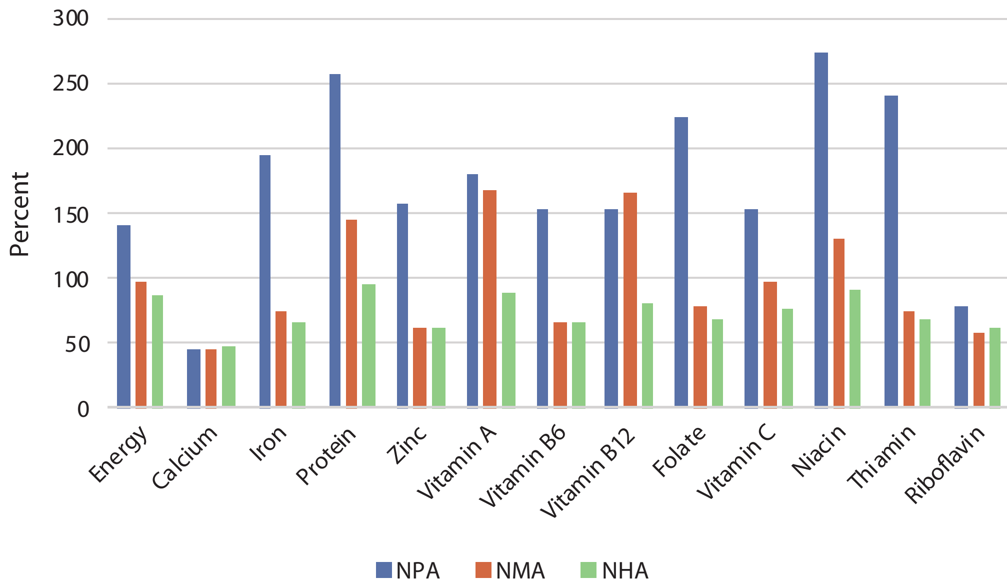
TABLE 5.1—NATIONAL ENERGY AND NUTRIENT PRODUCTION, MARKET, AND HOUSEHOLD ADEQUACY, SENEGAL (2017–2018)

	Production per day, AME	Consumption per day, AME	Recommended intake per day, AME	NPA (%)	NMA (%)	NHA (%)
Energy (Kcal)	3,855.8	2,848.6	2,750.0	140.2	97.3	86.5
Calcium (mg.)	449.0	485.0	1,000.0	44.9	43.9	47.0
Iron (mg.)	53.6	21.1	27.4	195.8	74.5	65.0
Protein (g.)	128.5	78.1	50.0	257.1	145.2	94.3
Zinc (mg.)	21.9	9.2	14.0	156.8	62.0	60.9
Vitamin A (mcg.)	1,084.8	1,118.3	600.0	180.8	167.9	89.1
Vitamin B6 (mg.)	3.1	1.4	2.4	152.7	66.7	66.4
Vitamin B12 (mcg.)	3.7	4.5	400.0	153.6	165.2	80.0
Folate (mcg.)	897.7	331.8	60.0	224.4	79.0	68.3
Vitamin C (mg.)	91.4	64.7	20.0	152.4	96.0	75.6
Niacin (mg.)	54.9	27.7	1.5	274.6	129.4	91.5
Thiamin (mg.)	3.6	1.2	2.5	241.1	73.3	68.8
Riboflavin (mg.)	1.3	1.1	3.5	77.7	58.3	60.6

Source: Authors' calculations; market and household adequacy are based on Projet d'Appui aux Politiques Agricoles (PAPA) (2017–2018) data, and production adequacy is based on data from Directorate of Analysis, Forecasting and Agricultural Statistics (DAPSA) (2017–2018), Food and Agriculture Organization of the United Nations (FAO) (2018), Ministry of Livestock and Animal Production (MEPA) (2018), Ministry of Fisheries and Maritime Production (MPEM) (2018), and Directorate of Water, Forests, Hunting and Soil Conservation (DEFCCS) (2018).

Note: AME = adult male equivalents; NPA = nutrient production adequacy; NMA = nutrient market adequacy; NHA = nutrient household adequacy.

FIGURE 5.1—ENERGY AND NUTRIENT PRODUCTION, MARKET, AND HOUSEHOLD ADEQUACY, SENEGAL (PERCENT)



Source: Authors' calculations; market and household adequacy are based on Projet d'Appui aux Politiques Agricoles (PAPA) (2017–2018) data, and production adequacy is based on data from Directorate of Analysis, Forecasting and Agricultural Statistics (DAPSA) (2017–2018), Food and Agriculture Organization of the United Nations (FAO) (2018), Ministry of Livestock and Animal Production (MEPA) (2018), Ministry of Fisheries and Maritime Production (MPEM) (2018), and Directorate of Water, Forests, Hunting and Soil Conservation (DEFCCS) (2018).

Note: NPA = nutrient production adequacy; NMA = nutrient market adequacy; NHA = nutrient household adequacy.

by processed millet.[6] Strategies to combat deficiencies in iron could include a focus on increasing consumption of millet as well as cowpeas, which are also rich in these key micronutrients and currently account for a very small share in households' budgets. Households in Senegal also spend very little on the foods richest in calcium (smoked and dried fish and powdered milk), as reflected in low adequacy levels for that micronutrient.

Table 5.3 summarizes the major crops accounting for Senegal's production of nutrients. It shows the dominant role of peanuts in national nutrient production, accounting for 20 percent of annual crop production in terms of volume and representing an even larger share of many major nutrients. Peanuts account for nearly 40 percent of all energy produced in Senegal as well as significant shares of calcium, and iron.[7] Cereals—millet, rice, and maize—are also among the major sources of energy, protein, and most micronutrients. Millet is rich in several key nutrients, representing 55.8 percent of national production of iron, compared to 12.5 percent of total crop production in terms of volume.[8]

Calcium is among the few nutrients examined for which production is insufficient to cover national nutritional requirements. Peanuts account for the largest share of Senegal's production of calcium, followed by cow milk. Calcium supplies could be increased by augmenting national production of milk, as well as of sesame, which is extremely rich in calcium and currently represents only 0.2 percent of national crop production.

Elasticities of Demand for Energy and Nutrients

Changes in incomes and in food prices affect households' food consumption patterns. As foods differ in terms of nutrient content, income and price changes also affect micronutrient consumption patterns. However, as the links are indirect, it is not always obvious to policymakers how price and income policies affect the consumption of individual

6 When results are disaggregated by rural and urban consumers, some interesting differences emerge. Rural households devote substantially larger budget shares to iron-rich millet grain than urban households; this likely contributes to rural households' higher nutrient household adequacy levels (a contrast to the general pattern of higher adequacies for urban households). Results for rural and urban households are available upon request from the authors.

7 Peanuts also account for large shares of national production of niacin, thiamin, protein, vitamin B6, folate, and riboflavin (not shown in in Table 5.3). Peanuts play an important but less prominent role in nutrient consumption; they figure among the top five dietary sources of protein, folate, niacin, and thiamin, and peanut oil is a major source of vitamin A (Table 5.2).

8 This analysis does not take into account differing levels of bioavailability of nutrients. Bioavailability is complex and depends on multiple factors, including an individual's health and nutrition status, overall diet composition, and the source of each nutrient. It is important to note that the bioavailability of iron and zinc from cereals is lower than from other sources (Arafsha et al. 2023).

TABLE 5.2—TOP FOODS CONTRIBUTING TO ENERGY AND NUTRIENT INTAKE, SENEGAL (NATIONAL AVERAGE)

	Food item	Nutrient intake share	Nutrient content per 100 grams	Budget share
Energy (Kcal)	Rice (broken)	18.7%	356.7	7.5%
	Rice (whole)	14.5%	352.3	5.8%
	Millet (processed)	7.9%	353.5	4.3%
	Vegetable oils	7.8%	900.0	4.9%
	Sugar	7.5%	400.0	4.8%
Calcium (mg.)	Dried fish	17.7%	1,939.0	1.2%
	Milk powder	15.5%	925.0	2.6%
	Rice (broken)	11.5%	35.5	7.5%
	Smoked fish	7.1%	1,133.0	1.0%
	Rice (whole)	4.1%	16.3	5.8%
Iron (mg.)	Millet (grains)	32.5%	15.2	2.5%
	Millet (processed)	16.3%	5.6	4.3%
	Rice (whole)	9.2%	1.7	5.8%
	Cowpea	4.9%	6.6	1.2%
	Maize (grains)	3.1%	3.3	1.2%
Vitamin A (mcg.)	Palm oil	35.8%	5,720.0	1.3%
	Vegetable oils	19.4%	850.0	4.9%
	Peanut oil	11.5%	850.0	2.3%
	Carrot	10.0%	637.0	1.3%
	Other vegetable oils	5.6%	856.3	1.0%
Vitamin B12 (mcg.)	Dried fish	59.7%	60.0	1.2%
	Fresh fish	24.3%	3.3	10.8%
	Meat (beef, sheep, and goat)	10.0%	2.2	7.1%
	Milk powder	3.3%	1.8	2.6%
	Poultry	1.5%	0.4	4.9%

Source: Authors' calculations based on Projet d'Appui aux Politiques Agricoles (PAPA) (2017–2018) data.

Note: Results for additional nutrients (protein, Vitamin B6, Vitamin C, folate, riboflavin, niacin, and thiamin) available upon request from the authors.

TABLE 5.3—TOP FOOD PRODUCTS CONTRIBUTING TO ENERGY AND NUTRIENT PRODUCTION, SENEGAL (NATIONAL AVERAGE)

	Product	Nutrient production share	Nutrient content per 100 grams	Share of production
Energy (Kcal)	Peanut	36.6	574.0	20.0
	Millet	18.7	365.0	12.5
	Rice	16.0	347.5	14.5
	Maize	7.4	345.3	5.9
	Cassava	4.5	109.5	10.7
Calcium (mg.)	Peanut	24.6	45.0	20.0
	Cow milk	12.3	191.0	n. a.
	Cassava	10.1	29.0	10.7
	Millet	10.1	23.0	12.5
	Sesame	5.0	777.0	0.2
Iron (mg.)	Millet	55.8	15.2	12.5
	Peanut	16.0	3.5	20.0
	Rice	5.0	1.5	14.5
	Sorghum	4.7	5.2	3.1
	Maize	3.6	2.4	5.9
Vitamin A (mcg.)	Oil palm fruit	82.3	5,310.0	1.8
	Mango	3.9	203.3	1.7
	Watermelon	3.7	25.0	16.8
	Cassava	2.9	20.0	n. a.
	Carrot	2.0	637.0	n. a.
Vitamin B12 (mcg.)	Sardinella, round	40.6	8.3	n. a.
	Sardinella, flat	29.9	8.3	n. a.
	Sheep meat	6.7	3.0	n. a.
	Spanish mackerel	6.1	10.0	n. a.
	Beef	4.7	1.7	n. a.

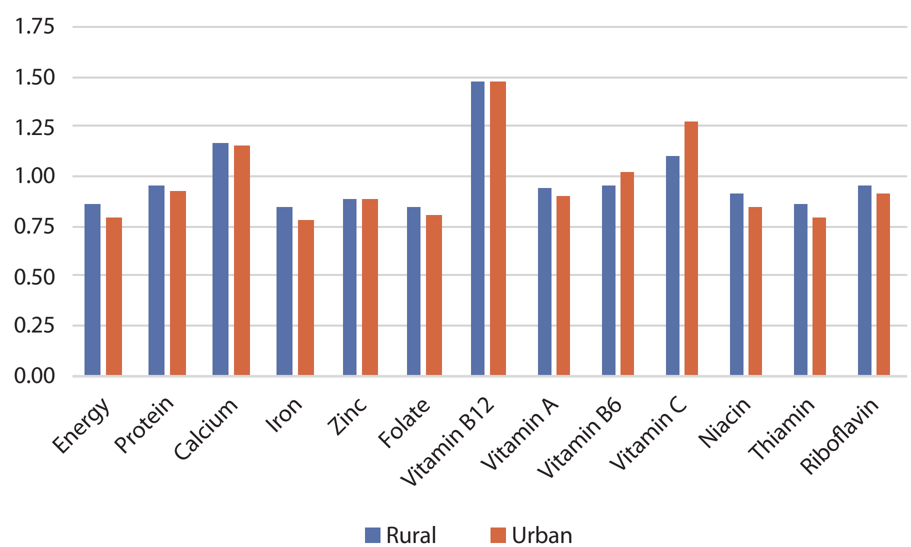
Source: Authors' calculations based on data from Directorate of Analysis, Forecasting and Agricultural Statistics (DAPSA) (2017–2018), Food and Agriculture Organization of the United Nations (FAO) (2018), Ministry of Livestock and Animal Production (MEPA) (2018), Ministry of Fisheries and Maritime Production (MPEM) (2018), and Directorate of Water, Forests, Hunting and Soil Conservation (DEFCCS) (2018).

Note: Share of production refers to share in the volume of annual crop production in kilograms, not including livestock and fisheries. N. a. = not applicable.

micronutrients. As a first step to assessing the impacts of changes in incomes or food prices on micronutrient consumption, the analysis estimated income and price elasticities of different food categories (see Ulimwengu et al. 2023 for methodological details). These elasticities were then used to derive elasticities of demand for the micronutrients contained in these foods with respect to incomes and food prices.

Figure 5.2 shows estimated income elasticities of energy and micronutrients in urban and rural areas of Senegal. Elasticities are all positive, meaning that demand for and consumption of all micronutrients is expected to increase with incomes. Elasticity values greater than one indicate that for a 1 percent increase in income, demand will increase by more than 1 percent; the opposite is true for elasticity values under one. Demand for vitamin B12, vitamin C, and calcium in both urban and rural areas is the most responsive to changes in household income, with more than proportionate increases expected to result from income growth. This reflects generally high income elasticities associated with animal-source foods and other higher-value food products in Africa (Colen et al. 2018). Income elasticities are lowest for energy, zinc, thiamine, niacin, folate, and iron. Low elasticities suggest that modest income increases may not be sufficient to overcome nutrient deficiencies quickly.

FIGURE 5.2—INCOME ELASTICITIES OF DEMAND FOR ENERGY AND KEY MICRONUTRIENTS, RURAL AND URBAN SENEGAL



Source: Authors' calculations based on Projet d'Appui aux Politiques Agricoles (PAPA) (2017–2018) data.

Price changes of food products also strongly impact households' consumption of micronutrients. Figure 5.3 shows estimated elasticities of demand for energy and selected micronutrients with respect to the prices of different food categories in rural and urban areas. Most elasticities are negative, indicating that demand for the micronutrient is expected to decline as food prices increase. Micronutrient elasticities capture households' changing food consumption patterns resulting from price changes; positive price elasticities may indicate that a price increase in a given food caused households to substitute or supplement other foods that are richer in that micronutrient.

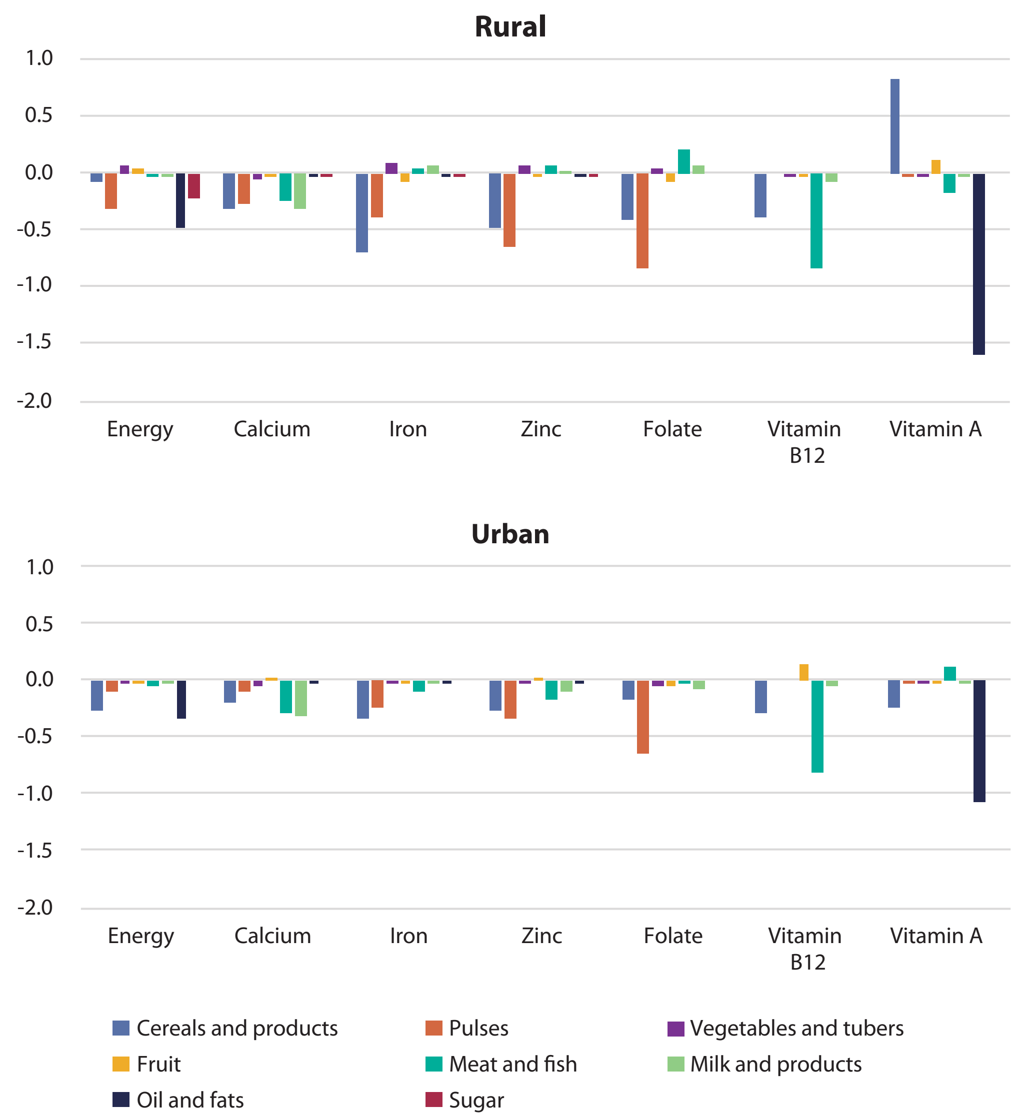
In both rural and urban areas, demand for vitamin A is highly sensitive to the price of oil; its absolute value is greater than one, indicating that price increases would provoke more than proportionate decreases in demand. The elasticity of vitamin B12 with respect to the prices of meat and fish is also among the highest elasticities in both urban and rural areas. Increases in the prices of pulses are expected to provoke significant decreases in demand for several micronutrients, especially for thiamin, niacin, and zinc in rural areas and folate in rural and urban areas. Demand for iron in rural areas is sensitive to the price of cereals.

Mapping of Nutrient Production, Market, and Household Adequacies

Figure 5.4 maps nutrient production, market, and household adequacies at the department level for energy, iron, vitamin A, and calcium.[9] Spatial patterns of the two adequacy measures differ markedly, with much lower levels of NHA than of NPA. For production adequacy, a similar geographical distribution appears for energy and zinc, as well as several other nutrients not shown in Figure 5.4 (folate, thiamin, niacin, protein, vitamin B6, and zinc). For these nutrients, there is sufficient production

9 We used forest area at the departmental level as a proxy to disaggregate production data on palm oil and nontimber forest products, which were only available at the national level.

FIGURE 5.3—ELASTICITIES OF DEMAND FOR ENERGY AND MICRONUTRIENTS WITH RESPECT TO FOOD PRICES, RURAL AND URBAN SENEGAL



Source: Authors' calculations based on Projet d'Appui aux Politiques Agricoles (PAPA) (2017–2018) data.
Note: Elasticity results for additional nutrients are available upon request from the authors.

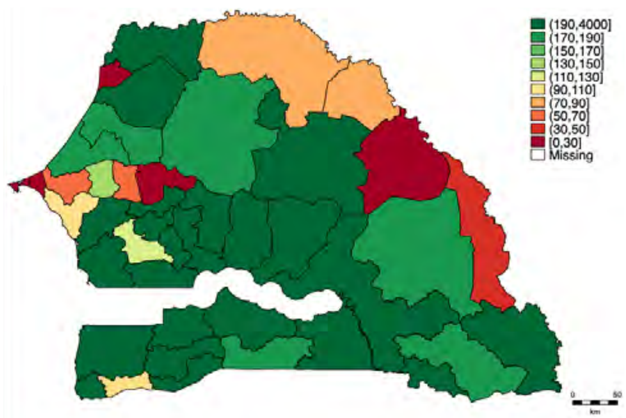
across a good part of the national territory, although there are some areas of high concentration in the northwest, center, and southern parts of the country. The departments located in the valley of the Senegal River (Bakel, Kanel, Matam, and Podor) and the Dakar region, as well as Mbacké, Saint-Louis, Thiès, and Ziguinchor tend to have a very low level of production adequacy. Indeed, these departments produce less than 70 percent of the recommended intake level per day and per AME for many of the nutrients examined.

However, there are significant geographical differences in the coverage of requirements for different micronutrients. For example, the iron maps show higher levels of adequacy in areas where millet, which is particularly iron-rich (Table 5.3), is widely cultivated (that is, the groundnut basin area, north of the Gambian border); for this nutrient, there is thus a certain correlation between areas with a high surplus of production and areas with larger quantities available in markets. However, the marketed quantities are below the quantities produced in most cases. This can be interpreted to result from food losses between production sites and markets, or from interdepartmental or cross-border trade.

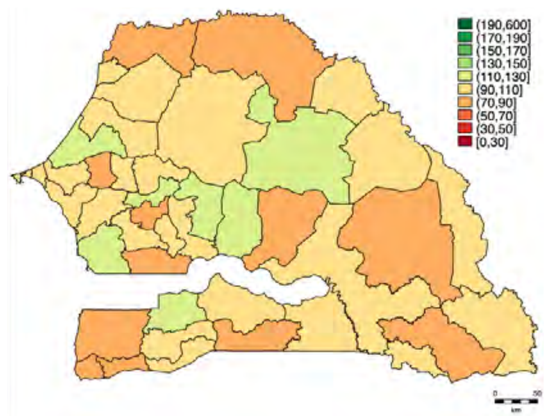
Vitamin A production surpluses are observed in southern Senegal where oil palm is most concentrated. The departments of Goudiry, Kédégou, and Saraya, in spite of their production surplus, show the lowest levels of household nutrient adequacy in vitamin A, suggesting that much of the vitamin A produced in these departments may be consumed elsewhere. When considering the production and household adequacy of calcium, there is no doubt that the lack of domestic production of calcium-rich foods is a major concern, as only the department of Koumpentoum produces a large surplus of calcium. Market adequacy is low, especially in eastern Senegal where less than 30 percent of the recommended calcium level is available in the market.

FIGURE 5.4—MAPPING OF NUTRIENT ADEQUACY AT THE DEPARTMENT LEVEL, SENEGAL

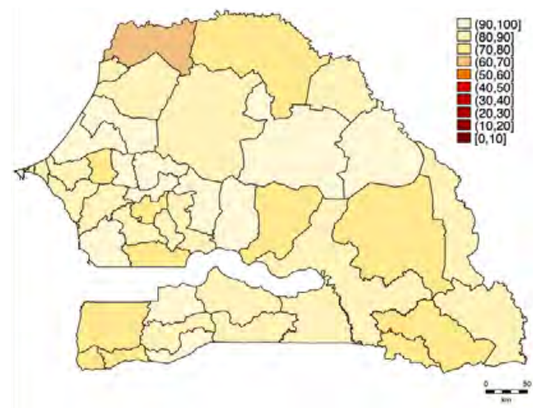
Energy: NPA



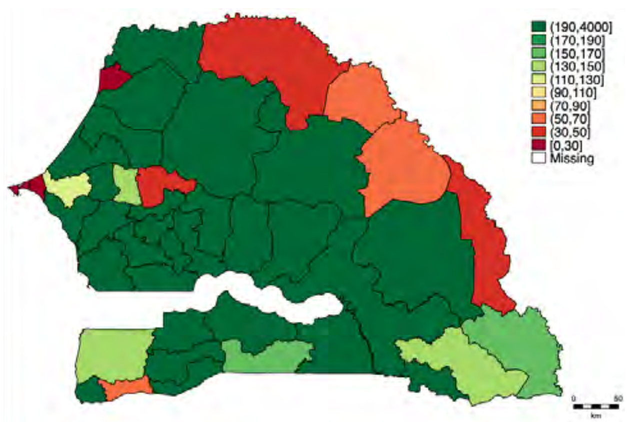
Energy: NMA



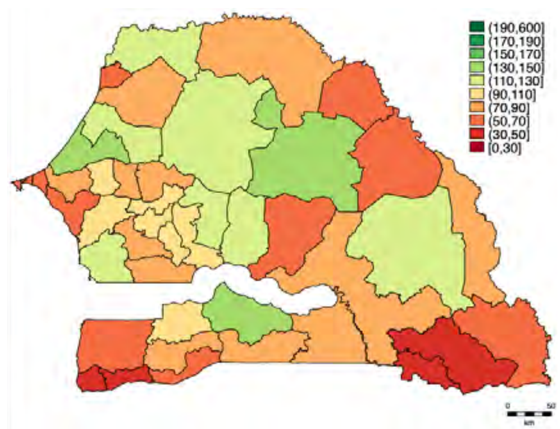
Energy: NHA



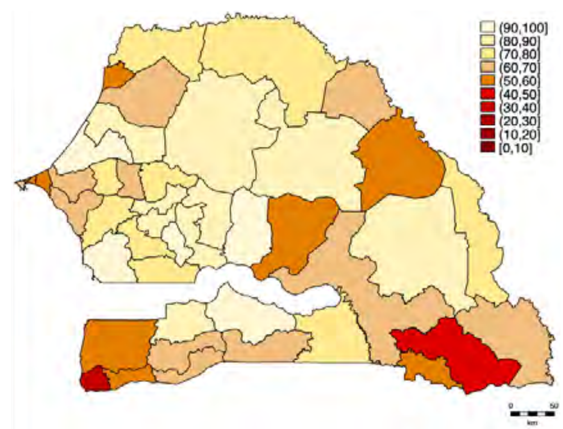
Iron: NPA



Iron: NMA



Iron: NHA

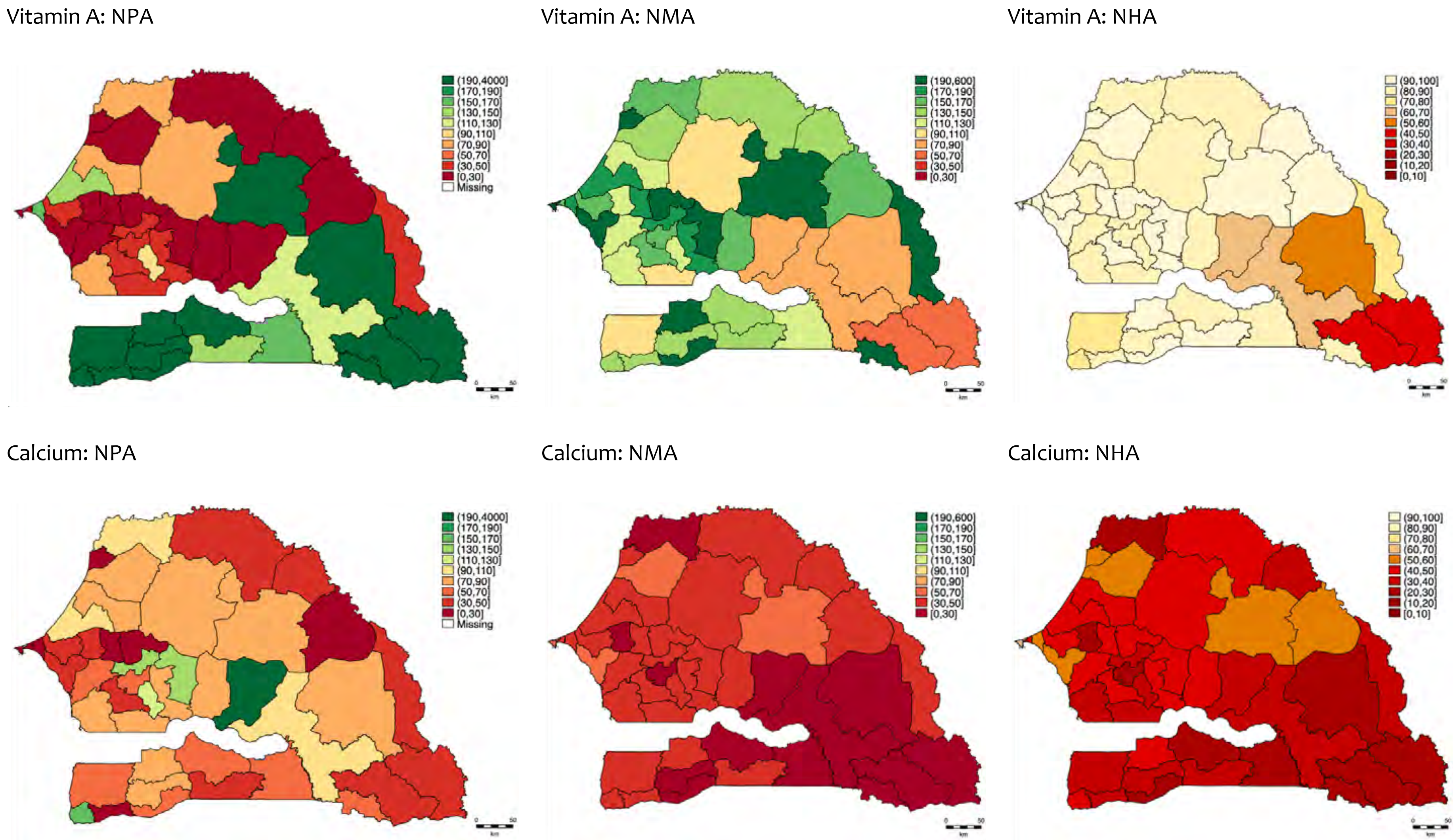


Source: Authors' calculations; market and household adequacy are based on Projet d'Appui aux Politiques Agricoles (PAPA) (2017–2018) data, and production adequacy is based on data from Directorate of Analysis, Forecasting and Agricultural Statistics (DAPSA) (2017–2018), Food and Agriculture Organization of the United Nations (FAO) (2018), Ministry of Livestock and Animal Production (MEPA) (2018), Ministry of Fisheries and Maritime Production (MPEM) (2018), and Directorate of Water, Forests, Hunting and Soil Conservation (DEFCCS) (2018).

Note: NPA = nutrient production adequacy; NMA = nutrient market adequacy; NHA = nutrient household adequacy.

continued

FIGURE 5.4—MAPPING OF NUTRIENT ADEQUACY AT THE DEPARTMENT LEVEL, SENEGAL



Source: Authors' calculations; market and household adequacy are based on Projet d'Appui aux Politiques Agricoles (PAPA) (2017–2018) data, and production adequacy is based on data from Directorate of Analysis, Forecasting and Agricultural Statistics (DAPSA) (2017–2018), Food and Agriculture Organization of the United Nations (FAO) (2018), Ministry of Livestock and Animal Production (MEPA) (2018), Ministry of Fisheries and Maritime Production (MPEM) (2018), and Directorate of Water, Forests, Hunting and Soil Conservation (DEFCCS) (2018).

Note: NPA = nutrient production adequacy; NMA = nutrient market adequacy; NHA = nutrient household adequacy.

Rwanda

Table 5.4 provides an overview of the absolute level of nutrient production and consumption in Rwanda, as well as the recommended amounts, and the three measures of nutritional adequacy for energy, protein, and 10 micronutrients at the national level. Figure 5.5 graphically presents the three measures of adequacy.

Rwanda's production covers the recommended levels of some nutrients (protein, vitamin B12, folate, vitamin C, and riboflavin). The highest surpluses are observed for vitamin C (production adequacy of 202 percent), folate (148 percent), and protein (133 percent). For the remaining nutrients, production is insufficient to cover daily nutrient requirements. The situation is even more critical for vitamin A, with less than 50 percent NPA.

NHA is far lower than NPA for most nutrients, suggesting high levels of nutrient loss between production and consumption. Except for folate, protein, and vitamin C, for which households reach at least half of the recommended levels, the average Rwandan diet seems insufficient. Vitamin C is the only nutrient with a level of market adequacy greater than 100 percent. However, the high level of availability of this nutrient in the market does not translate into sufficient consumption at the household level. The large difference between NMA and NHA for vitamin C suggests that there are significant disparities in households' access to foods rich in this nutrient.

Aside from vitamin C, NHA tends to be similar to NMA for most of the nutrients examined, suggesting that national-level nutrient consumption is distributed fairly evenly among households. In general, the three levels of adequacy combined clearly indicate that the risk of micronutrient nutrient deficiency could be an issue in Rwanda.

Key Foods Contributing to Energy and Nutrient Production and Consumption for Rwanda

Table 5.5 lists the specific food items that contribute to households' micronutrient intake as well as budget shares of each key food. The top sources of energy reflect the importance of roots and tubers in Rwandan diets, with Irish potatoes, cassava flour, and sweet potatoes together accounting for 28 percent of total energy. Corn flour is the largest single contributor to energy, accounting for 14 percent of energy consumed, but is not among top sources of any of the other nutrients. Roots and tubers also represent major sources of several micronutrients despite not being particularly rich in these nutrients, due to their large food budget shares. For example, Irish potatoes, the second highest source of energy, are also major sources of iron. Cassava flour is an important contributor of calcium and iron, and sweet potatoes are among the top sources of iron.

Calcium adequacy is extremely low, particularly in rural areas, where households consume only 33 percent of requirements on average. Amaranth is the highest contributor to calcium

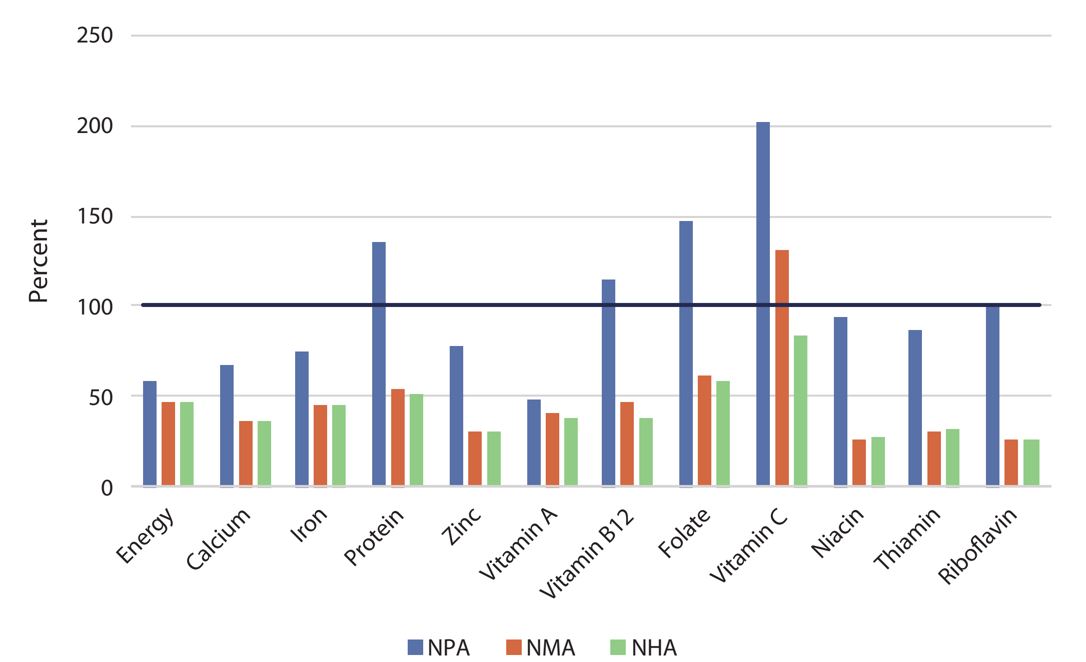
TABLE 5.4—NATIONAL ENERGY AND NUTRIENT PRODUCTION, MARKET, AND HOUSEHOLD ADEQUACY, RWANDA (2016)

	Production per day, AME	Consumption per day, AME	Recommended intake per day, AME	NPA (%)	NMA (%)	NHA (%)
Energy (Kcal)	1,622.2	1,350.8	2,750	59.0	47.0	47.1
Calcium (mg.)	668.5	386.1	1,000	66.8	36.3	36.6
Iron (mg.)	20.3	13.2	27.4	73.9	45.4	45.8
Protein (g.)	66.6	28.3	50	133.3	53.7	51.4
Zinc (mg.)	10.8	4.4	14	77.1	29.9	30.9
Vitamin A (mcg.)	291.0	259.9	600	48.5	40.1	37.5
Vitamin B12 (mcg.)	2.7	1.2	2.4	110.9	47.1	38.1
Folate (mcg.)	590.8	258.4	400	147.7	61.1	58.6
Vitamin C (mg.)	121.0	82.4	60	201.6	130.6	83.8
Niacin (mg.)	18.8	5.5	20	94.0	25.9	27.1
Thiamin (mg.)	1.3	0.5	1.5	86.5	30.6	31.9
Riboflavin (mg.)	1.7	0.5	1.7	101.7	25.8	25.8

Source: Authors' calculations; market and household adequacy are based on data from National Institute of Statistics of Rwanda (NISR) (2016–2017); production adequacy is based on data from NISR (2016–2017), Ministry of Agriculture and Animal Resources (MINAGRI) (2017), and Rwanda Agriculture Board (RAB) (2017).

Note: AME = adult male equivalents; NPA = nutrient production adequacy; NMA = nutrient market adequacy; NHA = nutrient household adequacy.

FIGURE 5.5—ENERGY AND NUTRIENT PRODUCTION, MARKET, AND HOUSEHOLD ADEQUACY, RWANDA (PERCENT)



Source: Authors' calculations; market and household adequacy are based on data from National Institute of Statistics of Rwanda (NISR) (2016–2017); production adequacy is based on data from NISR (2016–2017), Ministry of Agriculture and Animal Resources (MINAGRI) (2017), and Rwanda Agriculture Board (RAB) (2017).

Note: NPA = nutrient production adequacy; NMA = nutrient market adequacy; NHA = nutrient household adequacy.

intake but accounts for less than 1 percent of food budgets; increasing amaranth consumption could potentially contribute to addressing calcium deficiencies. Similarly, dried or smoked fish represent an important source of calcium and are extremely high in calcium content, but account for only slightly more than 1 percent of food expenditures. In addition to calcium, amaranth is also the top source of vitamin A, and dried or smoked fish is the top source of vitamin B12, both nutrients with severe nutrient consumption adequacy gaps.

Other foods of note include dried beans, which are the top contributors of zinc and are among the top five sources of iron. Palm oil is very rich in vitamin A and is the second largest source of vitamin A in diets. Rice accounts for the highest budget share of a single food product, 8.7 percent, but is not among the top sources of any nutrient (except for niacin, not shown in Table 5.5).

Table 5.6 summarizes the five most important national crops accounting for Rwanda's production of selected nutrients. Beans play an even more important role in terms of production than in consumption: Although they are not the dominant crop in terms of volume, they are by far the largest contributor to the production of several nutrients. Beans account for nearly 15 percent of all energy produced in Rwanda and more than 20 percent of national production of iron and zinc. The important but less prominent role of beans in nutrient consumption may reflect exports of beans produced in Rwanda to neighboring countries (FAO 2023).

The table demonstrates the dominant role of sweet potatoes in national production in terms of volume. Sweet potatoes account for 15 percent of annual crop production volume and play significant roles as sources of energy, calcium, and vitamin A; this reflects mainly their large share in production, as sweet potatoes have relatively low nutrient content for calcium and vitamin A compared with other top sources.

Cereals—millet and sorghum—are also among the main sources of energy, protein, and many of the micronutrients examined. Maize is among the top five sources of all nutrients shown except vitamins A and B12 and calcium. Animal and fishery products are the main sources of vitamin B12 production in Rwanda and also contribute significantly to the production of several other nutrients, with milk representing a major source of energy, calcium, and vitamin A and cattle meat among the top sources of iron.

Calcium and vitamin A are among the nutrients for which production is inadequate to meet national requirements. Maize and sorghum are high in energy but account for less than 6 percent and 3 percent respectively of production in Rwanda. Cassava leaves and green vegetables (*inyabutongo*) each represent less than 2 percent of crop production but provide 280 milligrams or more of calcium for every 100 grams consumed. Cassava leaves and green vegetables are also important sources of vitamin A production, after carrots. Increased production

TABLE 5.5—TOP FOOD CONTRIBUTING TO ENERGY AND MICRONUTRIENT INTAKE, RWANDA (NATIONAL AVERAGE)

	Food item	Nutrient intake share	Nutrient content per 100 grams	Budget share
Energy (Kcal)	Corn flour	14.3%	355.0	6.3%
	Irish potato	11.1%	105.0	7.9%
	Cassava flour	9.4%	341.0	4.4%
	Peanut oil	9.2%	900.0	4.5%
	Sweet potato	7.5%	92.0	5.3%
Calcium (mg.)	Amaranth	18.8%	346.0	0.9%
	Dried or smoked fish	9.6%	1,248.1	1.2%
	Fresh milk	8.2%	119.0	1.6%
	Cassava leaves	6.8%	298.0	0.6%
	Cassava flour	6.6%	66.0	4.4%
Iron (mg.)	Irish potato	14.2%	1.3	7.9%
	Dried beans	13.4%	2.8	7.7%
	Amaranth	12.9%	8.3	0.9%
	Cassava flour	5.7%	2.0	4.4%
	Sweet potato	5.5%	0.6	5.3%
Vitamin A (mcg.)	Amaranth	29.9%	362.0	0.9%
	Palm oil	22.2%	5,490.0	0.4%
	Carrot	11.8%	552.0	0.6%
	Cassava leaves	10.0%	287.0	0.6%
	Tomato	4.5%	26.0	3.3%
Vitamin B12 (mcg.)	Dried or smoked fish	57.4%	23.8	1.2%
	Fresh milk	12.7%	0.6	1.6%
	Beef meat	12.6%	2.3	3.0%
	Fresh fish	3.8%	2.9	0.7%
	Milk powder	2.4%	3.2	0.1%

Source: Authors' calculations based on data from National Institute of Statistics of Rwanda (2016–2017).
Note: Results for additional nutrients available on request from authors.

TABLE 5.6—TOP FOOD PRODUCTS CONTRIBUTING TO ENERGY AND MICRONUTRIENT PRODUCTION, RWANDA (NATIONAL AVERAGE)

	Food item	Nutrient production share	Nutrient content per 100 grams	Share of production
Energy (Kcal)	Bean	14.7%	303.0	7.6%
	Milk	12.2%	70.0	n. a.
	Maize	11.8%	342.5	5.4%
	Sweet potatoes	8.3%	101.0	15.4%
	Sorghum	6.1%	338.5	2.8%
Calcium (mg.)	Milk	50.5%	119.0	n. a.
	Bean	10.4%	88.7	7.6%
	Cassava leaves	4.5%	298.0	1.0%
	Green vegetables: *inyabutongo*	4.4%	280.0	1.7%
	Sweet potatoes	4.4%	22.0	15.4%
Iron (mg.)	Bean	27.8%	7.2	7.6%
	Cattle meat	10.7%	7.3	n. a.
	Maize	8.9%	3.3	5.4%
	Sorghum	6.8%	4.7	2.8%
	Potato	5.8%	1.4	9.6%
Vitamin A (mcg.)	Milk	39.9%	41.0	n. a.
	Green vegetables: *inyabutongo*	11.8%	326.0	1.7%
	Cassava leaves	9.9%	287.0	1.0%
	Carrots	5.0%	589.0	0.3%
	Sweet potatoes	3.7%	8.0	15.4%
Vitamin B12 (mcg.)	Milk	63.3%	0.6	n. a.
	Cattle meat	19.7%	1.8	n. a.
	Goat meat	5.0%	3.0	n. a.
	Fish	4.5%	2.1	n. a.
	Pig meat	3.8%	1.0	n. a.

Source: Authors' calculations based on data from NISR (2016–2017), Ministry of Agriculture and Animal Resources (MINAGRI) (2017), and Rwanda Agriculture Board (RAB) (2017).

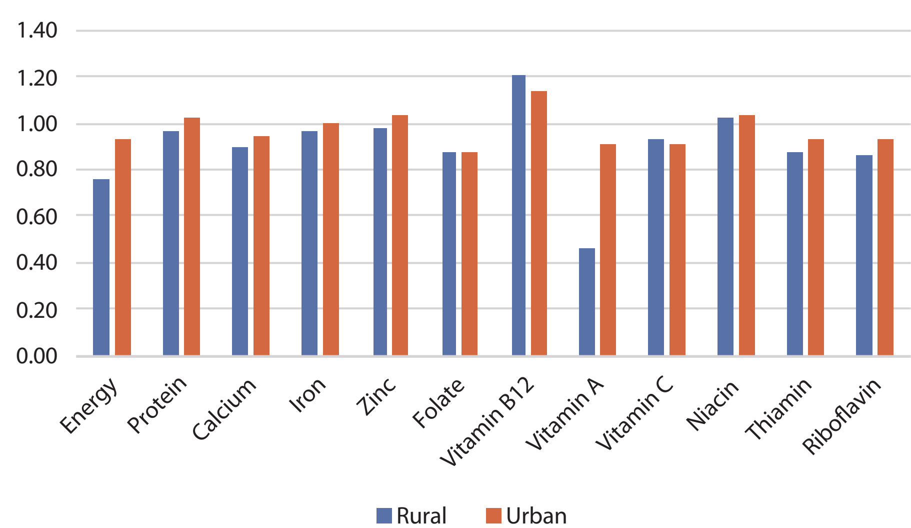
Note: Production share refers to share in the volume of annual crop production in kilograms, not including livestock and fisheries. Results for additional nutrients available upon request from authors. N. a. = not applicable.

of green vegetables and cassava leaves, which are relatively rich in calcium and vitamin A, and maize, which is high in energy, would help to improve production adequacy; enrichment could also provide the opportunity to increase the availability of vitamin A, calcium, and other micronutrients.

Elasticities of Demand for Energy and Nutrients

Figure 5.6 shows estimated income elasticities of energy, protein, and micronutrients in urban and rural areas. Demand for vitamin B12 in both urban and rural areas is the most responsive to changes in household income, with more than proportionate increases expected to result from income growth. Income elasticities are close to 1.0 for several other nutrients, reflecting proportional or slightly less than proportional increases in consumption in response to changes in income.

FIGURE 5.6—INCOME ELASTICITIES OF DEMAND FOR ENERGY AND KEY NUTRIENTS, RURAL AND URBAN RWANDA



Source: Authors' calculations based on data from National Institute of Statistics of Rwanda (2016–2017).

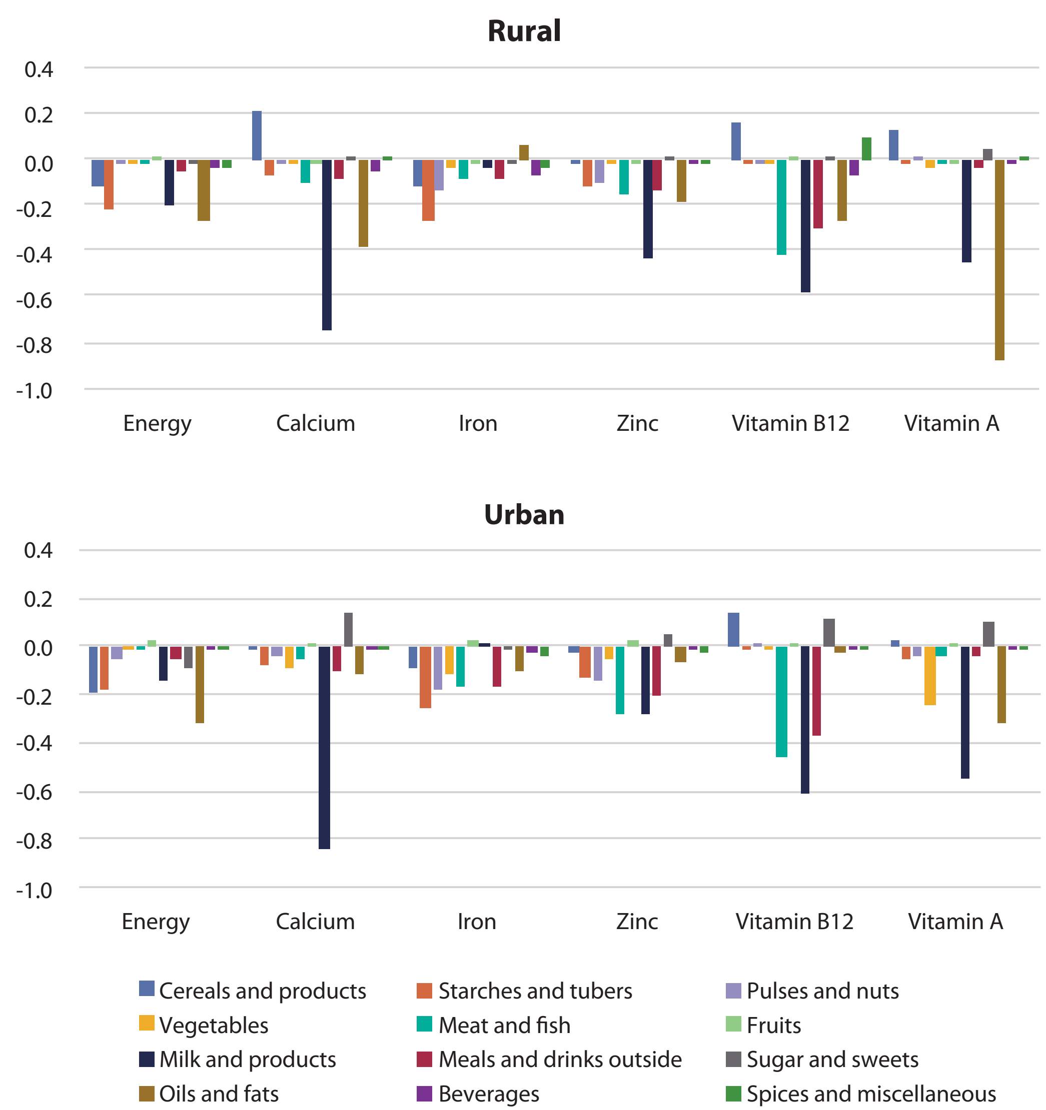
Of all nutrients examined, the lowest income elasticity is that for vitamin A in rural areas. The elasticity value of 0.46 suggests that a given increase in income would result in a significantly smaller increase in vitamin A demand. The low responsiveness of vitamin A demand to income increases suggests that it may be challenging to address extremely low vitamin A adequacy levels in rural areas through cash transfers or other income-increasing interventions alone. In general, income interventions may be most effective at improving nutrition when combined with education efforts or incentives for purchases of nutrient-rich foods.

Price changes of food products also strongly impact households' consumption of nutrients. Figure 5.7 shows estimated elasticities of demand for energy, protein and micronutrients with respect to the prices of different food categories in rural and urban areas. Most elasticities are negative, indicating that demand for the nutrient is expected to decline as food prices increase. As noted earlier, nutrient elasticities capture households' changing food consumption patterns resulting from price changes; positive price elasticities may indicate that a price increase in a given food caused households to substitute or supplement other foods that are richer in that nutrient but less expensive.

A key observation from Figure 5.7 is that the prices of milk and dairy products have strong impacts on demand for several of the nutrients with the highest adequacy gaps, including calcium, zinc, vitamin B12, vitamin A, and riboflavin, in both urban and rural areas. This suggests that actions to lower milk prices through supply increases, cost-reducing technologies, or price subsidies could be effective interventions to increase the consumption of key nutrients. Prices of starches and tubers also show relatively strong effects on demand for several nutrients, including folate, vitamin C, niacin, and thiamin.

The demand for vitamin A is highly responsive to the price of oil in rural areas, and to a lesser extent to that of milk and dairy products; in urban areas, milk prices have the strongest impact on vitamin A demand. Oil prices also have strong impacts on the demand for riboflavin and for calcium in rural areas. Demand for energy is relatively inelastic but is most responsive to prices of oils and fats in both urban and rural areas. Prices of starches and tubers, milk and milk products, and cereal products also impact the demand for energy.

FIGURE 5.7—ELASTICITIES OF DEMAND FOR ENERGY AND NUTRIENTS WITH RESPECT TO FOOD PRICES, RURAL AND URBAN RWANDA



Source: Authors' calculations based on data from National Institute of Statistics of Rwanda (2016–2017).
Note: Elasticity results for additional nutrients are available upon request from the authors.

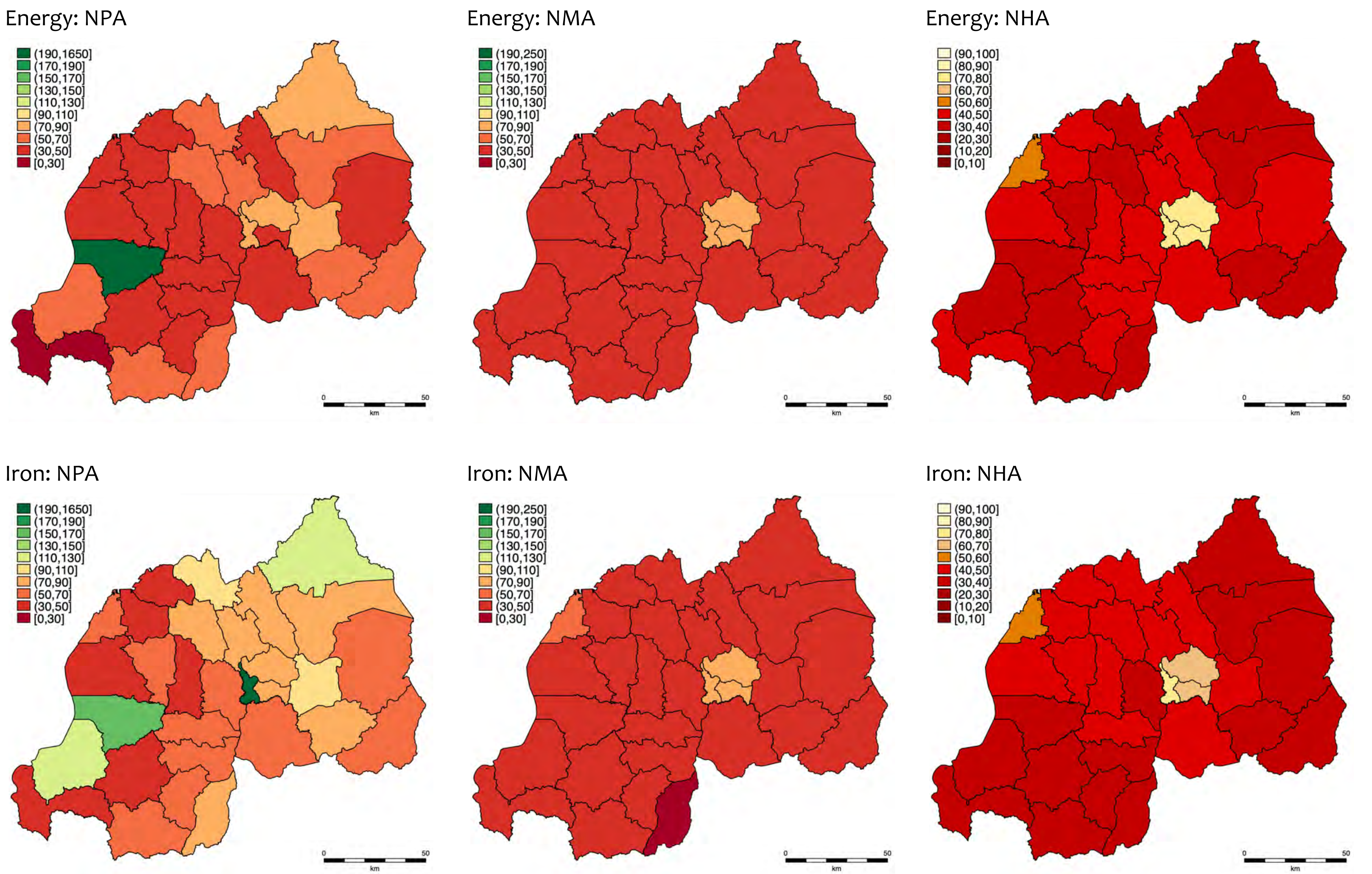
Mapping of Nutrient Production, Market, and Household Adequacies

Figure 5.8 maps NPA, NMA, and NHA at the district level for energy, iron, vitamin A, and calcium. A very different spatial pattern can be observed between production and household adequacy, with much lower levels of household adequacy. The most alarming deficiency is observed for vitamin A, with low production adequacies in most districts (less than 30 percent of intake requirements in much of the country) and correspondingly low levels of consumption adequacy observed at the household level.

The Kigali districts have a much higher level of household adequacy than other districts for most nutrients, and higher production adequacy for several nutrients. The Karongi district of western Rwanda has relatively high production adequacy in each of the nutrients examined, but this does not translate into higher-than-average household adequacy. Aside from the higher levels in Kigali, NHA does not show large variations across the country for most nutrients; for some, including iron (as well as protein, folate, thiamin, and niacin, not shown in Figure 5.8), adequacy is slightly higher in northwestern districts.

As observed for vitamin A, the lack of domestic production of calcium-rich foods appears to be a major concern. In fact, only the districts of Gasabo and Karongi produce a surplus of calcium. In addition, households in Rwanda do not appear to be filling the gap in calcium from sources other than national production, as household adequacy levels are below 40 percent in most districts. Increasing production of calcium-rich foods such as cassava leaves, green vegetables, and milk and increasing access to other calcium-rich foods through trade are among effective strategies to combat calcium deficiencies.

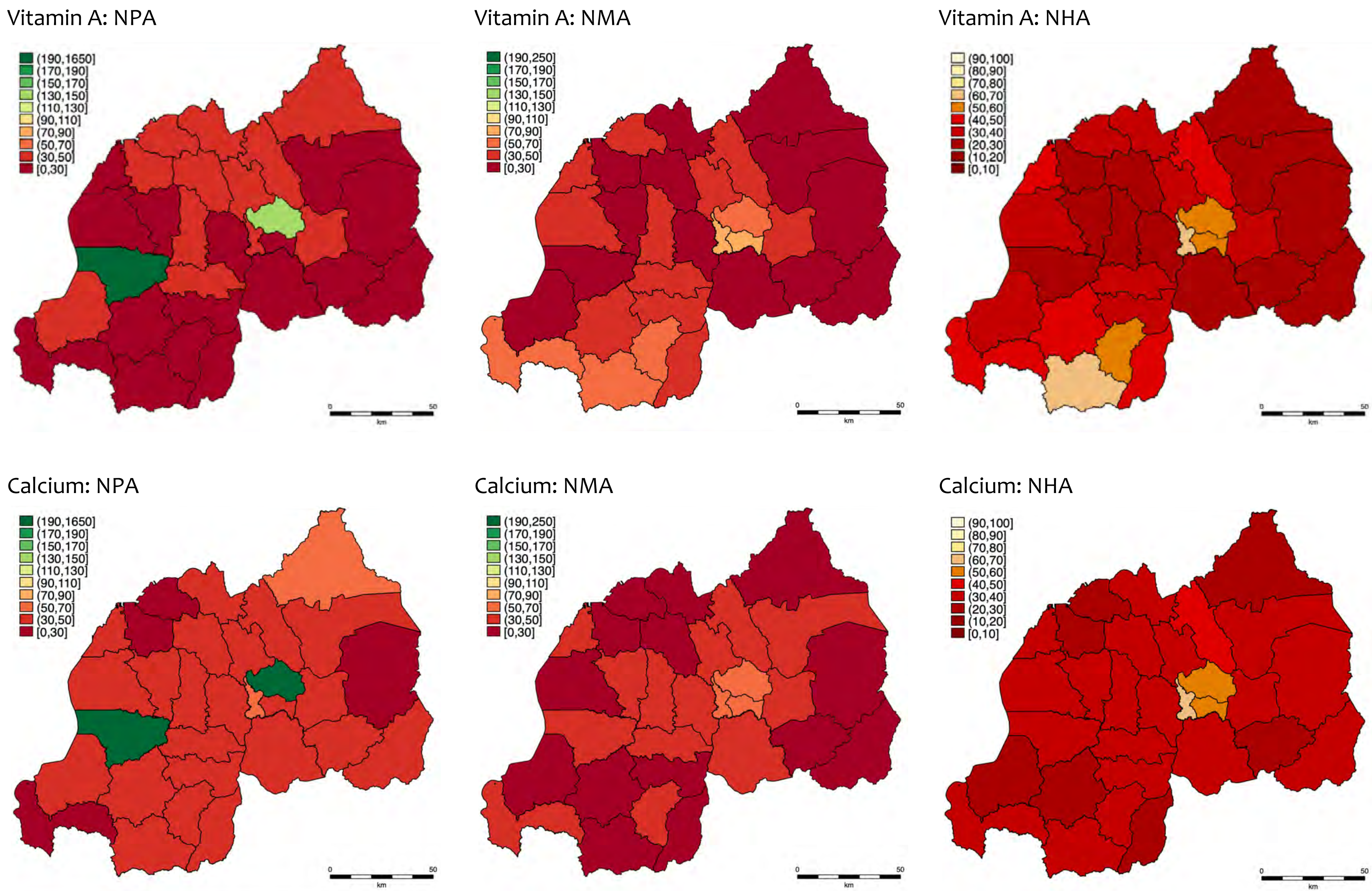
FIGURE 5.8—MAPPING OF NUTRIENT ADEQUACY AT THE DISTRICT LEVEL, RWANDA



Source: Authors calculations; market and household adequacy are based on data from National Institute of Statistics of Rwanda (NISR) (2016–2017); production adequacy is based on data from NISR (2016–2017), Ministry of Agriculture and Animal Resources (MINAGRI) (2017), and Rwanda Agriculture Board (RAB) (2017).

continued

FIGURE 5.8—MAPPING OF NUTRIENT ADEQUACY AT THE DISTRICT LEVEL, RWANDA



Source: Authors calculations; market and household adequacy are based on data from National Institute of Statistics of Rwanda (NISR) (2016–2017); production adequacy is based on data from NISR (2016–2017), Ministry of Agriculture and Animal Resources (MINAGRI) (2017), and Rwanda Agriculture Board (RAB) (2017).

The Case for Country-Specific Nutrition-Smart Food Systems

Senegal and Rwanda face multiple micronutrient adequacy gaps, in many cases severe. Adequacy levels vary by nutrient, by country and subnational area, and by food system segment: for example, NPA, NMA, and NHA tend to differ markedly from each other in Senegal. In Rwanda, NMA and NHA tend to be similar to each other, but substantially lower than production adequacy. Differences between NPA, NMA, and NHA can give a first indication of potential causes for inadequate nutrient intake and suggest context-specific ways for addressing deficiencies. In this section, we review some potential strategies for increasing NPA, NMA, and NHA in Senegal and Rwanda.

To achieve the goal of making nutritious foods more accessible and affordable, all strategies pursued must account for trade-offs and ensure that the system is sustainable both in terms of production and in ensuring the well-being of all stakeholders involved. Trade-offs can manifest in various ways, from environmental and economic perspectives to sociocultural implications. Intensifying production of certain nutritious foods might result in greater environmental degradation if not done sustainably. Overfarming can deplete soils, and overfishing can damage aquatic ecosystems. Lower prices can sometimes mean that smallholder farmers earn less for their produce, potentially increasing economic inequalities. Making nutritious foods cheaper might inadvertently lead to overconsumption of certain nutrients if not balanced with dietary education.

Increasing Nutrient Production Adequacy

For both Senegal and Rwanda, NPA is much higher at the national level than market and household consumption adequacy. Senegal produces more than sufficient levels of nearly all the nutrients examined compared with national requirements, while Rwanda produces sufficient levels of about half the nutrients examined. This could suggest that efforts to increase nutrient consumption should put significant emphasis on increasing the retention of nutrients between the production and consumption stage. However, even though the association between NPA and NMA or NHA is not clear-cut, low levels of consumption adequacy are in some cases likely to be the result of low production adequacy. For example, in Senegal, the two nutrients with the lowest household adequacy levels—calcium and riboflavin—are the only two with inadequate production. Similarly, the lower levels of NMH and NHA in Rwanda compared to Senegal are likely related at least in part to lower NPA. Thus, increasing production adequacy should be part of the portfolio of strategies addressing nutrient intake gaps in both countries, and particularly for Rwanda.

Adjusting the crop production mix could contribute to increased production of key nutrients, depending on the agronomic potential for expanding production in nutrient-rich crops. For example, ongoing efforts to support local dairy industries in Senegal and Rwanda can be complemented with incentives to encourage the production of calcium-rich crops, such as sesame in Senegal and cassava leaves and green vegetables in Rwanda, to lessen shortfalls in calcium production adequacy in both countries. Another important approach to increasing the production of key nutrients is through biofortification. Biofortification is a process through which the nutrient content of crops is enhanced through breeding; it has been found to be a cost-effective way to reach rural populations that might be underserved by other interventions such as supplementation and industrial fortification (Bouis and Saltzman 2017).

Increasing Nutrient Market Adequacy

Efforts to increase the availability of nutrients for consumption can include interventions to increase the share of agricultural production that is ultimately consumed (for example, by reducing postharvest losses and food waste and decreasing nutrient loss during storage and processing) as well as to increase the supply of nutrients from sources other than national production. Here we focus on two such sources with significant potential to increase nutrient adequacy: trade and industrial fortification.

Increasing Nutrient Supply through Trade

Trade should feature among key strategies to address nutrient gaps in both Senegal and Rwanda. Domestic exchange within countries can help allocate nutrients from surplus to deficit zones. While this is true for both countries, interdepartmental variations in nutrient adequacy are particularly noticeable in Senegal. Figure 5.4 shows that adjacent departments often have wide variations in NPA. Variation in terms of NMA is not as large but still apparent, suggesting that there may be scope for increased interdepartmental trade to address nutrient gaps in some areas.

Beyond reallocation within countries, global and intra-African trade has great potential to reduce nutrient gaps in Senegal and Rwanda. Numerous studies underline the positive impacts of trade in enhancing food security in general and increasing micronutrient adequacy in particular. For example, Odjo and Badiane (2018) and Makochekanwa and Matchaya (2019) find that regional cereal production patterns are more stable than national production patterns, suggesting that increased regional trade would increase the market stability and improve resilience to local production shocks. Bonuedi, Kamasa, and Opoku (2020) find that trade facilitation efforts in Africa improve food security by increasing the availability food in markets, reducing volatility of food supplies, and increasing the variety of foods available, as well as helping to reduce postharvest losses. Importantly, trade can increase dietary diversity, which is associated with greater nutrient intake adequacy (Ruel 2003). Dithmer and Abdulai (2017) empirically test the impacts of trade openness on diets and find that greater openness increases dietary diversity as well as calorie consumption.

Several global-level studies have found that international trade can help to increase supplies of micronutrients in areas with production deficits (Ge et al. 2021; Wood et al. 2018). Geyik and colleagues (2021) suggest that the contribution of trade is generally not sufficient to meet requirements in nutrient-deficient low-income countries; however, intra-African trade in particular makes a sizable contribution to supplies of vitamin A and vitamin B6 on the continent. Olivetti and others (2023) find that Africa's global imports make significant contributions to its iron and zinc requirements. While imports from outside the continent supply larger quantities of nutrients than intra-African trade, those intra-African imports represent a relatively sizable share of imported vitamin A and vitamin B12. In Senegal, regional imports may explain the greater availability of vitamin B12 in national markets than would be suggested by national production patterns, with higher NMA than NPA. The contribution of intra-African trade to filling nutrient gaps may be higher than suggested by official trade statistics because a sizable share of cross-border agricultural trade is informal and unrecorded. The portion of trade in nutrient-dense perishable products that takes place informally is thought to be particularly high, as border delays are especially costly for perishable products (Olivetti et al. 2023).

Intra-African trade is limited by numerous obstacles, including lengthy border requirements, lack of harmonization of procedures and requirements, and high transport costs. Trade facilitation efforts such as those associated with implementation of the African Continental Free Trade Area could help to enhance the contribution of intra-African trade to food security and nutrition. Countries should consider trade policies as an important tool to increase supplies of key micronutrients for which local production does not meet requirements. In Senegal, calcium and zinc are not produced in adequate quantities, and these two nutrients as well as riboflavin show the largest shortfalls in household consumption adequacy. Senegal's trade policies should consider the nutrient content of food products and aim to minimize barriers to imports of foods rich in calcium, riboflavin, and zinc. In Rwanda, calcium, vitamin A, iron, and zinc production fall far short of meeting national requirements; trade policies that facilitate the imports of products rich in these nutrients could contribute to filling gaps. It should be noted that trade can also contribute to the increased availability of foods high in fat, salt, sugar, and other substances associated with increased risk of noncommunicable diseases. Policies to mitigate this risk should focus on improving the quality of the entire supply of food rather than on restricting trade—for example, with quality or nutrition standards that apply to domestically produced as well as imported food (Martin and Laborde Debucquet 2018).

Increasing Nutrient Supply through Industrial Fortification

Another way to increase NMA at the post-production level is through industrial fortification, which involves adding nutrients to food products at the processing stage. Fortification has been successfully used in high-income countries for decades to address micronutrient gaps at the population level (Tulchinsky 2015). Fortification is becoming more prominent in low-income countries as well, where it has been associated with large reductions in anemia, goiter, and neural tube defects (Keats et al. 2019).

Both Senegal and Rwanda have identified fortification as a key strategy to combat micronutrient deficiencies. In Rwanda, fortification of maize flour, wheat flour, edible oil, sugar, salt, and cereal-based products became mandatory in 2019; Senegal mandated fortification of oil and wheat flour in 2009 (Nakitto, forthcoming). However, both countries face challenges in enforcing and improving the effectiveness of fortification programs. In Rwanda, enforcement of fortification regulations and standards is lacking, and the current extent of food fortification remains unknown (Guthiga and Kirui 2019; Nakitto, forthcoming). Challenges include the high cost of fortification equipment and inputs, which limits the ability of processors to comply, as well as a substantial share of the population that does not consume commercially processed food. In Senegal, enhancing the reach and effectiveness of fortification efforts is constrained by the fragmented nature of some industries. For example, small-scale salt production and packaging makes salt iodization challenging. Rice is not subject to mandatory fortification despite being a major staple and dominant source of energy (Table 5.2), perhaps due to the disaggregated industry structure in which small-scale mills process most of the rice (Nakitto, forthcoming). Small-scale food fortification could be an important way to reach consumers not served by large-scale food industries, and approaches to overcome the associated challenges should be explored (Philar and Johnson 2005).

Both countries should enhance capacities for fortification monitoring and quality assurance on the part of government bodies, as well as implementation capacities of processors. Efforts should be made to ensure adequate levels of consumption of fortified foods, including through education efforts or price incentives. Finally, more data is needed on the current status of fortification as well as the effectiveness of fortification efforts; these topics should be integrated into existing and new data collection efforts (Nakitto, forthcoming).

Increasing Nutrient Household Adequacy

Even when the overall availability of nutrients is sufficient to meet the population's requirements, some households may not be able access the required nutrients. This is the case, for example, for vitamin A and vitamin B12 in Senegal and vitamin C in Rwanda, each of which show NMA of well over 100 percent but with nutrient household adequacy values of 89 percent, 80 percent, and 84 percent, respectively (Tables 5.1 and 5.4). In many cases, this is likely to be related to households' limited purchasing power and the relatively high cost of nutritious foods. Headey and Alderman (2019) found that nutrient-dense foods such as animal products and fruits and vegetables are relatively expensive compared to starchy staples, especially in low-income countries. FAO and others (2023) estimated that healthy diets supplying adequate energy and micronutrients were financially unattainable for more than 1 billion Africans, nearly 80 percent of the continent's population.

Social protection programs—including income transfers to increase households' overall purchasing power, as well as targeted price interventions—can help to alleviate financial barriers to nutrient access. Increases in income are expected to increase overall food consumption, but impacts on nutrient intake differ by nutrient. Our income elasticity estimates (Figures 5.2 and 5.6) suggest that income increases would produce the largest consumption responses for vitamin B12 in both countries as well as calcium and vitamin C in Senegal. Efforts to increase consumption of these nutrients may find income transfers to be an effective avenue. For some nutrients, such as vitamin A in rural Rwanda, relatively low income elasticities suggest that other types of interventions may be better vehicles for addressing deficiencies.

Strategies to increase intake of specific nutrients could also include price subsidies for key foods. Figure 5.3 suggests that in Senegal, decreases in the prices of oil and of meat and fish could be effective strategies to increase demand for vitamin A and vitamin B12, respectively, while decreases in the price of pulses would raise demand for several key nutrients including thiamin, niacin, folate, and zinc. In Rwanda, demand for several nutrients with large adequacy gaps (including calcium, zinc, vitamin B12, vitamin A, and riboflavin) is fairly responsive to the price of milk products (Figure 5.7). As in Senegal, demand for vitamin A is sensitive to the price of cooking oil in rural Rwanda.

In addition to price and income interventions, nutrition education programs can help to increase households' demand for and consumption of nutritious food. Education efforts can include commercial marketing of healthy foods, maternal nutrition education programs, and community nutrition education outreach programs (FAO 1997; Jardí, Casanova, and Arija 2021). One example of a community outreach program is Rwanda's *One Egg Per Child, Everyday* campaign, launched by Rwanda's National Child Development Agency and UNICEF Rwanda in 2022. The campaign aims to raise awareness among both women and men on the importance of feeding animal source foods to children.

Policymakers in both countries can consider additional education efforts aimed at increasing the consumption of other nutrient-rich foods. For example, in Rwanda, amaranth is an important source of calcium, iron, zinc and vitamin A despite currently accounting for less than 1 percent of households' food expenditures (Table 5.5); increased amaranth consumption could help to fill the large household adequacy gaps for these nutrients. In Senegal, millet represents a smaller share of food expenditures than rice but is significantly richer in iron and zinc (Table 5.2) as well as other key nutrients.

Conclusion

Although micronutrient deficiencies are widespread in African countries, patterns vary by nutrient and by country, as well as within countries. In addition, micronutrient deficiencies can stem from multiple causes. A similar deficiency could be related to low production of a nutrient in one area and from lack of purchasing power in another. The design of strategies to combat micronutrient gaps needs to be guided by detailed evidence on the prevalence and extent of deficiencies as well as by local production, market, and food consumption patterns.

This chapter presents an approach to generate needed evidence to support the design and implementation of nutrition-smart food systems strategies. We find that both Senegal and Rwanda face serious nutrient consumption gaps at the household level, with deeper inadequacies in Rwanda. In both countries, production adequacy is much higher than market adequacy and household adequacy, suggesting that a large share of the nutrients produced do not become available for consumption. In Senegal, production adequacy was well over 100 percent for nearly all nutrients examined; for Rwanda, around half of nutrients showed sufficient production levels. In Senegal, nutrient market adequacies generally exceeded nutrient household adequacies, suggesting that nutrient consumption varies substantially among households. The distribution of nutrients seems to be more evenly allocated in Rwanda. While policymakers in the two countries may wish to put more emphasis on adequacy at different stages in the food system, multiple strategies and approaches, including efforts to increase the production of nutrients, increase nutrient supply through other sources such as industrial fortification and trade, and increase households' access to nutrients in markets, can complement each other in combatting micronutrient deficiencies.

Overall, our findings suggest that there is a strong case for promoting nutrition-smart food systems in Africa. Due to a combination of factors—including climate change, economic disparities, and health issues—many African countries face significant challenges in ensuring adequate nutrition for their populations. A nutrition-smart food system could help tackle these problems by promoting the availability and affordability of healthy, nutritious food, as well as environmental sustainability. However, promoting nutrition-smart food systems in Africa would require addressing multiple challenges, including infrastructural constraints, low agricultural productivity, and policy and institutional barriers.

Future work should extend the analysis to consider the issue of bioavailability. While a nutrition-smart food system aims to provide the necessary nutrients in a form that the body can effectively use, if bioavailability is not accounted for, people might consume enough nutrients according to dietary recommendations but still suffer from deficiencies. Some nutrients can inhibit or enhance the absorption of others. For instance, nonheme iron (found in plant foods) is better absorbed when consumed with foods rich in vitamin C, while phytates in grains and legumes can inhibit its absorption (Hallberg and Hulthén 2000). From a policy and intervention perspective, it is more cost-effective to promote foods with high nutrient bioavailability than to promote those where a significant portion of the nutrients will not be absorbed.

In addition, future analyses should examine in more detail the contribution of trade to meeting nutrient requirements in Africa. Another important area of analysis relates to changes observed in food systems in the past two decades that lead to increased consumption of higher-value foods—including perishable foods such as fruits, vegetables, and animal products that tend to be relatively rich in micronutrients—as well as processed foods, some of which are relatively rich in energy, sugar, and salt. The impacts of this dietary transition on nutrient adequacy are unclear and would be important to explore.

CHAPTER 6

A Paradigm Shift in Food Safety for Africa

Amare Ayalew, Fatima Olanike Kareem, and Delia Grace

Introduction

Food safety systems globally, and more so in Africa, have not kept pace with the complexity of food safety challenges. In Africa, these challenges include, inter alia, fragmented food safety management and mandate, and poor investment and budgetary finances on sanitary and phytosanitary (SPS)–related quality infrastructures (Jaffee and Henson 2004; Czubala, Shepherd, and Wilson 2009; PAQI 2020). The challenges are further aggravated by the poor food safety culture in the continent. These challenges of unsafe food have undermined the pace and state of food system transformation in the continent. This is because unsafe foods adversely impact public health but also thwart efforts at boosting trade in food and agricultural commodities and reduce agricultural trade (Jaffee et al. 2019; Kareem, Martínez-Zarzoso, and Brümmer 2022), thereby leading to loss of earnings and income (Kareem, Martínez-Zarzoso, and Brümmer 2022; Kareem and Martínez-Zarzoso 2020). In addition, unsafe food undermines the potential and actual gains in improving food security and nutrition.

Food safety is crucial to the attainment of the continent's Comprehensive African Agriculture Development Programme Malabo Declaration Commitments on accelerated agricultural growth and transformation for shared prosperity and improved livelihood, especially the commitments that hinge on ending hunger, poverty reduction, and tripling intra-African trade in agricultural commodities by 2025. In addition, it is germane to the attainment of many of the United Nations Sustainable Development Goals, especially those that relate to well-being.

With the Malabo Declaration coming to an end in 2025, the post-Malabo policy choices that Africa makes will be critical for implementation of the United Nations Food Systems Summit recommendations, the common African position for this, and to achieve sustainable food systems transformation in the continent. The increasing evidence on burden of unsafe foods indicates that poor food safety is a key factor leading to food systems underperformance, and in particular the ability of food systems to deliver nutrition and health outcomes. Africa and the world at large have long ignored food safety as an important driver of food and nutrition security and economic empowerment. While the recent prioritization of food safety is encouraging, there is a need for transformative ideas to fully integrate food safety into food systems transformation efforts and avoid costly delays and setbacks.

As this volume of ATOR aims to contribute to the knowledge base to inform discussions around the post-Malabo phase and therefore to inform the policy direction for the successor of the Malabo Declaration for agricultural and food systems transformation in Africa, this chapter provides background information and practical considerations related to the food safety context in Africa. Food safety is a good example of the complexity of the challenges facing food systems transformation that can be addressed effectively only through systems approaches with multisectoral and multidisciplinary measures. It is in this context that we examine the continuing progress and dramatic changes needed to attain food safety for all in Africa.

The chapter reveals that Africa has made some progress in its food safety system and management, particularly some of its policy practices and legal policies. These are particularly related to the emergence of its continental food safety policy agendas, which seek to improve coordination among the different drivers and actors of food safety systems, while moving from fragmented food safety management. However, significant gaps exist that need to be bridged to enable the emergence of an improved food system capable of ensuring safe and sustainable food system transformation for the continent. These gaps are in respect to a food safety investment framework, poor generation of credible evidence and data for state-of-the-art risk assessments, and food safety management, as well as poor food safety culture and norms, and others.

The chapter begins with background about the health and economic impact of unsafe food as well as the changing situations and trends shaping the food safety landscape; it briefly introduces basic concepts in global best practices and attempts to put that into the context of the food safety situation in Africa. The third section takes stock of continental policies and initiatives of relevance to raise food safety levels in Africa. The missing links/priorities in the fourth section depict critical items for consideration to achieve a paradigm shift in food safety within the continent; the section ends with a focus on key elements of the paradigm shift. The last section concludes with recommended policy directions.

Background, Context, and African Food Safety Landscape

Global best practices to address the complex challenge of food safety through farm-to-table approaches are well established. Given the large investments required to elevate food safety levels, countries (whether developed or developing) need to follow evidence-based and risk-based food controls in allocating resources to where there is the biggest potential for impact. General principles for strengthening food safety systems include integrating food safety into nutrition and food security policies and programs and fostering closer collaboration between the various sectors involved (agriculture, human health, animal health, trade, tourism, etc.). Also, in the spirit of the World Health Organization (WHO) Global Strategy for Food Safety launched in 2022, we must become better connected and collaborate to ensure that the right food safety knowledge, risk management methods, and interventions are successfully applied across the global food supply chain. There is also a need to address emerging food safety challenges and make use of advanced tools to improve food safety. Important background information and basic concepts are highlighted below.

Burden of Foodborne Illness

Ten years ago, food safety was not considered among the most important public health problems. This changed with the publication of the first estimates of the global burden of foodborne diseases (FBD) by the Foodborne Disease Epidemiology Group (FERG) of WHO in 2015. At the time of assessment, 35 of the most important FBD were together responsible for a health burden of 600 million illnesses; 476,000 deaths; and 42 million lost disability-adjusted life years (DALYs) annually, similar to the numbers caused by malaria or tuberculosis (Havelaar et al. 2015; Gibb et al. 2019).

The health burden was also estimated for each WHO region, and Africa south of the Sahara was the region with the highest per capita burden. Extrapolating from the FERG studies to account for population increase, it was conservatively estimated that in Africa (including northern Africa), 160 million FBD episodes and 210,000 FBD deaths, or 20 million lost DALYs, will occur in 2023—most of which are preventable.

The WHO (2015) burden of disease report showed that FBD are an important cause of morbidity and mortality and a significant impediment to socioeconomic development worldwide. The most frequent causes of foodborne illness were diarrheal disease agents, particularly norovirus and *Campylobacter spp.,* which accounted for 55 percent of deaths due to foodborne illness. Other major causes of foodborne deaths were *Salmonella typhi, Taenia solium,* hepatitis A virus, and aflatoxin.

WHO (2015) acknowledges data gaps were the major hurdle in estimating the FBD burden in national studies, and the global and regional estimates provided by FERG offer an *interim solution,* until improved surveillance and laboratory capacity are developed. The global report's coverage of chemical contaminants is particularly modest, and the report indicates that the burden of the four chemical agents estimated "should be considered the tip of the iceberg in terms of foodborne chemicals and their impact on the global burden of disease" (WHO 2015, 89). For other health links to food safety, such as aflatoxin as causes of malnutrition and stunting and dioxin and immune effects or cancer, data were not available to allow disease burden estimates (WHO 2015).

Despite its data gaps and assumptions, the WHO study presents the first ever estimates of the global burden of FBD and should serve as an important resource to focus activities that will reduce this burden. The estimates will be invaluable for countries where local data gaps prevent the development of a complete picture of FBD. Obtaining a clear view of the global impacts of unsafe food is a very complex undertaking. What is clear, however, is that even the latest global data are likely to be an underestimate; few countries routinely collect surveillance data, and available data depend on affected individuals' coming forward for treatment and being correctly diagnosed (Crean and Ayalew 2016). It appears the full extent and burden of unsafe food, especially the burden arising from chemical and parasitic contaminants, is not well known.

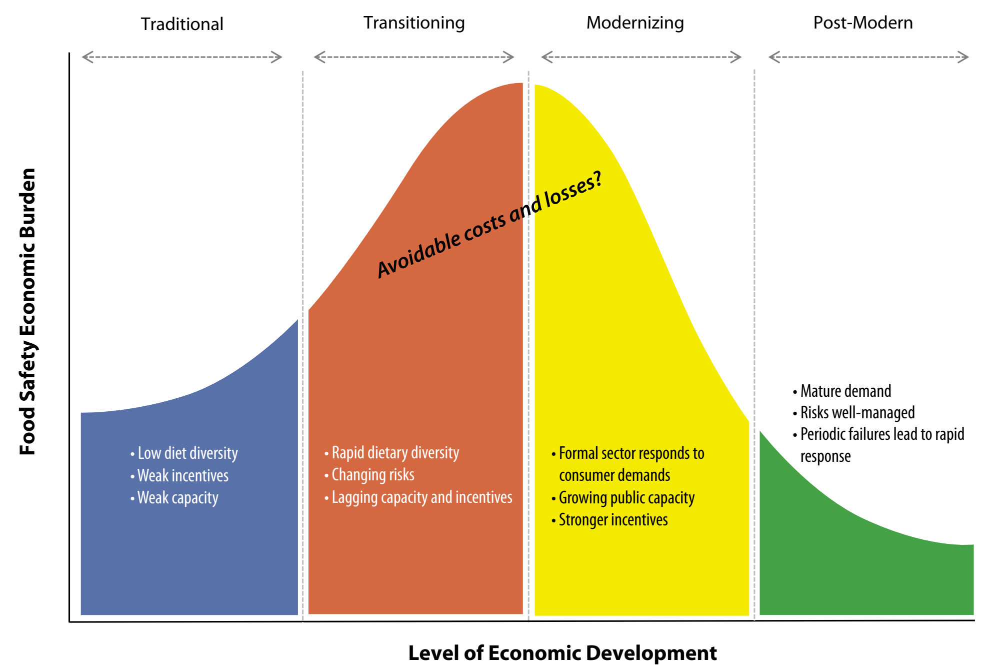
In addition to the public health burden, precise information about the socioeconomic impact of unsafe food is foundational to prioritize food safety and to allocate meager resources where there is potential for biggest return. Focker and van der Fels-Klerx (2020) distinguish between the impact of FBD on society and on the agrifood industry. The impact of FBD on society includes the costs related to loss of quality of life and mortality, loss of productivity and medical care expenses, and costs for meeting food safety requirements. Based on the FBD burden reported by WHO (2015) and gross national income per capita, Jaffee and colleagues (2019) estimated the economic burden from foodborne illness to low- and middle-income countries at around $110 billion in 2016 dollars[1]. Their estimate aggregates the domestic cost of unsafe food in terms of the cost of FBD on the basis of productivity losses and the cost of treating foodborne illnesses. The productivity losses alone for Africa south of the Sahara are

1 All dollars are US dollars.

estimated at $16.5 billion (Jaffee et al. 2019), that is, 17 percent of the total loss for low- and middle-income countries. This lower financial impact from productivity losses in Africa despite its tragically high burden of FBD is because the DALY valuation method depends on income per capita. It is not clear, though, if Jaffee and colleagues (2019) focused on DALYs lost in the working-age population because it is assumed productivity loss is based on losses in product or income per worker.

Comprehensive global estimates of the cost of lost trade or lost domestic market related to food safety are not available so far. However, the value of rejections of high-value food exports from low- and middle-income countries to the EU is about $2 billion per year (Jaffee et al. 2019). It is well established that noncompliance with food safety standards can cost the agrifood sector in contamination tracing, product recalls, suspension of production and clean up, and loss of market share because of brand reputation damage. The *Listeria* outbreak in South Africa in 2017–2018 led to losses in productivity attributed to listeriosis from lost days at work, which together with export value losses for food processors were in excess of $15 million (Olanya et al. 2019). The difficulty of sourcing safe raw materials and even the low food safety culture in the workforce make a country less attractive for investments in agro-processing and the agrifood sector.

FIGURE 6.1—THE FOOD SAFETY LIFE CYCLE



Source: Jaffee et al. (2019).

To inform their food safety policies and actions with the right evidence and effectively contribute to global estimates, African countries need to greatly improve their capacity for generating quality FBD data, which requires investments in their disease surveillance capacity—this includes health regulation (putting in place official reporting requirements), diagnostics capacity, data management, and public awareness.

The Food Safety Life Cycle and Food Safety in Food Systems under Transition

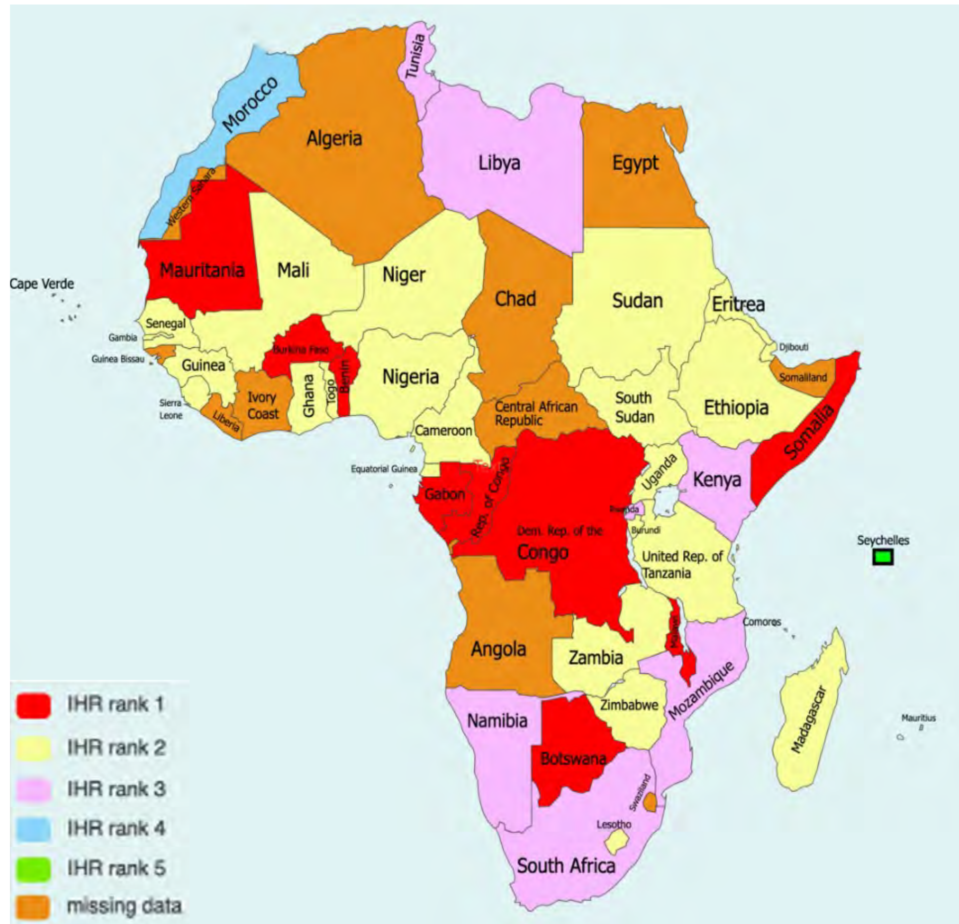
Levels of FBD and incentives for enhancing food safety management capacity vary systematically both with the level of economic development and with the stage of urbanization within a country (Jaffee et al. 2019). In the poorest countries and in remote areas of richer countries, most food is produced within the household or locally, and only small amounts of risky foods are consumed (fresh produce and animal-source foods). As countries become richer and in urban areas where the poor live (slums), food safety problems rapidly increase as larger amounts of risky foods are consumed; as supply chains become longer and more complex, they create additional opportunities for microbial growth and cross-contamination (Grace 2015). With further development, or in the value chains serving the urban rich, demand for food safety increases, as do both public and private food safety controls, and thus food safety improves. Finally, in high-income countries, food safety is generally high (Figure 6.1). This pathway or food safety risk cycle has the important implication that much of the African food system is in the critical transitioning zone where food control capacity is not keeping pace with challenges and where food safety is likely to deteriorate before it gets better. On the other hand, this suggests we are at a moment of opportunity where appropriate actions can preclude health and financial loss.

Food Control Systems: Performance of African Countries in International Health Regulations and Performance of Veterinary Services

National food control systems comprise the competent authorities and the resources, structures, arrangements, and procedures set up in a member state to ensure that official controls are performed in accordance with the food safety regulations of the country (FAO and WHO 2019). Until the recent African Union (AU) initiative (highlighted in the "AU Policies and Strategies Addressing Food Safety" section) to undertake food control assessments using international tools, only a few African countries have had systematic assessments of food safety capacity. However, some data sources give insights. First, situational analyses conducted by the International Livestock Research Institute (ILRI) in 2010 and 2020 in 15 African countries identified the following problems: lack of a national food safety policy, unreliable data on food safety, fragmented responsibilities, redundancies, a focus on hazard rather than risk, and weaker food safety regulatory oversight for domestic markets than exports. The studies recommended incremental formalization and accreditation/certification mechanisms as well as stronger coordination and more and better laboratory testing (Jabbar and Grace 2012; Kang'ethe et al. 2021).

In addition, WHO international health regulations (IHR) provide an overarching legal framework that defines countries' rights and obligations in handling public health events and emergencies that have the potential to cross borders. Countries report to WHO each year on their capacity to handle these events, and this includes their capacity for FBD surveillance and response; 47 African countries have inadequate IHR ratings of 1 or 2 (Figure 6.2).

FIGURE 6.2—NATIONAL FOOD SAFETY CAPACITY DERIVED FROM WORLD HEALTH ORGANIZATION INTERNATIONAL HEALTH REGULATIONS (IHR)



Source: Authors' analysis.

Furthermore, a useful tool for gauging the capacity of national food safety management with a focus on animal-source foods is the result of the assessments by the World Organisation for Animal Health (WOAH) of performance of veterinary services (PVS) in various countries. Performance is assessed across four critical dimensions: human, physical, and financial resources; technical authority and capability; interaction with interested parties; and measures to ensure market access. The most recent version of the PVS assessment tool covers 38 critical competencies, with experts' ratings of each capacity on a 5-point scale from *little or no capacity* scoring 1 to *a high level of competence or application of best international practice* scoring 5. Jaffee and colleagues (2019) developed an Index of Animal Sourced Food Safety Capacity based on 18 criteria from PVS. The study found a close association between high member state capacity and low burden of disease and vice versa. This is some of the strongest evidence that building member state capacity in food safety will reduce the burden of FBD.

Food Safety Actors, Stage of Development, Needs, and Governance

To facilitate governance of food safety in Africa, Member States are at the forefront of food control functions with some support from Regional Economic Communities (RECs) and AU. At the national level, food safety management in several Member States is highly fragmented as they are managed by multiple bodies such as designated ministries, departments, and competent authorities and agencies, although we are witnessing a number of Member States setting up single-agency food control systems such as the establishment of the Gambia Food Safety and Quality Authority and the National Food Safety Authority of Egypt, among others.

As fragmentation leads to suboptimal use of scarce resources (Jaffee et al. 2019), the emergence of the AU food safety policy agenda aims to improve coordination based on the notions of shared responsibilities. Thus, as a departure from the "old order," management of food safety would be based on the notion of "shared responsibilities" coupled with sensitivity to the African context and its informal food markets, as contained in the continent's new food safety strategy (AU 2022). Shared responsibilities in food safety system management mean that food safety risks would be managed by three major players: (1) government, which has oversight and implementation functions; (2) the food business sector, which is primarily responsible for ensuring food safety; and (3) consumers, who manage risks at the household level/consumption phase. Here, the government encompasses all agencies, ministries, and departments that are engaged in official food control functions as well as government-controlled research institutions, public academia, and the media. The food business sector includes business owners; those in control of food businesses such as farmers, processors, distributors, producers, retailers, wholesalers, food consulting firms, private media, and private research institutions; and others (AU 2022).

These stakeholders currently assume a limited role in food safety governance in Africa, although they are unequivocally important in the emergence of an efficient and strong food safety system. For instance, academia and research are crucial to strengthening science-based governance of food safety, promoting innovation and technology diffusion, conducting research and development, and bringing forth evidence-based policy solutions for the realization of modern food systems. In addition, the informal food system is rarely at play when it comes to governance or management of the food system. This is despite Africa's food system being largely informal, playing a huge role in the production and marketing of food to consumers, and constituting about 85–95 percent of the food sector in Africa south of the Sahara (Tschirley et al. 2015). In addition, one important required shift is the change in focus to include civil society organizations and other local nongovernmental organizations as well as consumers in the governance of the food system by strengthening civil society and consumer organizations to empower and engage in evidence-based advocacy, while also raising consumers' awareness and consciousness about safe food culture, and empowering them to demand safe food. Thus, we hope that governance based on shared responsibilities will bring a paradigm shift to the current food safety landscape management.

Emerging Trends in Food Safety

New food safety challenges will continue to emerge because of increased food imports, long food supply chains, climate change, intensification of production systems, the introduction of novel foods and novel processing and handling systems, and technological advances. The latter would help in enhancing the detection of foodborne hazards and improved diagnoses of foodborne illness and thus would play a crucial role in addressing these challenges. Such emerging issues have been covered in preceding sections. There are emerging trends in food safety that will influence how effectively and smartly African countries will be in addressing food safety challenges and becoming competitive in the continental and global food trade.

There is increasing use of technologies in food safety with promising success: blockchain with application so far limited in traceability (Jin et al. 2020); use of advanced testing methods such as whole genome sequencing for outbreak management, with practical application observed in the 2017–2018 *Listeria* outbreak in South Africa (Smith et al. 2019); the Internet of Things—the interconnection of all things (such as sensors, devices, machines, computing devices) via internet or a communication medium—with main applications observed in supply chains to trace food products, followed by monitoring of food safety and quality in high-valued food (Bouzembrak et al. 2019); and big data technologies being used to provide predictive insights in several steps in the food supply chain, including the design of monitoring and sampling strategies (Jin et al. 2020). The application of big data generated from smartphones, social media, Internet of Things, and multimedia in food safety remains in its infancy, but it is influencing the entire food supply chain (Jin et al. 2020). The application of blockchain in food safety is quite promising and is expected to bring safer and transparent food chains in the near future, although issues related to data integrity and overcoming its complexity still need attention (Jin et al. 2020). Most of these technologies are interrelated. Blockchain, for instance, is likely to play a role in big data applications. Another emerging trend in food safety that has been ongoing for some time is finding practical models of food control such as co-regulation, which works through public-private partnerships; a big data–based co-regulation model for food safety governance has also appeared (Tao et al. 2018). Moreover, addressing food safety in the one-health approach has gained momentum to sustainably balance and optimize the health of humans, animals, plants, and the environment (more information under the "Food Safety and One Health" section).

African countries should proactively avoid the technological divide in food safety and should invest not only in technology infrastructure and data analytic capacity but also in what Jin and colleagues (2020), in relation to food safety, described as data fairness (that is, findability, accessibility, interoperability, and reusability [FAIR]): data quality and the standardization of communication protocols to benefit from the features that big data tools and other technologies can offer to improve food safety systems. Embracing the One Health approach will also enable African countries to strengthen coordination, collaboration, and leverage capacities across all sectors responsible for addressing health concerns at the human-animal-plant-environment interface.

Stocktaking of AU Policy Tools and Continental Initiatives for Food Safety in Africa

Africa's food safety landscape has historically been characterized by weak coordination and fragmentation. However, recent policy decisions have led to the emergence of harmonized policy agendas aimed to efficiently maneuver and manage its food system for an enhanced continental food safety system that aligns with international best practices and local conditions. This section thus highlights continental policy tools and initiatives with the view of showing available resources, promoting complementarity and synergies, and reducing duplication of efforts.

AU Policies and Strategies Addressing Food Safety

AU's SPS Policy Framework has been developed by the African Union Commission (AUC) Department of Agriculture, Rural Development, Blue Economy and Sustainable Environment. The framework provides an overarching road map for a modern, harmonized, and coordinated SPS system that is in line with the World Trade Organization (WTO) SPS agreement and the SPS International Standard Setting Bodies. It aims to facilitate accelerated agricultural development and transformation and improve public health, food security, and intra- and extra-Africa trade. The continental framework was developed to combat the numerous SPS challenges in the continent (AU 2019). The SPS Policy Framework at the AU level was developed to support implementation of the SPS Annex of the Africa Continental Free Trade Area (AfCFTA). The policy framework provides a road map to facilitate the harmonization of SPS policies and a guide to the operationalization of Annex 7 of the AfCFTA (WTO 2018; AU 2019), which is expected to be coordinated by the AfCFTA Secretariat. In addition, the framework aims to strengthen SPS systems in the continent while addressing the challenges that have made fraught Africa's food system in relation to plant, animal, and human health for enhanced safe trade. The framework's main purpose is to coordinate the continent toward a coherent, modern, and integrated continental SPS system that is in support of shared prosperity, food security, and health for all.

Aligned to the SPS Policy Framework, the AU has the Food Safety Strategy for Africa (FSSA). The FSSA complements the Plant Health Strategy for Africa and the Animal Health Strategy for Africa. Endorsed by the AU in February 2022 during its 35th Ordinary Summit of the Assembly of AU Heads of State and Government, the FSSA provides a harmonized structure for improving food safety systems to ensure that access to safe and nutritious food is guaranteed for all in Africa (AU 2022). The FSSA adopted the concept of shared responsibilities in the management of food safety risks.

The FSSA was developed through an inclusive process, reflecting the needs and interests of different stakeholders. The FSSA aims to promote food safety culture among the African people, advocacy for safe food, and a focus on evidence-based information while strengthening research and innovation as well as technology transfer and development (AU 2022). The strategy puts emphasis on creating an innovative policy and regulatory environment that facilitates bridging food safety capacity gaps in informal food markets, which is a shift from the decades of focus on the export trade and high-value formal market. This will help to manage food safety threats and reduce the burden of the current FBD that afflict the continent. Food safety and competitiveness in export trade will continue to be important, especially with the implementation of the AfCFTA, but since the effects are not known to trickle to domestic food safety, the emphasis of the FSSA is a proactive direction. The 15-year time frame for the FSSA does not seem to take into account the dynamic nature of food safety issues and may call for early revision, particularly with the anticipated changes in continental coordination through the future Africa Food Safety Agency.

The AU has also developed strategies addressing priority food safety hazards. The Strategic Framework for Scaling Holistic Aflatoxin Control in Africa is a synthesis of the model, tools, and templates developed by the Partnership for Aflatoxin Control in Africa working with six AU Member States and RECs (AU 2020). It is essentially a country-led, evidence-based approach for holistic, coordinated, and sustainable aflatoxin control. The 36th Ordinary Session of the AU Executive Council endorsed it in February 2020 for use in all 55 AU Member States as part of Comprehensive African Agriculture Development Programme implementation. The strategic approach puts the country government in the driver's seat and prepares the country for sustainable control of aflatoxins involving partnerships. The countries that tested the model have developed and included evidence-based, stakeholder-aligned aflatoxin control plans in long-term strategies and government systems; have put in place coordinating steering committees and technical working groups; and have succeeded, though to varying degrees, in financing their plans.

The country-led, country-planning approach can be applied to broader food safety, and the AU is promoting development of evidence-based national food safety action plans. AUC, in collaboration with the United Nations Food and Agriculture Organization (FAO), Bill & Melinda Gates Foundation, United States Agency for International Aid, and European Commission, has been supporting 18 Member States to undertake food control assessment using international tools (the 2019 FAO/WHO Food Control Assessment Tool) and develop national food safety plans to address identified gaps. The collaboration with FAO and the European Commission to support Member States in the Common Market for Eastern and Southern Africa region is at its final stages, and most of the countries engaged have validated their costed national food safety plans. There is interest in expanding this support toward evidence-based food safety and reaching many more Member States. Moreover, countries are showing readiness to undertake self-assessment of their food control system. The ultimate goal of these assessments should be developing a common vision around a national food safety plan, identifying priorities, developing cost estimates, increasing investments, and uplifting food safety levels in AU Member States.

The African Union Development Agency, working with the African Organization for Standardization and other partners, has developed Guidelines for Harmonizing Food Safety Standards and Legislation (AUC 2020). The guidelines were developed through scoping missions to some RECs (Common Market for Eastern and Southern Africa, Economic Community of Central African States, Economic Community of West Africa States, and Southern African Development Community) and Member States, online surveys, food safety workshops with stakeholders, and review of documents. Further work is needed to promote harmonization of food safety standards, which will play key roles in the implementation of the AfCFTA. The AfCFTA agreement provides a framework for the continent's food safety management and scope. The AfCFTA's guiding principle in relation to food safety management in the continent hinges on its Annex 7, which specifies provisions and clauses regarding SPS measures and procedures in the continent.

In addition to policies and strategies, the need to improve food safety coordination in the continent has been recognized over the years. The initiative by the AU to establish an Africa Food Safety Agency has undergone stakeholder consultation and is under final consideration by AU policy organs. The AUC should expedite the operationalization of the agency. The AUC, in collaboration with the National Food Safety Agency of Egypt, launched the African Food Regulatory Authorities Forum in October 2023, recognizing that collaboration between food-competent authorities and across stakeholders is imperative to address an increasingly complex and interdependent health, food production, and food trade environment.

Benchmarks for Food Safety Curriculum

Well-trained food safety manpower is a critical component of ensuring food safety. The Inter-University Council for East Africa (IUCEA) is a strategic institution of the East African Community (EAC) responsible for the development and coordination of higher education and research in the region. In 2006, IUCEA initiated a process of setting regional higher education benchmarks: quality standards based on internationally recognized frameworks. To date, IUCEA has issued 11 sets of curriculum benchmarks, the latest being for a bachelor of science in food safety. This was developed through a consultative process involving experts from universities, industry, and government agencies, among other partners, and was approved by the Executive Committee on July 4, 2022 (IUCEA and ILRI 2022). Another accomplishment is the ongoing development of benchmarks for a master of science course in One Health in EAC. Such benchmarks are pacesetting and also contribute to the harmonization of One Health programs/curricula in EAC's higher education institutions. In addition, the efforts are expected to stimulate a paradigm shift by other higher education institutions to incorporate food safety curricula into their programs. The benchmarks will help ensure that the several hundred higher education institutes teaching food safety in EAC do so to a uniform, high standard and that curriculum content reflects the needs of EAC, including food safety in the informal sector.

Food Safety and One Health

In the last few decades, One Health has emerged as the gold standard for addressing health problems at the interface of human, animal, plant, and ecosystem health. FBD are a quintessential One Health problem. First, they occur at the interface of human health, animal health, and ecosystems. Second, the most important FBD are zoonotic, managed by multiple sectors (typically including health, veterinary, trade, and tourism). Last, many FBD are associated with the types of food whose production has profound impacts on ecosystems and biodiversity (livestock and cereals). The Quadripartite, an initiative led by FAO, the United Nations Environment Programme (UNEP), WHO, and WOAH, has been spearheading international One Health and considers FBD one of its four priority areas (along with emerging zoonoses, neglected zoonoses and tropical diseases, and antimicrobial resistance) (FAO, UNEP, WHO, and WOAH 2022). In Africa, several One Health initiatives cover food safety. These include Afrohun and the One Health Centre for Africa, which aims to improve the health of humans, animals, and ecosystems through capacity building; strengthening of local, regional, and global networks; and provision of evidence-based policy advice on One Health in Africa south of the Sahara (ILRI OHRECA n.d.).

Africa Food Safety Index

Genesis and Nature of Africa Food Safety Index

Critical analysis by technical experts supporting the AU Biennial Review (BR) on agricultural transformation in Africa as well as AU Member State focal persons recognized that the omission of food safety in the first BR report produced in 2017 was one of the major gaps in the BR. This recognition led to stakeholder consultations and approval by policy organs that led to the development of the Africa Food Safety Index (AFSI) for reporting on food safety since the second cycle of the AU BR mechanism.

The AFSI is a composite index, developed by the AUC with a number of partners, comprising three indicators with a number of parameters. These indicators are the Food Safety System Indicator (FSSI), which is a *capacity indicator* that assesses whether rules, laws, regulations, and institutions governing the food safety system are in place in each Member State, and two *outcome indicators,* namely on public health—Food Safety Health Indicator (FSHI)—and on trade—Food Safety Trade Indicator (FSTI). The AFSI commits AU Member States to using these three indicators to track whether they have the necessary components of a functional food safety system and are on the path to reducing FBD by 50 percent and reducing trade rejections due to food safety hazards by 50 percent by 2025. The index, using data available in the countries, provides a useful benchmarking tool.

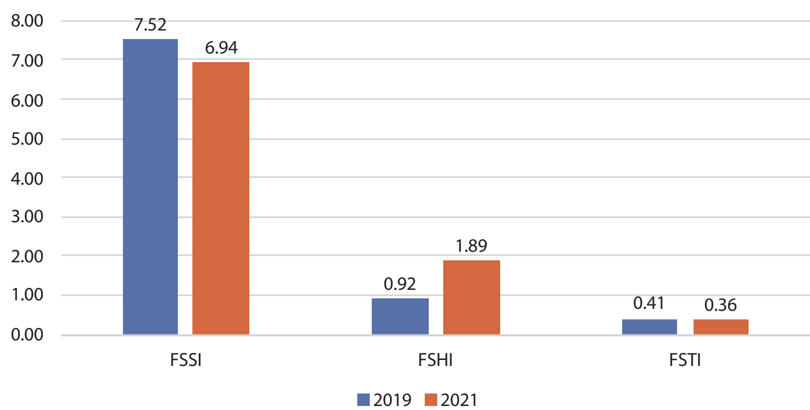
The AFSI is replaced by the SPS Index as of the current cycle of the BR (to be reported in 2024), and there have been discussions at technical experts' level to move the SPS Index to the Malabo Declaration Commitment on Intra-Africa Trade. We attempt to highlight the food safety situation of AU Member States in 2018 and 2020, as measured using the three indicators with a number of parameters. We will also reflect how best to reconcile the desire to track the impact of SPS matters without affecting the focus on food safety whether for trade or for the domestic market.

Performance of AU Member States and the AFSI Metric

In general, AU Member States have developed most components of a food safety system, but that does not translate into improved public health and improved trade related to food safety (Figure 6.3). To be on target toward achieving the food safety target by 2025 as stipulated in the AFSI, in 2021, Member States are expected to achieve at least a score of 5 (that is, 50 percent) out of a maximum score of 10. Those with scores that are greater than or equal to 5 are deemed to be on track in achieving their food safety target of improving public health, food safety, and trade in safe food; otherwise, they are not on track. With trade indicator scores of less than 0.5 (indicating less than 5 percent improvement since 2015 in export reduction rates) and the health indicator in 2021 being at less than 2 (indicating less than 20 percent improvement in key health and disease outcomes), Member States need strategies to make use of the positive components of their food safety systems, which in 2021 stand at 70 percent of the requirement, to minimize the adverse effects of unsafe food on public health and trade.

The categories of performance for each food safety indicator in Figure 6.4 also show that the number of countries (41 in 2018 and 46 in 2020) that have high-performing or reasonably performing food safety systems is encouraging, but that has yet to be reflected in improved public health and trade outcomes. These figures should be seen with caution for two reasons: (1) the limited number of countries that reported on the health indicator and particularly the trade indicator constrains meaningful analysis, and (2) data quality leaves much to be desired. BR reporting considers "no data" as "0" data.

FIGURE 6.3—AVERAGE SCORE OF AU MEMBER STATES IN THE THREE AFRICA FOOD SAFETY INDEX INDICATORS IN 2019 AND 2021



Source: Authors' analysis.

Note: FSSI = Food Safety System Indicator, FSHI = Food Safety Health Indicator, FSTI = Food Safety Trade Indicator. FSSI scores are measured on a scale from 1 to 10, with 10 indicating complete presence of a set of key elements of a functional food safety system. FSHI and FSTI scores indicate percentage rates of improvement in the indicators over the baseline of 2015.

Perspectives on Food Safety Tracking in the AU

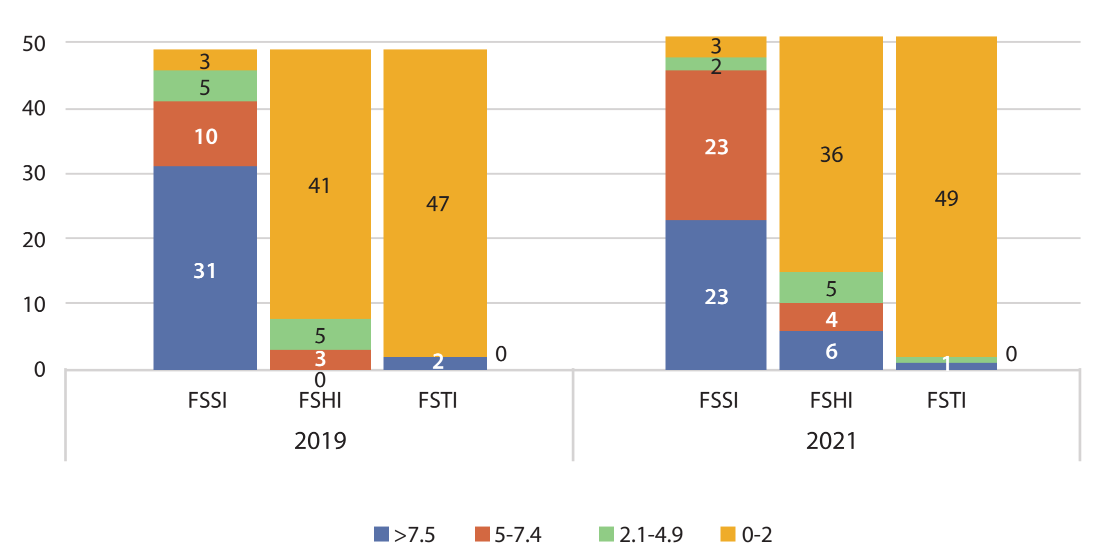
The AFSI is an innovative metric to track food safety and has a potential for long-term use to generate data and inform policies and actions in a rapidly changing food safety landscape. The evaluation of AFSI by AUC and ILRI (2022) showed the value of AFSI and areas for improvement. There are global efforts to emulate the AFSI to track food safety in the world, with even discussions held to include food safety indicators in the Sustainable Development Goals. In the AU BR, the shift to the SPS Index replacing the AFSI clearly will not address food safety adequately but will merely expand SPS beyond its scope. The One Health approach described under the "Food Safety and One Health" section is being adopted as a more comprehensive approach to address human, animal, plant, and environmental health.

WTO's Standards and Trade Development Facility (STDF 2010) advised distinguishing SPS indicators from other initiatives to develop and/or apply sector-specific indicators for food safety as well as animal and plant health systems. SPS indicators should go beyond sectoral indicators and serve as comprehensive, crosscutting indicators for a national SPS system as a whole.

If post-Malabo consultations come up with a mechanism similar to the BR, it is important to consider reinstating AFSI with the systems and health indicators while developing the trade indicator as a measure of impact of SPS issues on trade. It is important that the AUC provide unambiguous leadership and avoid introducing data collection requirements that are not supported by country-level setups. A national SPS system relies on the relevant competent authorities for food safety, animal health, plant health, and/or trade, and the focus of a national SPS system is export-oriented supply chains (STDF 2010). No country has the setup to address the entirety of food safety, plant health, and animal health issues under its SPS system.

The AfCFTA SPS Annex requires that AU Member States have in place a functioning SPS system. The full SPS capacity assessment and capacity building are in the realm of mandates of the AfCFTA Secretariat, which are broader than the BR or a comparable post-Malabo mechanism on agriculture and related sectors. It is noteworthy that the Malabo Declaration emphasizes input supply,

FIGURE 6.4—STATUS OF AU MEMBER STATES AS SCORED BY FOOD SAFETY INDICATORS IN 2018 AND 2020



Source: Authors' analysis.

Note: FSSI = Food Safety System Indicator, FSHI = Food Safety Health Indicator, FSTI = Food Safety Trade Indicator

mechanization, and postharvest reduction to boost productivity and is silent about reducing the impact of pests. Plant health and animal health factors that affect productivity should be emphasized in any post-Malabo continental direction as they are major contributors to the underproductivity of African agricultural and livestock systems. Further development of SPS capacity at the AfCFTA Secretariat is also expected to address continentally coordinated SPS benchmarking.

Missing Links/Priorities for Food Safety Management in Africa

Based on the foregoing and an assessment of established knowledge about capacities and competences to have mature food safety systems in place, this section addresses, without trying to be exhaustive, crucial missing links and priorities to achieve paradigm shift in food safety management in Africa.

Investment Framework

In recent years, food safety increasingly has been seen as a shared responsibility. Governments need to play effective vision-setting and convening roles, provide reliable information to other stakeholders, and effectively deploy a wide set of policy instruments to involve, incentivize, and leverage the actions of farmers, food business operators, and consumers (Jaffee et al. 2019). Recent studies on food safety in Africa made a range of largely aligned recommendations (Jaffee et al. 2019; Grace et al. 2019). The highest-priority recommendations were the following:

- More investment in food safety (by African governments, donors, and the private sector) is needed to ensure Africans have safe food.
- Member states should develop a unified, risk-based, food safety strategy that defines priorities and responsibilities, guides the coordination of measures by government and private entities, and establishes funding needs.
- The role of government should be less about finding and penalizing noncompliance and more about facilitating compliance via the provision of information, advice, incentives, and interventions to motivate and leverage investments and actions by value chain actors.
- Rather than strict enforcement, which is unworkable, an approach of gradual and continuous enhancements in food hygiene practices is more likely to secure the ongoing viability of the informal food sector, which is critical for food security in Africa.
- Consumers need awareness and tools to become partners in food safety through their own actions and through incentivizing and otherwise motivating food suppliers.
- Training programs, information campaigns, and other interventions should incorporate the science of behavior change including incentives and nudges.

Generation of Credible Evidence for Risk Assessment Constraining Food Safety Management

Risk Ranking—What Are the Priority Hazards and Food Matrices?

Hundreds or thousands of hazards can cause FBD. The aforementioned analysis of FERG looked at a few dozen of the most important, for which there was sufficient evidence to develop regional and global estimates. This found that 82 percent of the known burden of FBD in Africa is associated with microbial pathogens, in particular *Salmonella* species, toxigenic *Escherichia coli,* norovirus, and *Campylobacter* species (Havelaar et al. 2015; Gibb et al. 2019). Next in importance were heavy metals, especially lead, accounting for 8 percent of the burden. Among chemical hazards, aflatoxins have attracted much public attention, policy focus, and development assistance in recent times. Aflatoxins, naturally occurring toxins produced by fungi, can contaminate a wide variety of food crops including maize, sorghum, cassava, groundnuts, sesame, chili, and others. A large body of research in Africa and elsewhere has found causative links between aflatoxin levels in the diet and cancer. Aflatoxin has also been found to be a growth retardant in animals and is suspected of being a contributing factor to child stunting. Cyanide from cassava is a chemical hazard for which the associated health burden falls entirely on Africa.

Only in the last decade has good evidence on the burden of FBD started to emerge, and attribution to different food sources is even less clear. Animal-source foods and fresh vegetables are reported to be the most risky products (Hoffmann et al. 2017). However, as food safety risks are context specific, thorough studies that take into account the predominant diets of consumers in Africa are still needed. Consumers of street foods, ready-to-eat foods, foods eaten raw, and complementary foods are also especially vulnerable to acquiring FBD (Grace et al. 2019).

Role of National Burden of FBD Studies, Updating Database on FBD

WHO has initiated a follow-up study to revise the 2015 global burden of FBD report (WHO 2021). The next global report will be as good as the improvements made since 2010 (the base year for the 2015 report) in availability of adequate data and sufficient information on foodborne hazards and illness at the country level. Not only are national burden of FBD studies important inputs to global burden estimates, but they also allow the country more efficient allocation of resources to prevention, intervention, and control measures. They are an essential component of efforts to rank risks of FBD and establish food safety priorities. WHO (2021) has published guidance on assessing the burden of FBD with a focus on microbiological agents commonly transmitted through foods, which gives a complete picture of the data and resource requirements, the steps in the process including computation methods, and interpretation and communication of results. WHO (2021) also aims to foster harmonization of methodologies for estimating FBD burden across countries so that experiences can be shared, estimates compared, and food safety policy improved.

Estimation of the burden of disease caused by chemical hazards requires different data and methods than that of microbial hazards (WHO 2021). The incidence and hazard-based approach is considered the gold standard for estimating the burden of foodborne hazards, including foodborne chemicals (WHO 2021). However, WHO (2021) focuses on microbial hazards, and there is a need for global efforts to improve the database and methodology for assessing the burden of disease from chemicals. We hope the WHO reports have raised awareness among AU Member States planning their own foodborne burden of disease assessments to consider natural and anthropogenic chemicals.

Role of National Food Consumption Studies/Surveys

National dietary surveys or studies provide baseline information on individual-level food consumption patterns. Such studies are an important ingredient to national disease burden studies and serve a number of other purposes in evidence-based policymaking for food security and nutrition interventions. A number of methods are used in food consumption surveys, including 24-hour dietary recall. Harmonizing food consumption data including nutrient intake and food composition data will go a long way continentally and globally to achieve consistency and comparability.

Food Safety Culture and Norms: Measuring Culture, Changing Culture

Food safety culture is most commonly defined as the totality of the prevailing, relatively constant, learned, shared attitudes, values and beliefs contributing to the hygiene behaviors used within a particular food handling environment (Samuel, Evans, and Redmond 2019). As such, food safety culture is the sum of an organization's attitudes, beliefs, and values on food safety. Although most commonly applied to food businesses, food safety cultures must be inculcated in public-sector organizations, nongovernmental organizations, and households, an extension first developed in the context of Zimbabwe (Nyarugwe et al. 2016).

Behavior change communication plays a key role in promoting food safety culture. Distinguishing between risk perception by the general public and actual risks so that scarce resources are spent on managing major problems (Grace 2015), the use of effective risk communication that relies not just on passing information but on messages with emotional resonance, and building trust in the risk communicator (Reynolds 2011) are some of the key considerations.

The Informal Food Sector

For many years, food safety has been on the development agenda primarily as a trade and market access issue. Little attention was given to domestic markets, and within domestic markets, national control systems focused on the easier-to-inspect formal sector (Kang'ethe et al. 2021). A marked departure is the new AU FSSA, which emphasizes the importance of informal food markets to food security, livelihoods, and equity (AU 2022). While the modern food retail sector comprises supermarkets, convenience stores, and high-end restaurants, the traditional or informal sector comprises public markets with dozens or hundreds of vendors, which supply both customers and the owners of small shops or kiosks; mobile vendors of fresh or cooked foods; and informal restaurants or eateries. Both formal and traditional retail sectors mainly source fruit and vegetables from wholesalers and meat from local abattoirs, although significant quantities of poultry and fish are imported from outside Africa. Surveys in different countries in Africa find that 85–100 percent of food is obtained from informal markets (Hoffmann et al. 2017; Hannah et al. 2022). Overall, in Africa, around 20–30 percent of food is produced in households, around 20 percent in the formal sector, and 50–60 percent in the traditional sector. Although the formal sector is growing, the traditional sector will remain a major supplier of food for decades to come (Tschirley et al. 2010).

Food Fraud, Adulteration, Quality Issues

Food crime covers a wide range of immoral and illegal activities. These include adulterating food for economic gain, contaminating food for ideological reasons, and stealing food secrets. Food fraud can negatively impact health and nutrition security directly through reducing availability of food and indirectly by damaging the agrifood sector and hence access to food. Globally, food fraud costs $30–$40 billion a year (Schoolderman et al. 2015). Perspectives derived from criminology imply motivation, opportunity, and lack of adequate control systems predispose to food fraud and market. Economic, cultural, and individual risk factors for food crime have also been identified. Complex and rapidly transforming food systems are especially vulnerable to food fraud. In Tanzania, more than 50 percent of all imported goods, including food, are believed to be fake; a study of processed meat in South Africa found 68 percent contained undeclared animal and/or plant protein (Cawthorn, Steinman, and Hoffman 2013); and in Nigeria, 100 percent of bread samples contained potassium bromide (a banned chemical) (Ifiora et al. 2015).

Mainstreaming Gender into Food Safety

Women are important but underrecognized risk managers in the realms of food production, processing, selling, preparation, and consumption. Understanding the influence of gender on risk exposure and management is essential for improving food safety in informal markets (Grace et al. 2015). The role of women in the production, handling, and marketing of perishable foods such as milk, vegetables, and fruit, while ensuring safety through farm hygiene is well recognized. Women also play a key role in grain value chains such as groundnut shelling and marketing. Reduced access to resources is a barrier to technology adoption by women, and gender-sensitive food safety interventions are recommended (Garsow et al. 2022). Knowledge-based efforts are needed to meaningfully integrate gender into food safety initiatives. The AUC, in collaboration with the Impacting Gender and Nutrition through Innovative Technical Exchange in Agriculture mechanism of Tanager, an ACDI/VOCA affiliate, has undertaken gender analysis in 12 AU Member States to generate empirical data and systematically examine differences in the barriers and opportunities of male and female farmers and traders, specifically in relation to food safety and women's involvement in the food system. The reports will be released before the end of 2023.

Implementation Capacity: Food Safety Workforce, and Budget, Infrastructure (Food Safety Testing)

Africa is characterized by poor regulatory capacity to formulate and implement food safety regulations. This weak regulatory capacity has resulted from poor-quality infrastructure in the continent (including accreditation, metrology, testing, standardization, and measurements), with about 43 percent of AU Member States still below the required level of quality infrastructure needed to protect humans and the environment and to support trade (PAQI 2020). This also impacts the ability to enact standards based on scientific risk assessment as well as to implement certification and testing procedures and other enforcement capacities (Kareem, Martínez-Zarzoso, and Brümmer 2022). Furthermore, the poor implementation capacity in many African countries is propelled by the high investment costs of SPS-related facilities, which are enormous (UNIDO 2015) and could be more than the developmental budget of some countries, and the poor budgetary allocations to implement an efficient food safety system.

A survey carried out by AUC (2022) showed the limited staff capacity in food safety data generation and more so in risk assessment (Figure 6.5). The situation of food inspectors and regulators is also expected to be at least as insufficient.

The FSSA recognizes the importance of finance for an enhanced food safety system, with one of its seven implementation elements for an enhanced food system being "considerations about budgetary and investment." Member States are expected to allocate sufficient budget to improve their food safety systems.

The Paradigm Shift in Focus

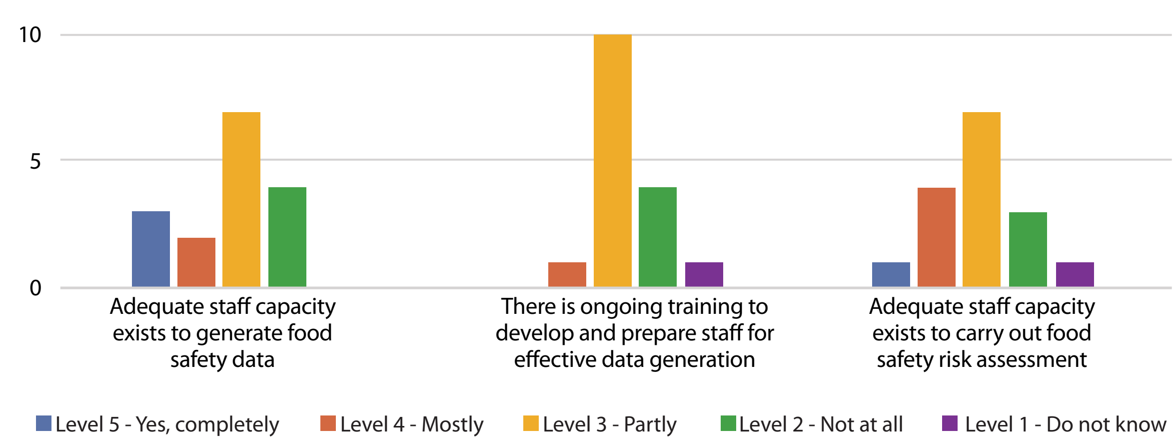
It is vital to focus attention on the recent changes in the food safety landscape that have the potential for biggest impact with limited resources. We hope the recent trend of food safety governance based on shared responsibilities will bring a paradigm shift to the current food safety landscape simply because there is no single entity that can solve the complex challenges of food safety. This trend should be institutionalized, and the policies and strategies of recent years that focus on evidence-based approaches such as the FSSA are believed to contribute to this shift. The strategies call for partnerships and collaboration to fully implement them and achieve the desired changes.

Any initiative to improve food safety data, such as the AU effort to develop a food safety data hub for Africa, allowing it to undertake sound risk assessment, is a move in the right direction. This should be complemented with country-level capacity building and investments in generating, sharing, and using credible food safety data.

The recommendation to shift from decades of focus on the export trade and high-value formal market to the informal food sector is at the heart of future improvements in food safety levels in domestic markets, as well as improvements to the competitiveness of the agrifood sector in international trade. The AUC is working to develop and test innovative models for regulating the informal food sector by Member States, which by definition have remained outside food regulatory schemes.

To address one of the fundamental root causes of poor food safety management, efforts are underway to strengthen food safety manpower in the continent.

FIGURE 6.5—SITUATION OF STAFF CAPACITY IN AU MEMBER STATES (16 RESPONDED) FOR FOOD SAFETY DATA GENERATION AND RISK ASSESSMENT



Source: AUC (2022).

Efforts of curriculum benchmarking that began in the EAC should be replicated in different regions of the continent, with the aim of producing the food safety workforce that the continent is in dire need of.

Coupled with risk-based approaches to prioritize food safety issues in which to invest meager resources, the overall increased recognition of the importance of finance for an enhanced food safety system is expected to improve food safety levels in Africa, if commitments made are delivered on. Sustainable financing of food safety is a mark of mature food safety governance in a country. A paradigm shift in the financing landscape, most of which should come from Member States themselves, would enable RECs and Member States to build technical capacities to comply with, enact, and enforce measures as well as pool investments to improve their food safety systems in line with international benchmarks.

Conclusion and Recommendations

Food safety is a complex developmental issue that straddles public health, agriculture, trade, tourism, and other sectors of the economy. Unsafe foods are a major cause of underperformance and a leverage point to fix inefficiencies in the food systems. Africa bears the burden of disproportionate FBD, and it is high time the continent prioritize food safety and sustain its goals of using safe food for enhancing the transformation of its agricultural food sector, driving domestic and regional markets, and attaining food security and improved public health. Effective and efficient food safety systems require state-of-the-art, risk-based, and safe and sustainable farm-to-table approaches that encompass shared responsibilities among all stakeholders in the food supply chain. While the present legal policies and policy practices of the African food safety system are being improved, significant room for improvement exists for an improved food safety system capable of ensuring a safe and sustainable food system transformation for the continent. Thus, the following recommendations stand out to further improve food safety systems in Africa.

1. Expediting the establishment of the Africa Food Safety Agency by the AUC, which is long overdue, to improve food safety coordination in the continent
2. Undertaking country situational analysis and food control assessment with a view to developing a unified risk-based food safety strategy that defines priorities, responsibilities, and emerging trends; guides the coordination of measures by governments and private entities; establishes funding needs; and emphasizes the integration of food safety in nutrition and related longer-term programs
3. Implementing the continental and regional strategies and frameworks with relevance to food safety, which were developed in recent years
4. Fostering sectoral and disciplinary collaboration while ensuring clarity of mandate—avoiding confusions between SPS, One Health, and sectoral capacities will be crucial to sustaining focus and avoiding episodic initiatives
5. Investing in developing estimates of FBD and economic burden for AU Member States (using harmonized methodologies) as most of the existing estimates are currently based on global studies
6. Improving methodologies and data for estimating the burden of chemical and parasitic hazards to respond to concerns that are underestimated
7. Taking proactive measures to prevent a technological divide in food safety, with a focus on investments in infrastructure and manpower so as to benefit from the features that Big Data tools, blockchain, whole genome sequencing, and future developments can offer to improve food safety and supply chains
8. Advancing the integration of gender in food safety initiatives by generating examples and methods
9. Advancing food safety culture and norms as fast as possible through programs that incorporate the science of behavior change including incentives and nudges
10. Supporting the Coalition for Action for Safe Food for All arising from the United Nations Food Systems Summit process, where food safety is featured as a crucial element of the Summit's Action Track 1

CHAPTER 7

A Forensic Framework and Decision Support System for Harmonized and Holistic Food System Resilience and Sustainability Analysis

Prince Agyemang, Ebenezer M. Kwofie, Marie-Anne Dessureault, and John M. Ulimwengu

Introduction

Background

Today, many innovative food system transformation programs are taking place in several parts of the world, including developing, and low-income countries as well as those in Africa south of the Sahara (Benfica et al. 2023). Notably, in Africa, food systems are at a crossroads, facing several endogenous and exogenous shocks and stressors. Approximately 282 million people in Africa are undernourished, with a prevalence of 22.8 percent as measured by the prevalence of undernourishment, a Sustainable Development Goal (SDG) indicator (FAO et al. 2017; Agyemang and Kwofie 2021). Furthermore, continuous floods and droughts in many parts of the continent have reduced food security and calorie intake, respectively, by 5–20 percent and 1.4 percent below 2019 levels (Balgah et al. 2023). By 2050, climate change is anticipated to slow the fight against hunger, with an estimated 78 million people in Africa projected to experience chronic hunger in addition to the current numbers (Hasegawa et al. 2018). The individual and combined effects of external shocks and stressors on the African food system, including climate change, soil degradation, price fluctuations, political conflict, and widespread fragility, have created a complex risk environment that threatens food security and the overall well-being of many Africans. Against the above background, there is a consensus within the scientific and policy advocacy community that the African food system is flawed.

For these reasons, building a resilient and sustainable food system while striving to achieve the SDGs by 2030, the Paris Agreement goals by 2050, and the Agenda 2063 goals is critical to ensuring sustainable and inclusive development on the continent. On the one hand, a resilient food system, as defined by Fan and colleagues (2021), can eradicate weaknesses and address future uncertainty, including disruptive shocks. Food system resilience offers a valuable lens for investigating human health and well-being and how the supporting food systems they depend on can absorb and recover from various shocks and stressors, including unintended events such as the COVID-19 pandemic (Upton et al. 2021) and the war in Ukraine. In terms of a food system's recovery from shocks, emphasis has been placed on employing transformative strategies that result in improved functioning postshock rather than a return to the status quo. Upton and colleagues (2021) developed a framework to measure the resilience of rural households in Malawi, Zambia, Madagascar, and Kenya with respect to the COVID-19 pandemic and policy responses. The study demonstrated that severe illness and mortality from COVID-19 in most households substantially increased food insecurity compared to indirect stressors such as market dynamics. Mkhize, Mthembu, and Napier (2023) employed income sources, employment status, household food budget, agricultural production, and anthropometrics as indicators for measuring local food access and acceptability in relation to land use in Umlazi Township in Durban, South Africa. From the study, more than 67 percent of informal dwellers were unemployed, while households were restricted to a monthly food budget of less than US$115 (2,000 South African rand).[1] Additionally, more than 73 percent of the inhabitants in the target community had little or no access to land for cultivation, further exacerbating food security issues within the community.

On the other hand, a sustainable food system, as defined by the Food and Agricultural Organization (FAO), delivers safe and nutritious foods so that the capacity of future generations across economic, environmental, and social dimensions is not compromised (Emadi and Rahmanian 2020). Parallel to studies measuring the resilience of food systems, Jacobi and others (2020) developed a framework that captured five dimensions—namely, food security, right to food, environmental performance, poverty and inequality, and social-ecological resilience—to measure food sustainability in six different food systems in Kenya and Bolivia. In the study, agro-industrial food systems scored the lowest in environmental performance and security, while their resilience scores were medium to high. Similarly, the right to food, poverty, and inequality had the lowest scores across the case study food systems. In light of the above and several other existing studies, conceptual and theoretical advances have been made to support policymakers and stakeholders in defining indicators and metrics highlighting the complex dynamics between the different components of the African food systems. However, the unintended consequences of proliferation in resilience and sustainability indicators hinder efforts to generate evidence and empirical measures that are practically consistent, comparable, and able to steer decisions toward a sustainable African food system. Additionally, no commonly agreed-upon domains and indicators for measuring food systems' resilience and sustainability exist. Also, the above studies and a proliferation of literature on interventions on the continent have often evaluated food system resilience and

1 All dollar amounts are in US dollars.

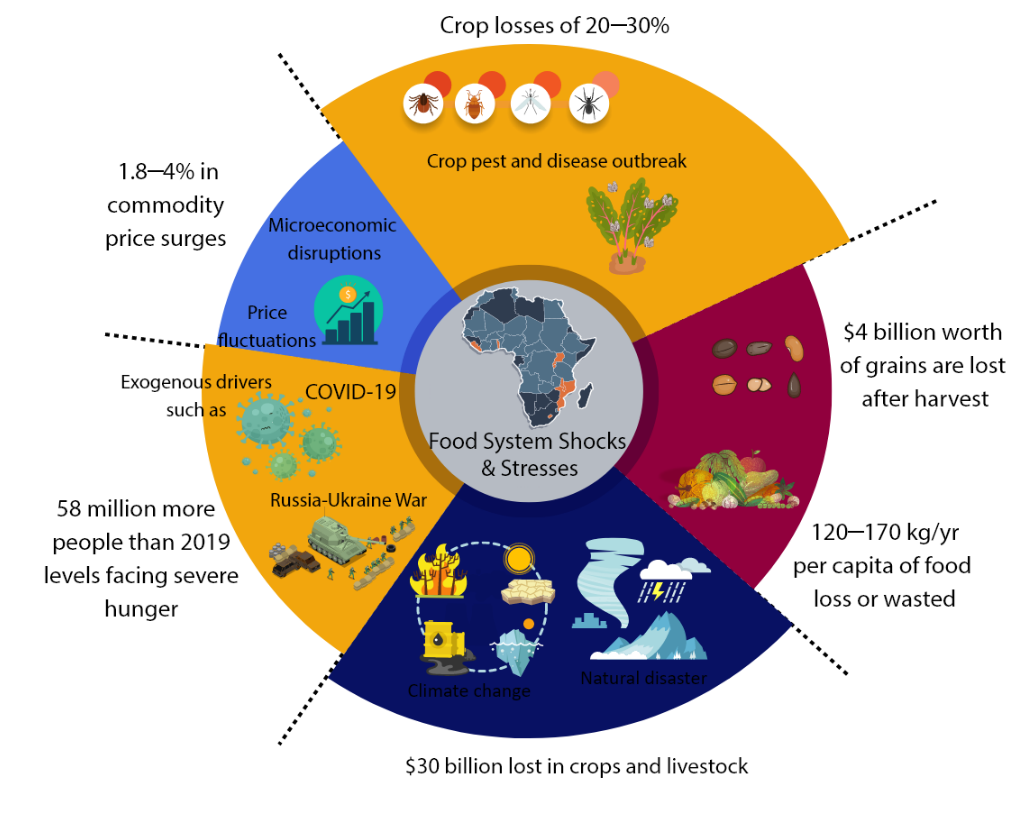
sustainability separately, neglecting their causal relationship, even though a resilient food system may contribute to sustainability (and vice versa), and strategies aiming to enhance resilience can promote sustainability (and vice versa).

Based on this premise, this chapter proposes a forensic framework that provides an opportunity to curtail weaknesses and build the capacity of food system actors while dealing with uncertainties, shocks, and external stressors. Furthermore, the proposed forensic framework incorporates multiple components and outcomes across multiple scales and levels, including social, economic, health, and environment, through harmonized sustainability and resilience dimensions and indicators. It also provides a quantitative approach to support decision-makers in objectively designing actions that systematically steer food systems toward sustainability and resilience. In the long term, this chapter sets a foundation for a holistic, harmonized, integrated food system resilience and sustainability assessment through a novel decision support system, Food System Rapid Overview Assessment using Scenarios (FS-ROAS), that helps stakeholders assess food systems and design appropriate interventions. Finally, a case study of the African continental and subregional food systems is examined, considering three harmonized dimensions—food and nutrition, socioeconomic, and environmental—to illustrate how the elements of the proposed forensic framework can be applied to a harmonized resilience and sustainability analysis. In anticipation of revisions to the 2014 Malabo Declaration on Africa Agriculture and the 2015–2025 Comprehensive African Agriculture Development Programme (CAADP), the proposed decision support system, FS-ROAS, presents an opportunity for heads of state and governments of the African Union to explore potential consequences of their recommitment to sustainable development in Africa.

Shocks and Stressors Affecting Food Systems in Africa

According to Ansah and colleagues (2019), the term *shocks and stressors* may be defined as events that may disrupt the normal functioning of a socioeconomic agent or activity, subsequently trickling down to tamper with household food security. These shocks could be categorized as covariate, which often threaten a broader population, or idiosyncratic, which affect an individual or household level (Lin 2011; Bullock et al. 2017). However, the manifestations of these shocks or perturbations within the African food system vary at different spatiotemporal scales. Figure 7.1 presents examples of stressors and shocks derailing the resilience and sustainability of the African food systems. At the production level, extreme weather conditions (droughts and floods), climate change, pest and disease outbreaks, and low technology adoption have exposed the fragilities of the African food system. For example, between 2008 and 2018, approximately $30 billion was lost in Africa

FIGURE 7.1—EXOGENOUS DRIVERS, SHOCKS, AND STRESSORS INFLUENCING THE AFRICAN FOOD SYSTEM



Source: Adapted from Baudron et al. (2019), Nordhagen et al. (2021), and Loboguerrero et al. (2019).
Note: Dollar amounts are in US dollars.

south of the Sahara and North Africa in crops and livestock due to these shocks and stressors. This led to a disaster-induced production loss of 559 calories per capita per day, equivalent to a 20 percent daily loss in the recommended dietary allowances for both men and women on the continent (FAO 2018). Furthermore, climate extremes impact approximately 16 million people annually (FAO and ECA 2018). At the distribution and retail level, price spikes, currency fluctuations, microeconomic disruptions, declining competitiveness in export markets, and wars influenced price inflation.

According to the International Monetary Fund, these shocks bring about a 1.8–4.0 percent price surge in agricultural commodities beyond generalized price increases (Okou et al. 2022). At the household level, shocks and stressors affect income and access to food, land, and livestock assets, and essential services such as water, health care, and electricity. The systemic shocks discussed above, along with unprecedented events such as the COVID-19 pandemic, the Ebola outbreak, and the war between Ukraine and Russia, have driven millions in Africa into deeper poverty, loss of livelihoods, and diminishing food purchasing power.

Why Are Analytical Approaches Based on Harmonized Indicators Needed?

In a review commissioned by the United Nations Development Programme, Winderl (2014) reported 18 indicators for measuring disaster resilience across households and subnational, national, and global scales. In another scoping review by Barrett and colleagues (2021), between 2008 and 2020, more than 9,558 published studies discussed food system resilience. However, the study also reported that the concept and development of resilience were inconsistently theorized and reliant on methods that have not been adequately reconciled to identify which metrics and tools best address a desired question within a defined food system. A study by Schipper and Langston (2015) also reported parallel findings when investigating 17 indicator frameworks for evaluating vulnerabilities and adaptation practices. In the context of sustainability, several indicators have been reported that can be adopted to measure the performance of food systems. In this regard, Béné and others (2019) employed a rigorous protocol to report on a subset of 27 indicators aggregated into four dimensions. Chaudhary, Gustafson, and Mathys (2018) reported on 25 sustainability indicators across seven domains: nutrition, environment, food affordability and availability, sociocultural well-being, resilience, food safety, and waste. However, despite much recent attention being given to the sustainability and resilience of food systems, most studies on the subject remain conceptual and general. In addition, generated evidence and data to support policy actions are frequently weak, fragmented, and arbitrary.

Moreover, no commonly agreed-upon set of indicators against which to measure food system dimensions exists for evaluating a defined food system. Furthermore, most studies have evaluated either the resilience or the sustainability of a defined food system, ignoring the causality between these two pillars. A resilient food system may contribute to a sustainable one, although sustainability is a function of more than just resilience (Roosevelt, Raile, and Anderson 2023). Thus, the outcomes of a resilient food system are inherently linked to a sustainable food system, and vice versa. Both sustainability and resilience are crucial for addressing the challenges faced by food systems, including environmental degradation, climate change, economic instability, and population growth. Sustainable food systems are likely more resilient because they depend less on nonrenewable resources, have lower environmental impacts, and support local economies and social equity. Conversely, more resilient food systems are likely to be more sustainable in the long term because they are better equipped to adapt to shocks and stresses and to maintain their functionality in the face of change (Tendall 2015). Therefore, efforts to promote sustainability and resilience are often intertwined and involve measures such as promoting agroecological farming practices, diversifying agricultural production, supporting local food economies, and strengthening social safety nets. By viewing resilience and sustainability as complementary, policymakers and stakeholders can make more informed decisions, weighing both immediate adaptive needs and long-term sustainability goals. Hence, a harmonization effort to capture the inherent similarity between food system resilience and sustainability indicators in harmony with the SDGs could permit comparability of different local food systems to help design resilience and sustainable adaptation programs that improve human health while operating within a safe planetary space. Since food systems differ in size and structure from one African country to another and between rural and urban areas, harmonized indicators must account for local food system resilience and sustainability drivers. Hence, this framework supports the need to strive for a resilient food system while working toward sustainability in the long term.

Forensic Framework Development and Harmonization

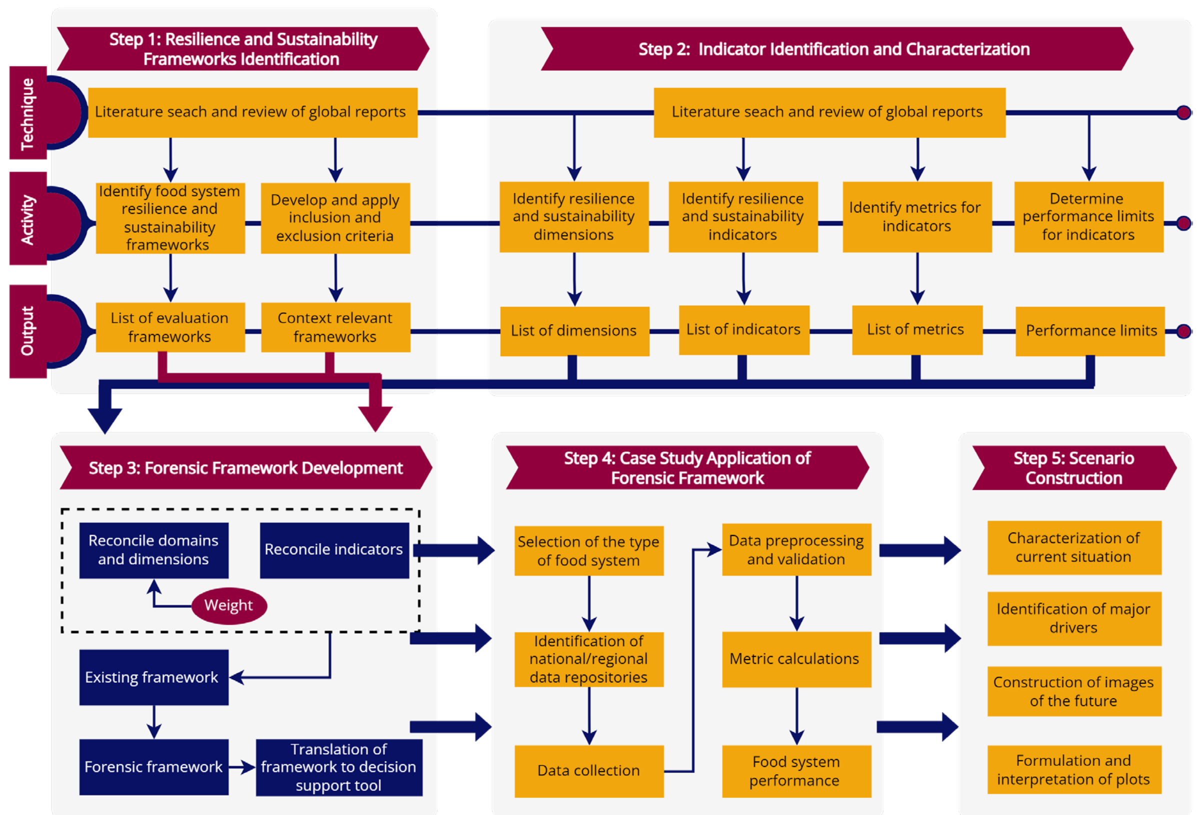
Theoretical Method and Approach

Figure 7.2 presents the methodological approach to developing a harmonized resilience and sustainability forensic framework. The approach consists of five main steps: (1) identification of resilience and sustainability frameworks, (2) identification and characterization of indicators, (3) development of the forensic framework and decision support system, (4) application to a case study, and (5) design of sustainable strategies through scenario construction. In component one of the methodological framework, a literature search strategy using keywords such as "food system resilience framework," "food system sustainability framework," and "sustainability and resilience framework" on search engines such as Google Scholar, Web of Science, and Science Direct were used to identify frameworks employed to quantify food system resilience and sustainability.

Additionally, conceptual and implementation studies that have discussed the resilience and sustainability of food systems were considered during the literature scoping. Moreover, existing studies and literature reviews by Arthur and colleagues (2022) and Béné (2020) also provided a useful reference point to a broad array of frameworks adopted to conceptualize the resilience and sustainability capacity of food systems. The next component within step 1 focused on subjecting the identified frameworks to three-stage inclusion and exclusion criteria, including (1) an alignment with the SDGs, (2) the capacity to capture food system outcomes, and (3) external shocks. These frameworks are the foundation of the proposed forensic framework.

Step 2 of the methodological approach applied a similar literature search approach to identify food system resilience and sustainability and resilience dimensions, domains, indicators, metrics for quantifying each indicator, and a reference performance limit. Keywords applied in the literature search included "sustainability indicators," "resilience indicators," "food system indicators," and "resilience and sustainability indicators." Indicators under the FAO's custodianship (SDG 2, 5, and 12) were also included. Similar to the activities in step 1, the identified indicators were subjected to three-level criteria, which revealed the identified indicator's relevance, quality, and interpretability. Additionally, the usefulness of an indicator in supporting policy design, planning, and decision-making was considered. Finally, data requirements, measuring tools, and reference performance limits outlined in SDGs 2, 5, and 12 were identified. Throughout this document,

FIGURE 7.2—METHODOLOGICAL FRAMEWORK



Source: Based on the work of Agyemang et al. (2022) and Jacobi et al. (2018).

candidate dimensions, domains, or indicators come from this pool of identified domains, dimensions, and indicators determined from the literature.

In step 3, the work of Constas, d'Errico, and Pietrelli (2022) served as the foundation for designing harmonized dimensions. The dimensions and domains identified from step 1 were aggregated into four food system dimensions in alignment with SDGs 2, 5, and 12. The four dimensions, (1) food security and nutrition, (2) socioeconomics, (3) politics and governance, and (4) environment (clean and healthy planet), reflected universal goals and food system outcomes desired by all. Similarly, the identified indicators were further aggregated into four food system dimensions. Due to the relative abundance of dimensions and indicators as applied in the literature, an evaluation process using a five-point Likert scale was applied to translate indicators and dimensions to the four food system dimensions through a stakeholder survey.[2] Each stakeholder was asked to rate the relative closeness or overlap of an identified domain/dimension from the literature in relation to the four aggregated resilience and sustainability dimensions. The survey results were translated into aggregate weights of importance through a weighted fuzzy-entropy technique (Parkash et al. 2008; Chen and Li 2010). Then, a forensic framework was constructed, combining a series of outputs from the steps above and the harmonized indicators. This time, building on the works by Agyemang and Kwofie (2021), Agyemang (2022), and Hebinck and colleagues (2021), a forensic framework was developed. For any forensic investigation, some indicators may be more valuable than others; hence, the framework allows stakeholders to select a candidate set of indicators from a preliminary list based on a set of criteria, including the availability of data for the selected indicator.

In step 4 of the methodological framework, we employ the forensic framework to assess resilience and sustainability in the African food system, drawing upon secondary data from (FAOSTAT 2020). Finally, we designed resilience and sustainability strategies in step 5 and explored the ramifications of the selected indicators through scenario design and machine learning (ML) modeling. The end-to-end ML pipeline to investigate plausible future scenarios is explicitly presented in the works of Agyemang and colleagues (2023) and Meroni and colleagues (2021).

Resilience and Sustainability: Definition of Terms

The term *resilience* has been applied in various contexts, such as ecology, engineering, agriculture, and economics, to understand whether systems could become more robust to external perturbations or shocks. Adger (2000, 349) and Carpenter and colleagues (2001; 767) describe resilience as the "ability of social groups (groups or communities) to cope with external stressors and disturbance as a result of external social, political and environmental change." Similarly, Folke and colleagues (2010, 2), Walker and colleagues (2006, 2–3), and Perrings (2006, 417) defined resilience as the "capacity to continue to develop in the face of change, incremental and abrupt, expected and surprising." It follows that a resilient food system can withstand, adapt to, and recover from shocks and stressors, ensuring that it continues to provide sufficient, healthy, and sustainable food for all. This includes dealing with potential disruptions like economic instability, climate change, conflict, and pandemics (Zurek et al. 2022). In the same harmony with the above definition, Tendall and colleagues (2015, 18) also defined food system resilience as "the capacity over time of a food system and its units at multiple levels, to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances."

According to the FAO, a sustainable food system can be defined as "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised" (Nguyen 2018, 4). This definition is synonymous with the one proposed by the ERA-Net SUSFOOD program. In this, the term *sustainability in food system* refers to a "food system that supports food security, makes optimal use of natural and human resources and respects biodiversity and ecosystems for present and future generations, and which is culturally acceptable and accessible, environmentally sound and economically fair and viable, and provides consumers with nutritionally adequate, safe, healthy and affordable food" (Rokka 2018, 4).

The above definition of resilience and sustainability recognizes the importance of different dimensions and the time relevance of achieving such goals within the food system. Thus, we can define these concepts as being complementary to each other. In this study, the two concepts will be harmonized to simultaneously provide an opportunity to measure a given food system's performance (sustainability)

2 Stakeholders surveyed were from international and academic institutions and nongovernmental organizations.

and provide a means to design solutions to address present challenges over future periods (resilience), bearing in mind inherent trade-offs.

Resilience and Sustainability: Harmonized Dimensions and Indicators

Table 7.1 summarizes a candidate food system's resilience and sustainability dimensions identified from the literature, aggregated weighted scores, and harmonized dimensions. Each candidate dimension was translated to a food system scale of relevance, that is, household, district, regional, national, global, urban, and all scales. The aggregated weighted scores were obtained by translating the survey results through a weighted fuzzy entropy method. For each candidate domain harmonized to the four dimensions, the sum of weights is 1. In Table 7.1, the orange-shaded region refers to the highest weight, while the gray-shaded regions reflect the lowest weight attributed to the harmonized domains. The aggregated weighted scores show the relative closeness of the candidate dimension to the harmonized dimension. The highest weight, of 0.62 (62 percent), was reported for the aggregation of the air dimension to environmental sustainability dimensions. Fuzzy entropy weight between (0.3–0.61), (0.29–0.45), (0.33–0.53), and (0.29–0.62) were estimated for the closeness of candidate dimensions to, respectively, the food security and nutrition, socioeconomic, politics and governance, and

TABLE 7.1—RESILIENCE DOMAIN AGGREGATION, RESPECTIVE RATINGS, AND FOOD SYSTEM SCALE OF IMPORTANCE

TABLE 7.1—RESILIENCE DOMAIN AGGREGATION, RESPECTIVE RATINGS, AND FOOD SYSTEM SCALE OF IMPORTANCE

Sustainability domains from the literature	Aggregated sustainability dimension				
	Food security and nutrition	Socioeconomics	Politics and governance	Environment	Food system scale
Food security	0.37	0.30	0.18	0.14	All
Food nutrient adequacy	0.49	0.17	0.21	0.13	All
Affordability and availability	0.36	0.30	0.17	0.18	All
Food safety	0.41	0.31	0.20	0.08	All
Nutrition	0.37	0.18	0.27	0.17	All
Food waste and use	0.31	0.19	0.23	0.28	All
Food utilization	0.32	0.23	0.33	0.12	All
Diet quality	0.61	0.21	0.08	0.10	All
Food environment	0.34	0.20	0.26	0.20	All
Right to food	0.42	0.27	0.18	0.14	All
Income, poverty, and inequality	0.16	0.45	0.21	0.17	H
Socio-ecological performance	0.22	0.23	0.25	0.30	All
Sociocultural wellbeing	0.19	0.36	0.30	0.15	All
Human capital	0.10	0.45	0.22	0.22	H
Threatening conditions to income and access to food	0.46	0.33	0.15	0.06	All
Social safety nets	0.10	0.45	0.28	0.16	
Access to basic service	0.26	0.28	0.30	0.17	H, D
Stability	0.18	0.29	0.24	0.29	H, D,Re
Natural capital	0.13	0.16	0.27	0.44	All
Agricultural and non-agricultural assets	0.34	0.23	0.26	0.18	
Employability	0.06	0.35	0.33	0.26	H
Structural factors	0.08	0.27	0.53	0.12	H
Agency-related features	0.38	0.24	0.21	0.18	All
Policies affecting the food environment	0.33	0.20	0.33	0.14	All
Strategic planning	0.16	0.20	0.52	0.12	All
Effective implementing	0.30	0.18	0.34	0.18	All
Accountability	0.23	0.17	0.37	0.24	All
Environmental performance	0.14	0.23	0.13	0.49	All
Ecosystem stability	0.13	0.07	0.25	0.55	All
Resilience	0.38	0.15	0.15	0.33	All
Waste and loss reduction	0.20	0.19	0.27	0.34	All
Air	0.06	0.10	0.22	0.62	All
Water	0.35	0.18	0.11	0.37	All

Source: Domain and dimensions were sourced from Chaudhary et al. (2018), Béné et al. (2019a), Jacobi et al. (2020), Seekell et al. (2017).

Note: The food system scales adopted include household (H), district (D), regional (Re), national (N), global (G), rural (R), urban (U), and all scales (All). The orange-shaded region refers to the highest weight, while the gray-shaded regions reflect the lowest weight attributed to the harmonized domains.

environmental dimensions of sustainability. The weights demonstrate the extent to which the stakeholders surveyed considered the identified dimension to be associated with the aggregated domains. The weight of least importance, of 0.06, was estimated for the translation of employability and air to the aggregated food security and nutrition dimension. Although employability and air play a critical role in the food value chain, their weighted scores demonstrate that they could be best represented under socioeconomic and environmental dimensions. The harmonization of the resilience and sustainability dimensions helps to counter the potential negative effects associated with the proliferation of dimensions associated with food system analysis.

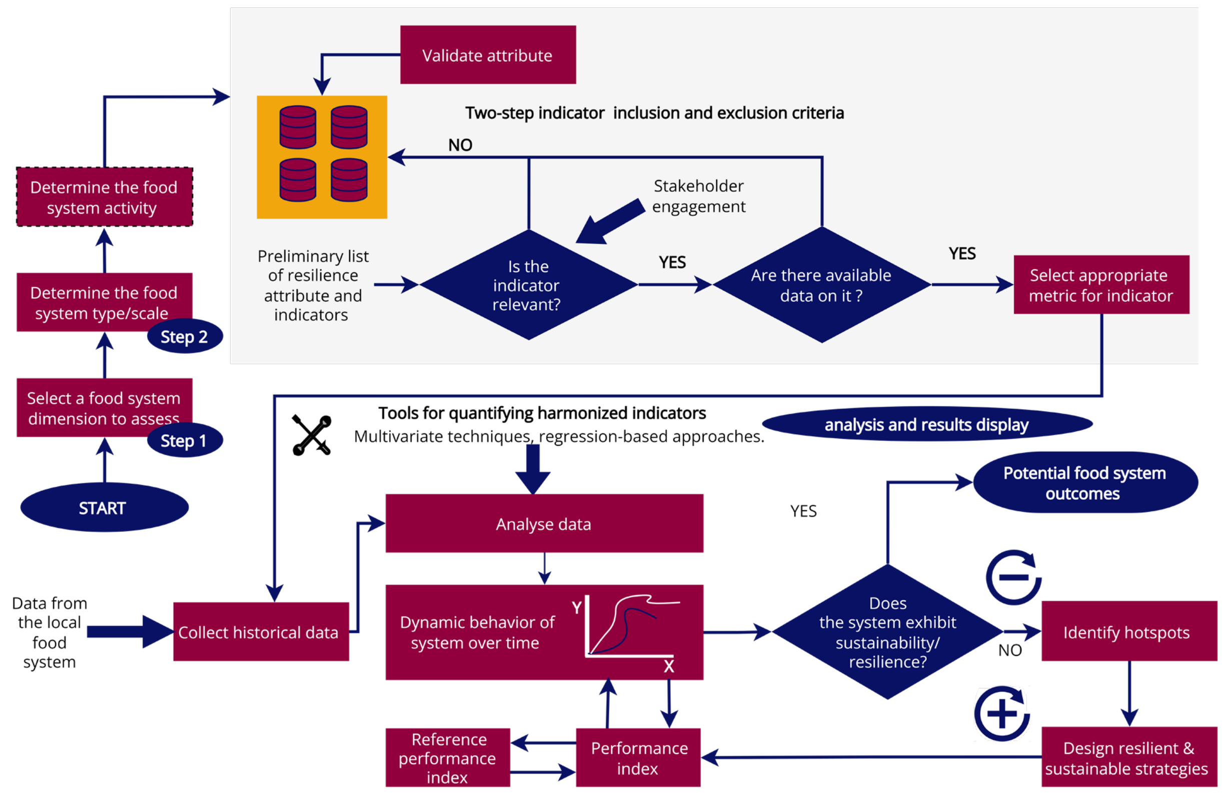
Differentiating between the regional, country, and local levels when analyzing food system resilience and sustainability is crucial due to the variability in context, scale, and interconnectedness of food systems. Each level has its unique challenges, resources, and opportunities. The local level might grapple with issues related to local farming practices, while at a national level, policies and infrastructural developments play a more significant role (Ingram 2011). The scale determines the nature of challenges and solutions. Regional challenges might encompass transboundary water issues affecting agriculture, while local challenges might involve soil quality or local market dynamics (Ericksen 2008). A change at the local level might ripple up to influence national and regional systems. Understanding each level helps in mapping these interconnected dynamics. Different stakeholders operate predominantly at different levels. Engaging with them requires an understanding of the level they influence most prominently.

Table A7.1 maps the indicators to the harmonized resilience and sustainability dimensions. It also demonstrates the different scales of applying the indicators. For example, indicators such as greenhouse gas emissions from the food system per capita (production-based) were mapped to all scales of assessment for the environmental dimension. This implies that at the regional, national, and local scales of food system assessment, the indicator can be adopted to measure the resilience and sustainability of a food system. However, indicators such as income diversity and land or growing space owned were mapped to socioeconomic and environmental dimensions. These indicators are applicable at the household scale of assessment. It is important to highlight that there is an inexhaustible list of indicators that could be added to Table A7.1; however, data constraints will be critical in adopting these indicators for food system analysis.

Forensic Framework for Resilience and Sustainability

This section presents the novel forensic framework for resilience and sustainability (f-RESUS). The overarching goal of the f-RESUS framework is to accommodate

FIGURE 7.3—FORENSIC FRAMEWORK FOR FOOD SYSTEM ASSESSMENT



Source: Based on the work of Agyemang et al. (2022) and Jacobi et al. (2018).

variations across different resilience and sustainability frameworks and dimensions in assessing the performance of a food system. Figure 7.3 presents the implementation framework for executing the forensic assessment. This framework can guide the development of an interactive decision support tool, allowing users to implement the assessment through a series of steps. The first step involves selecting a harmonized dimension of interest for analysis. The decision-maker can select from the four harmonized sustainability dimensions: food security and nutrition, socioeconomics, politics and governance, and environment. The choice of a dimension and scale of analysis will consequently populate a preliminary list of indicators subjected to inclusion and exclusion criteria to obtain candidate indicators for the analysis. The most critical criterion is the availability of secondary data on the selected indicator. When data are unavailable, the system automatically requests the decision-maker to enter the necessary or relevant data.

In step 2, the decision-maker can select the level of food system of interest: regional, national, district or local, rural, urban, or household. It is important to highlight that the choice of food system scale for the assessment may require specific indicators that might not be considered for others. The decision-maker can then visualize the sustainability of the defined system, redesign strategies, and explore the impact of the proposed strategies. The dynamics of these explorations were achieved by employing ML models. The results of the f-RESUS framework were further translated into a novel decision support tool leveraging the best-performing ML model.

ML Models

We used a multivariate model of the following form: $y = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n + e_{,i}$, where β_0 is the y-intercept, the y-value when all explanatory variables are set to 0. β_1 to β_i are the coefficients for variables x_1 to x_i; by design, y increases or decreases with a one-unit change in that variable, assuming that all other variables are held constant (Maulud and Abdulazeez 2020). In the current study context, the variables y refer to the indicators presented in Table 7.2, while x_i to x_n are the characteristics and drivers that influence a food system. The ML models adopted in this paper include the linear regression model, ridge regression model, LASSO (least absolute shrinkage and selection operator) regression, random forest model, elastic net regression model, and support vector regression model. Details of these models' specifications, data preprocessing, and statistical validation approach adopted in this study are presented extensively in the work of Agyemang and colleagues (2023). All experiments applying the ML algorithms and end-to-end pipeline framework were implemented using Python programming and the scikit-learn library.

Application: Case Study and Adaptability (the African Food System)

To illustrate how the f-RESUS may be applied to assess a food system dynamically, we examine the African food system considering three harmonized resilience and sustainability dimensions: the food security and nutrition, socioeconomic, and environmental dimensions. Under the food security and nutrition dimension, four outcome indicators were selected to prove the concepts presented above. Likewise, one outcome indicator (surface temperature change and emissions from agricultural land) was selected from the environmental sustainability perspective. The food price index and import quantity index were selected under the socioeconomic dimension.

Study Areas and Dataset Description

All datasets used in the study are from FAOSTAT (FAO 2020). The dataset ranged from 2000 to 2020 and was segregated into three African and subregional food system levels: production, supply, and loss/waste along the value chain. Each node of the food value chain described above contributes data on the following agricultural produce: cereals, starchy roots, pulses, vegetables, fruits, meat, eggs, milk, and fish. In addition, key food system drivers include food price inflation (weighted average), percentage of government expenditure, agriculture credit, development flows to agriculture from donors, and employment in agriculture. The food balance dataset adopted in this study shows the sources of supply and their utilization for each food item—thus, each primary commodity—and a number of processed commodities potentially available for human consumption in terms of caloric value (kcal/capita/day). This implicitly reflects the contributions of key food system actors such as producers, transporters, aggregators, processors, and retailers. A detailed description of these actors is beyond the scope of this chapter. To ensure collinearity in communication, the production (in 1,000 metric tons), supply (in kcal/capita/day), loss/waste (in 1,000 tons), value chain, and additional drivers mentioned in the previous paragraph will be referred to as "food system driving forces" throughout the rest of this paper. Overall, there were 735 data points. About 2.3 percent of the data points had to be imputed through five techniques: *k*-nearest neighbor, mean, median, iterative, and expectation-maximization methods. A total of 13.7 percent of the data points reflected food security and nutrition indicators.

Indicator Description

Table 7.2 presents the selected indicators for the corresponding harmonized dimensions, their descriptions, and their current performance limits. The current performance limit will serve as a reference to investigate the impact of designing resilient and sustainable strategies to address the challenges within the food security and nutrition, environmental, and socioeconomic dimensions of sustainability.

TABLE 7.2—SELECTED INDICATORS FOR THE EVALUATION OF THE FOOD SECURITY/NUTRITION, ENVIRONMENTAL, AND SOCIOECONOMIC DIMENSIONS OF THE SUSTAINABILITY OF THE AFRICAN FOOD SYSTEM

Indicator name	Description	Current performance
Food security/nutrition		
Number of undernourished people (million)	The number whose habitual food consumption is insufficient to provide the dietary energy levels required to maintain a normally active and healthy life	254.7 million (in 2020)
Number of obese adults (18 years and older) (million)	The number of people with a body mass index of over 30	81.5 million (in 2016)
Number of women of reproductive age (15–49 years) affected by anemia (million)	Relative proportion of females in a given population that are affected by anemia	122.7 million (in 2019)
Minimum dietary energy intake (kcal/capita/day)	Measured per capita dietary energy intake that falls below the minimum level required	1,740 kcal/cap/day (in 2022)
Environmental		
Temperature change on land (meteorological year)	Mean surface temperature change due to agricultural production across a meteorological year	1.008°C
Emissions from agricultural land	The greenhouse gas emissions generated from the agrifood systems. It is computed following the Tier 1 methods of the IPCC guidelines	2,794,333.052 tons of CO2 (equiv.)
Socioeconomic		
Food price inflation	Change in price of a basket of food commodity	10.76% (2020)
Import quantity index	The physical quantity of agricultural products imported for domestic consumption or processing for a given reference year	133 (2020)

Sources: FAOSTAT (2020) and WHO (2023).
Note: IPCC = Intergovernmental Panel on Climate Change

Dynamic Modeling Through the ML Pipeline

This section discusses the application of ML models to assess and predict the unintended consequences of adopting different strategies within the African food system using the eight indicators highlighted in Table 7.2.

Correlation Between Food System Drivers and Sustainability Indicators

Figure 7.4 presents the correlation (Spearman) between the food system drivers and the selected indicators in Table 7.2. From Figure 7.4, it is evident that there is a strong positive correlation between the selected indicators and the driving forces of the food system on the continent. From the food supply perspective, we observe a strong positive correction with the sustainability indicators except for the cereals and milk supply. However, a weak negative correlation of between 0.19 and 0.76 is observed between cereal supply and five selected indicators (number undernourished, number affected by anemia, minimum dietary intake, surface temperature change, and import quantity index). On the contrary, a weak positive correlation of 0.17 and 0.05 is observed between cereal supply and, respectively, the number of obese adults (million) and food price inflation.

Additionally, a negative correlation in the range of 0.33 to 0.62 exists between milk supply and the selected indicators. The results suggest that the risk of the supply of cereals and milk contributing to the selected eight indicators is low. The results corroborate the work of Babio and colleagues (2022), who reported an inverse association between the consumption of dairy products and obesity prevalence risk through a meta-analytical study. Similarly, the share of employment was inversely correlated with all selected indicators and driving forces (except milk and cereal supply), demonstrating a weak to strong relationship, with a Spearman coefficient of 0.38 (number of undernourished) to

1.00 (number of obese and number affected by anemia). Likewise, agricultural expenditure demonstrated a similar relationship with food price inflation, with a negative correlation of 0.16. Therefore, due to the negative correlation, a threshold value of more than 0.50 inverse correlation was set to exclude food system driving forces with such an association from further analysis.

The results in this section suggest that food system drivers such as milk supply, agricultural expenditure by the government, and share of employment may not exert a direct causation on the selected indicators but do describe an observable pattern between them. Furthermore, the agricultural share of government expenditure and share of employment in agriculture can have independent consequences, which may be causally linked to the selected indicators' capacity to describe the resilience and sustainability of the African food system. However, the large share of the African population employed in agriculture (54 percent) does not necessarily lead to food security and nutrition. For example, a study by Adeyanju and others (2023) sampled 400, 429, and 606 young farmers in (respectively) Kenya, Nigeria, and Uganda, and reported low dietary diversity across the three countries despite their being food producers.

Policy and Strategies to Achieve SDG Targets

This section uses the best model (see the work of Agyemang and others 2023) to explore future strategies within the African food system and their potential consequences through short-term scenario designs. We designed scenarios around critical issues that trigger actions to shape the future of the African food system. Five critical drivers—namely, agricultural production, food supply, food loss, agricultural credit, and development flows—are considered in the scenario designs. The 2030 timeline was selected because it marks the reference point to achieve SDGs. In this study, a designed scenario is regarded as sustainable and resilient if it yields reductions in the indicators and limits the trade-offs between them compared to the reference year of assessment. In each constructed scenario, the projections at the endpoint of 2030 will be compared to the base year 2020.

FIGURE 7.4—CORRELATION BETWEEN THE VALUE CHAIN DATASET AND SELECTED INDICATORS

Source: Authors, based on data from FAOSTAT (2020) and WHO (2023).
Note: LS = loss; PD = production; SP = supply.

Business-As-Usual Scenario

In the business-as-usual (BAU) scenario, no efforts are made to address the current challenges; however, due to the rise in population and the demand to feed a projected 1.7 billion people on the continent by 2030, food production and supply will grow at an annual rate of 2.6 percent from 2020 to 2030 (Baquedano 2021). There are no changes in government expenditure share toward agriculture and consistent fluctuations in food price inflation. Again, little or no efforts are made to address persistent food loss along the value chain. Thus, food loss is further increased by a similar percentage along the value chain. Additionally, financial support from donors is delayed, with as low as a 1.5 percent increase in 2030 above the 2020 levels.

Stable Scenario 1: Increased Agricultural Production

In this scenario, we explore an increase in agricultural production by 15 percent above the projected levels by 2030, with a 25 percent reduction in food loss and waste due to the adoption of artisanal technologies to address postharvest losses. New agricultural ventures and employment opportunities are created due to increased credit for agriculture through financial institutions, approximately 9–12 percent above 2020 levels. There is an increase in development flows for agriculture through funds from external donors.

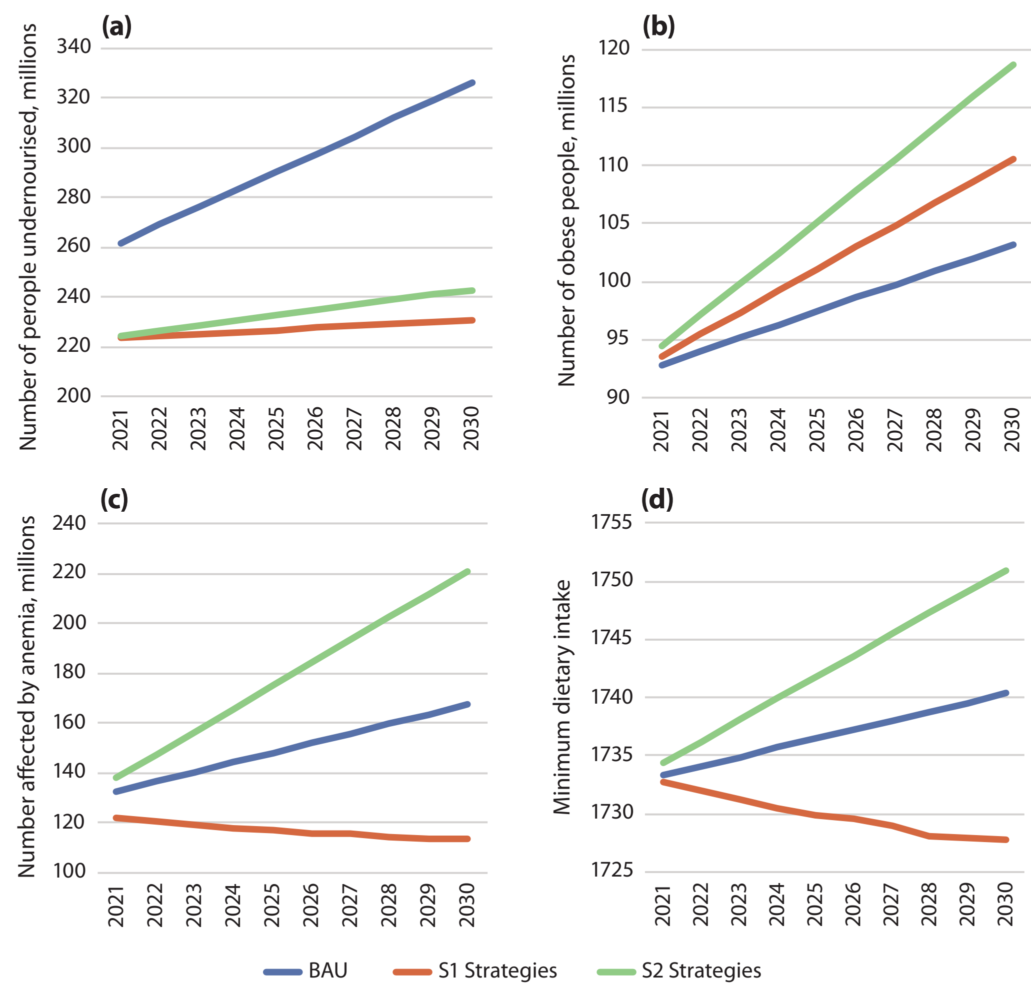
Stable Scenario 2: Increased Agricultural Credit

In this scenario, we explore a 15–18 percent increase in agricultural credit from financial institutions on the continent. This, along with government support, increases agricultural production. International donor agencies also increase their commitment to support the African food system (19–20 percent above 2020 levels at the end of 2030). Agricultural credit and government funds are redirected toward providing subsidies and technologies, increasing the production and supply of nutritious and healthy foods by an estimated 12 percent above the BAU scenario. Little effort is made to reduce food waste, with a potential reduction of 10–15 percent below the reference year level.

Interpretation and Logical Flow of Constructed Scenarios at the Continental Level

We can observe varying outcomes on the selected food security and nutrition indicators from the snapshots of the logical implications of the scenarios constructed in the sections below (Figure 7.5). From the first scenario, we

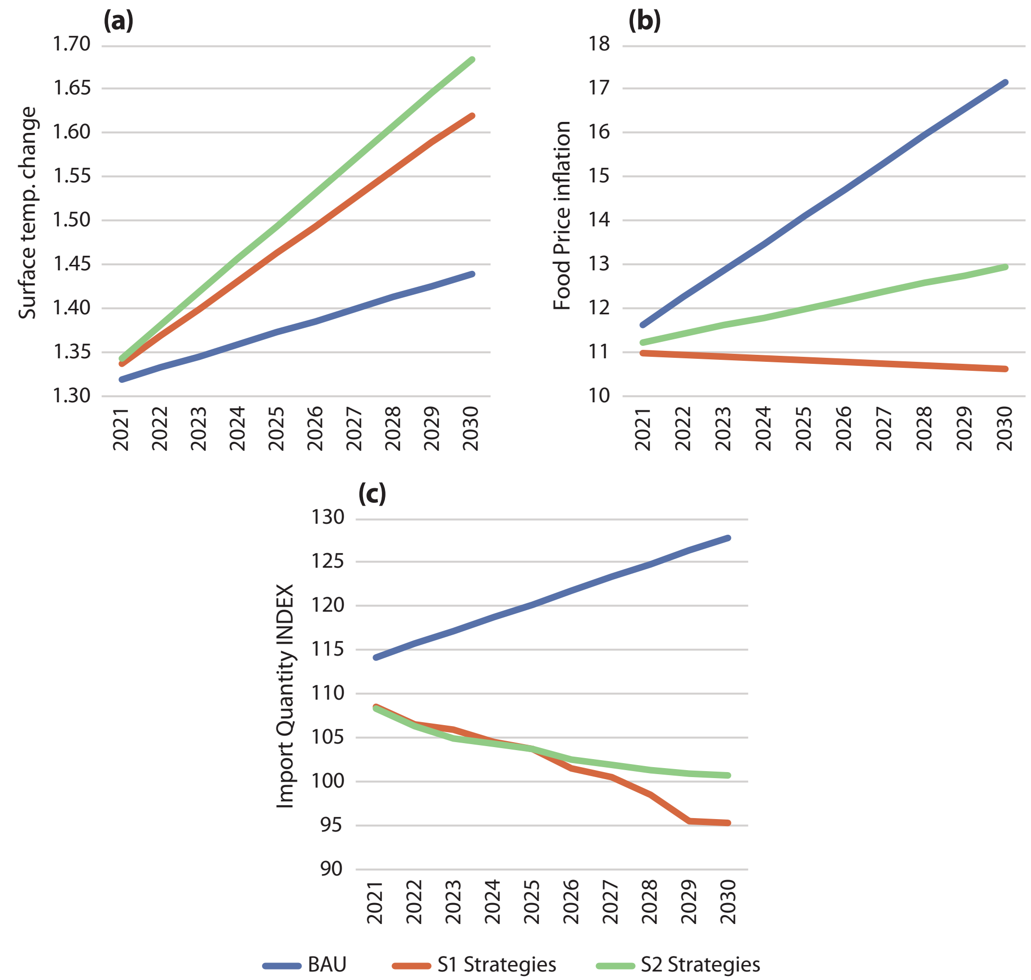
FIGURE 7.5—SNAPSHOT OF THE LOGICAL IMPLICATIONS OF THE CONSTRUCTED SCENARIOS AGAINST THE BUSINESS-AS-USUAL CASE



Source: Obtained from the application of ML models for forecasting.
Note: BAU = Business-as-usual; S1 = scenario 1; S2 = scenario 2.

can observe a profound shift in the number of undernourished people (230.8 million). A projected 23 million fewer people are undernourished, representing a 9.4 percent decrease when compared to the reference year 2020, when 254.7 million people were undernourished. In the second scenario, 83.2 million fewer people become undernourished compared to the BAU scenario. However, compared to the reference year 2020, there are a projected 11.7 million fewer people who become undernourished. Additionally, between 2021 and 2030, we observe a steady trend in absolute numbers for the projected number of people undernourished in scenarios 1 and 2. On the other hand, the BAU scenario shows a steeper increase to 326.18 million people who become undernourished, 71.5 million more than in the reference year, 2020.

FIGURE 7.6—SNAPSHOTS OF THE UNFOLDING FUTURES FROM THE CONSTRUCTED SCENARIOS



Source: Obtained from the application of ML models for forecasting.
Note: BAU = business-as-usual; S1 = scenario 1; S2 = scenario 2.

Interestingly, scenarios 1 and 2, respectively, result in a projected 7.3 and 15.5 million more obese people than the BAU scenario. This increase in the projected number of obese people represents 28.9 to 37.2 million more people projected to be obese compared to 2016 (81.5 million, as of the time of the study). Additionally, Figure 7.5(c) shows that scenarios 1 and 2 will result, respectively, in a projected 113.5 and 221.2 million people who will remain anemic. This represents a 7.5 percent reduction (scenario 1) and an 80.2 percent increase (scenario 2) compared to the 122.7 million people anemic in 2019. We observe a steady increase in minimum dietary intake to meet the reference daily calorie intake for an average adult. Despite the increase in supply, we observe an estimated decrease of 7.2 kcal/capita/day (scenario 1) and an increase of 15.9 kcal/capita/day (scenario 2) in dietary energy intake when comparing the scenarios against the reference year, 2020 (1,740 kcal/capita/day).

Moving on to observe projected changes in environmental and socioeconomic drivers, Figure 7.6 presents the logical unfolding of the future concerning temperature change on land, import quantity index, and food price inflation. In all scenarios, a rise in temperature is observed in the range of 1.43°C to 1.68°C, representing an 18.4–33.4 percent change from the reference year, 2020. In the food price index, there is a marginal decrease in scenario 1 (10.64) but an increase in scenario 2, to 13.0 at the end of 2030. However, in the BAU scenario, there is a dramatic increase, to 17.2, representing a 59.6 percent increase from the reference year, 2020.

Additionally, regarding the quantity of imports of foods, due to the projected increase in production, we observed reductions in the range of 12.3 to 17.4, representing 10.8 to 15.6 percent less than the reference year. The results presented in this section suggest that inherent and inevitable trade-offs must coexist to achieve sustainable and resilient food systems. As has been described above, there are instances where we observe projected reductions and increases, suggesting that depending on the indicator of interest to a decision-maker, a constructed food system scenario can be described as resilient and sustainable or otherwise.

Logical Flow of Increased Agricultural Production Scenarios at the Subregional Level

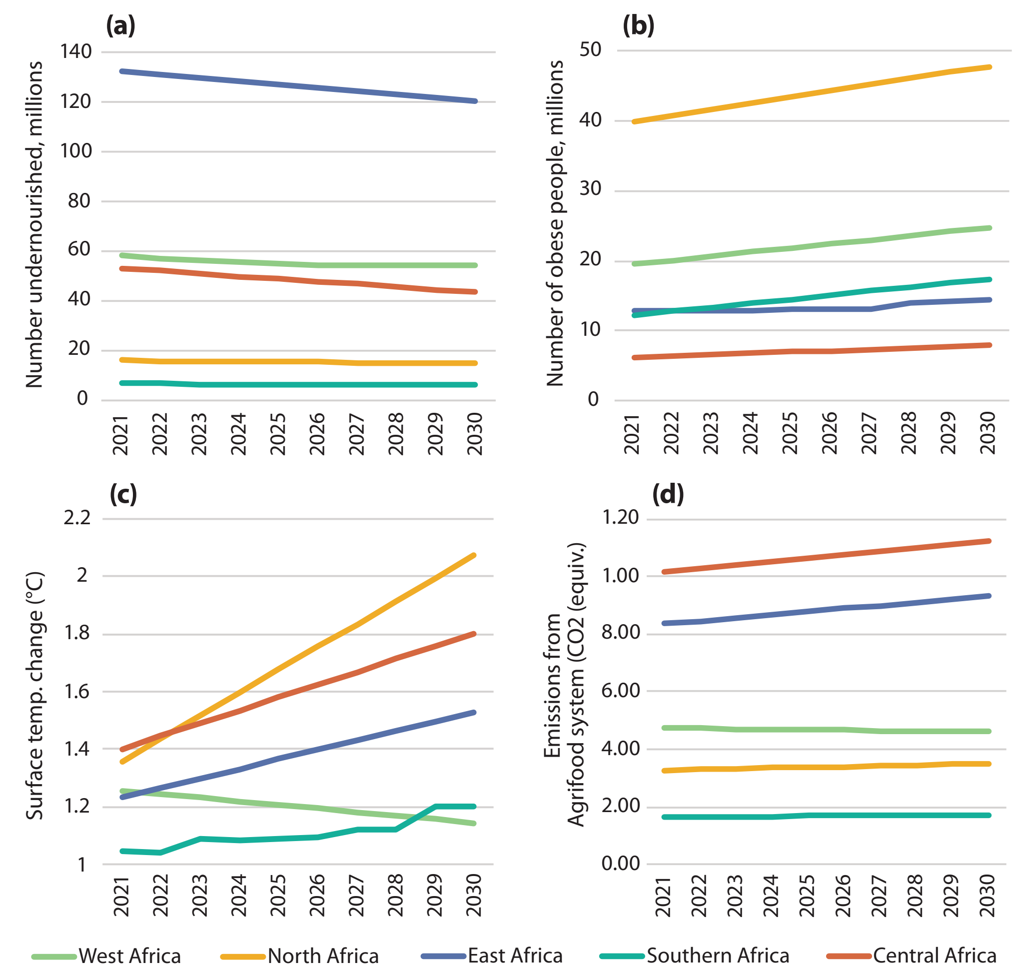
The analysis at the continent level extended to investigate the ramifications of the modeled scenarios at the subregional level. In this context, we explored the implication of the increased agricultural production scenario at five subregional levels: West, North, East, Central, and Southern Africa. Figure 7.7 presents the logical implications on four selected indicators. Across the different regions, it can be observed that the number of undernourished people decreases between 2.8 and 17.5 percent. The most significant reduction is observed in Central Africa (43.4 million), where an estimated 7.5 million people are projected to shift from being undernourished compared to the baseline year (51 million in 2020). However, the number of obese people increases between 23.9 percent and 35.8 percent across all regions compared to the baseline year, 2020. This time, Central Africa (1.9 million people) has the lowest number of people projected to be obese, as against West Africa, which has a projected 8.9 million people projected to be obese by 2030.

Within the environmental dimension, it can be observed that surface temperature change due to agriculture increases for all regions except West Africa, where it decreases from 1.22°C in 2020 to 1.14°C by 2030. The most significant increase is observed in North and Southern Africa, where surface temperature change increases by 36.2 percent and 40.5 percent above the baseline year levels of 1.32°C and 0.71°C, respectively. Similar observations are made when we consider emissions from agrifood systems. In this, emissions in the form of CO_2 (equivalent) increased between 5.5 and 11.5 percent for all regions except West Africa, where it was reduced by 4.1 percent below the baseline year.

Logical Flow of Increased Agricultural Credit Scenarios at the Subregional Level

Figure 7.8 presents the logical implications of the increased agricultural credit scenario at different regional levels. The plot narrative of this scenario suggests opposing yet similar trends when compared to the scenario of increased

FIGURE 7.7—LOGICAL FLOW OF EVENTS ACROSS THE DIFFERENT SUBREGIONS ON THE AFRICAN CONTINENT



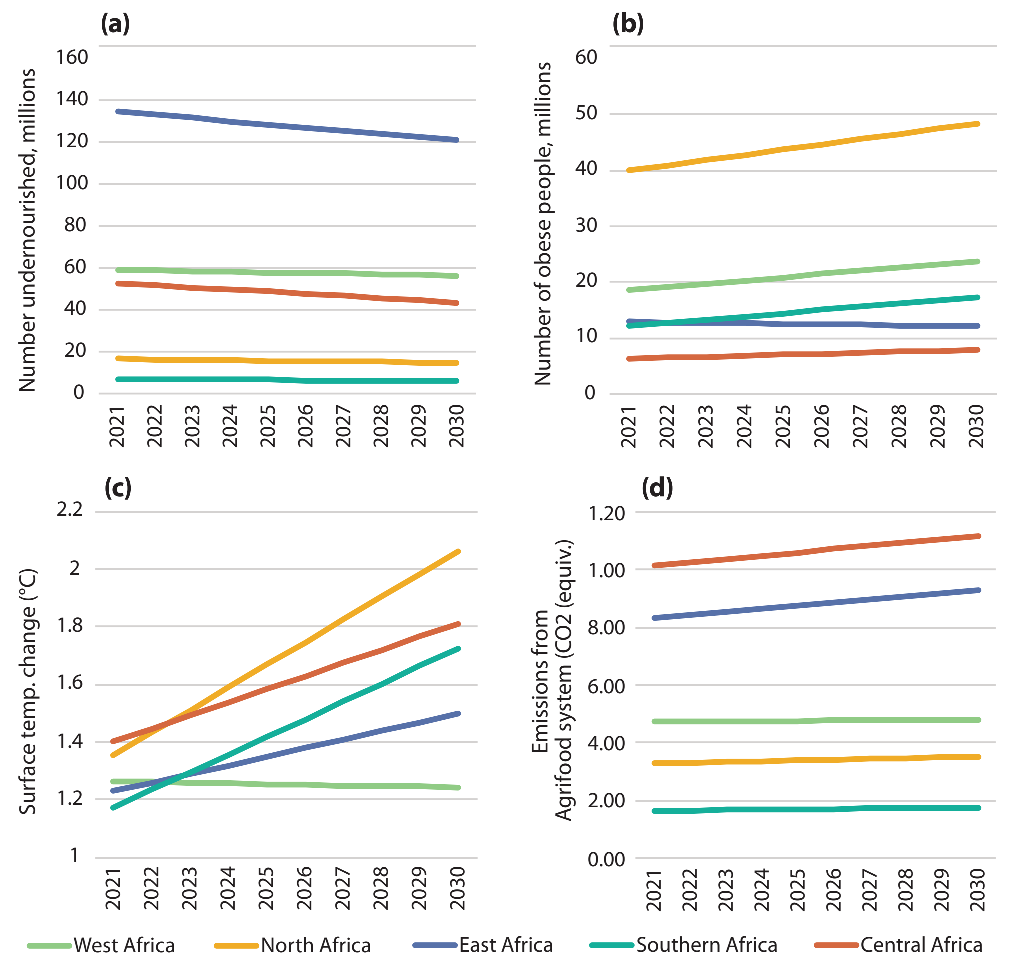
Source: Obtained from the application of ML models for forecasting.

agricultural production. For example, in West Africa, 600,000 more people become undernourished, while the North, East, and Southern Africa regions are projected to experience a 2.7–4.4 percent decrease in the number of people who become undernourished. In all regions, there is a projected small (0.1–1.7 percent) or no (Central Africa) change in minimum dietary energy intake in 2030 compared to 2020. Contrary to the scenario of increased agricultural production, in the possible future of this scenario, we observe an increase in surface temperature change across all regions, of between 2.3 percent (West Africa) and 58.7 percent (Southern Africa).

Overall, the constructed scenarios have illustrated the possible outlook within the African food system in the future by providing an opportunity to compare different outcomes. Inferring from the different outcomes, it is inevitable that inherent trade-offs must be accounted for if the African food system is to be repurposed to address its pressing sustainability issues through the revision of the Malabo 2015 agenda.

Figure 7.9 provides a much more straightforward way to evaluate the effects of the different scenarios across the selected indicators using two snapshots: one at the baseline year of 2020 and the other at the endline year of 2030. In both stylized scenarios, the findings suggest little to no change in the minimum dietary energy intake at continent and subregion levels. Interestingly, regions such as West Africa and Central Africa are projected to experience significant reductions in food price inflation—estimated to be 30.9–40.2 percent and 33.3–34.5 percent, respectively, when the baseline year, 2020, is compared to 2030. Across different regions, we observe significant variations; however, the two snapshots for both scenarios suggest a significant change for some indicators, while others will not change significantly in the future.

FIGURE 7.8—LOGICAL FLOW OF IMPLICATIONS ACROSS SUBREGIONS UNDER THE SCENARIO OF INCREASED AGRICULTURAL CREDIT

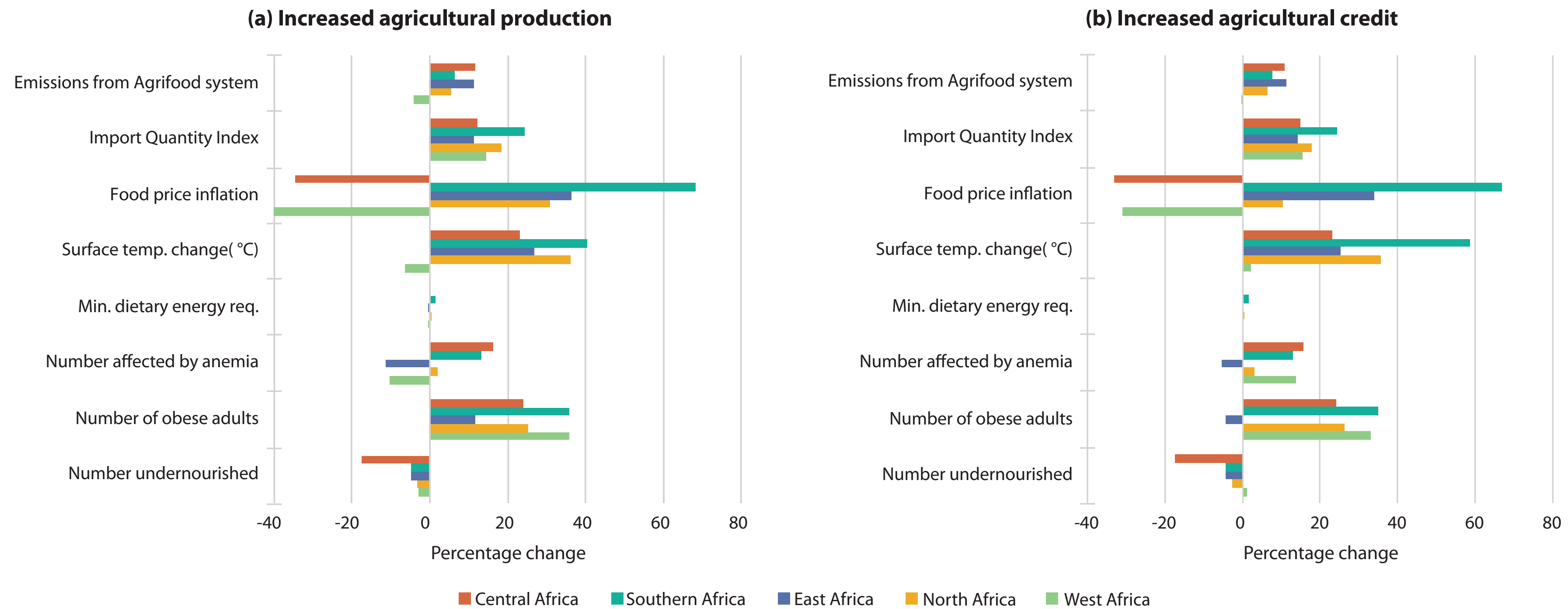


Source: Obtained from the application of ML models for forecasting.
Note: BAU = business-as-usual; S1 = scenario 1; S2 = scenario 2.

Translation of Models into a Decision Support System

Scenarios can be powerful tools for exploring the implications of different decisions. Pairing scenarios with relevant food system drivers and sustainability indicators provides an opportunity to predict the future of Africa's food system. This section proposes developing a novel decision support system using the ML algorithms presented in this study to enable stakeholders and policymakers to explore scenarios for a resilient and sustainable African food system. In addition to the ML algorithms, the proposed decision support system was built on the f-RESUS,

FIGURE 7.9—SNAPSHOT OF THE EFFECT OF THE STYLIZED SCENARIOS BETWEEN BASELINE (2020) AND ENDLINE (2030) REFERENCE YEARS



Source: Obtained by finding the difference between the baseline year and the forecasted endline year.

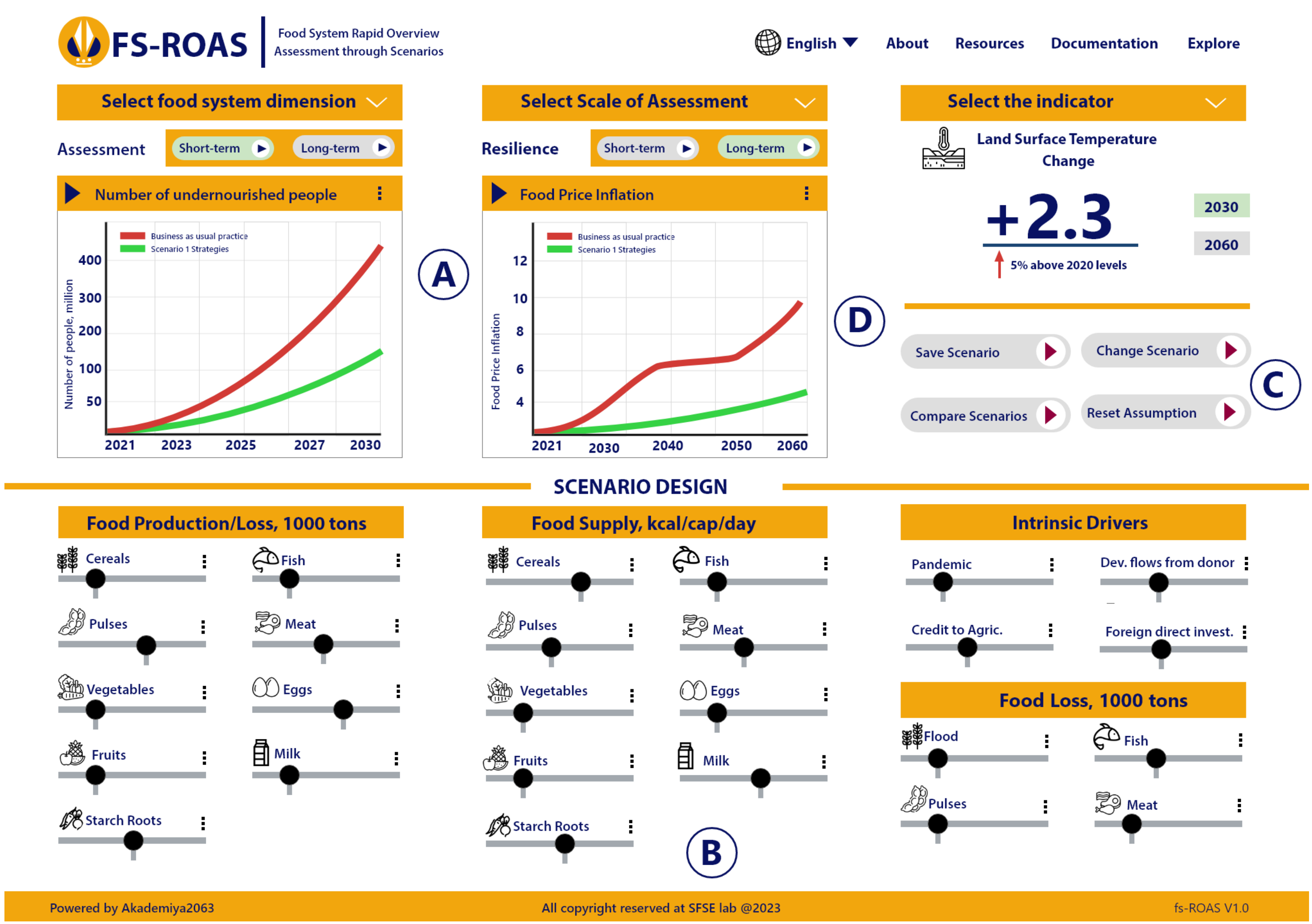
Note: A negative change connotes a reduction to levels more desirable, while a positive change refers to an exacerbation of challenges related to indicators to undesirable levels.

presented above; it provides the logical framework for designing and adapting the proposed decision support system.

The proposed decision support system, FS-ROAS, provides an opportunity to analyze food system transformation with harmonized sustainability and resilience indicators across four dimensions. Figure 7.10 presents the dashboard for the FS-ROAS decision support system.

FS-ROAS is characterized by specific modules that support assessing and designing mitigation strategies and comparing different strategies (marked A to D). The Reset Assumption button enables users to revert to the baseline scenario described earlier in the chapter. Likewise, the Change Scenario button enables a user to construct plausible scenarios, while the Save Scenario button supports storing the outcomes of an explored scenario. The Comparison Scenario button enables a comparison of possible outcomes for two or more constructed stylized scenarios against the BAU scenario. Depending on data availability, the proposed assessment and construction of stylized scenarios to address the multiple challenges of the food system can be translated to regional, national, and local food systems. Thus, conducting a similar analysis for specific regions and countries is possible.

FIGURE 7.10—DASHBOARD FOR THE F-ROAS DECISION SUPPORT SYSTEM



Source: Authors and based on the work of Agyemang et al. (2022). All icons used were obtained from flaticon.com and freepick.com.

Study Limitations/Shortcomings

The use of ML models in operational settings poses practical difficulties related to the setup of the modeling framework. ML workflows often consist of model and feature selection, hyperparameters, and model testing in a way that is relevant to an application. This makes it data-intensive—but there was not a large dataset available for the present study. A dataset of size 735, which can be described as data-poor, was applied in this study, generating many conflicts between the training and testing phases. Additionally, using a data-poor system may lead to information leakages between the training and test datasets.

Future Research in this Area

Future studies will investigate incorporating data that capture other food drivers within the food systems, thus increasing the size of the dataset used in training and forecasting. Further research will also explore the calibration, practical significance, and testing of ML models, such as neural network regression techniques, to increase the robustness of the predictions. More studies will focus on developing the proposed FS-ROAS decision support system and testing it with stakeholders and policymakers within the African food system.

Implications of the Study on the Malabo Declaration on African Agriculture and CAADP

Drawing insights from the present study and learning from previous practices that have shaped the current African and subregional food system is critical to the decision-making process among African heads of state. Strengthening African food systems to increase resilience and sustainability involves a wide range of strategies aimed at tackling the complexities and interconnectedness of agricultural, socioeconomic, and environmental factors. Some commitments within the Malabo Declaration on CAADP in 2014 suggested (1) recommitment to enhance investment finance in agriculture, (2) commitment to ending hunger by 2025, (3) commitment to enhancing the resilience of livelihoods and production systems to climate variability and other shocks, and (4) reaffirming commitment to end hunger by 2025 through strengthening development policies. However, the lessons from the stylized scenarios, which leveraged ML models that employed data from previous food system elements since 2000, suggest that multiple trade-offs must coexist to achieve a sustainable food system in Africa. In other words, if policymakers are to recommit to similar policy mitigation strategies, then there must be an opportunity to explore what possible endpoints can be achieved during the revisions of the Malabo Declaration on African Agriculture and CAADP.

As demonstrated through the stylized scenarios of increased agriculture production and increased agriculture credit, a recommitment to declarations in harmony with these scenarios could result in an estimated 11.75 to 23.81 million fewer people who become undernourished by 2030. Additionally, 9.2 million fewer people are projected to be anemic, while import quantities are projected to be reduced by between 12.2 and 18.5 percent compared to the baseline year, 2020. However, policymakers must bear in mind potential unintended consequences, such as the projected increase in obese people (28.9–37.1 million more people), the increase in surface temperature change to 1.62°C–1.68°C, and increased emissions from agrifood systems (3.7–7.6 percent higher than 2020 levels).

The proposed decision support systems provide an opportunity to explore stylized scenarios such as agricultural production diversification, climate-smart agriculture promotion, education and training, and policy and institutional reforms. Exploring such scenarios could give policymakers a broader perspective and opportunity to envision snapshots of the future of Africa's food system when revising and recommitting to the Malabo Declaration on African Agriculture and CAADP.

Concluding Remarks and Recommendations

This chapter set out to develop a forensic framework incorporating multiple components and outcomes across multiple scales and levels, including social, economic, health, and environment, through harmonized sustainability and resilience dimensions and indicators. In harmonizing candidate dimensions, a fuzzy entropy weight within the ranges of 0.31–0.61, 0.29–0.45, 0.33–0.53, and 0.29–0.62, respectively, was estimated for their closeness to the food security and nutrition, socioeconomic, politics and governance, and environmental dimensions of sustainability. The aggregated weighted scores demonstrated the relative closeness of the candidate dimensions to the aggregated dimensions and the extent to which the stakeholders surveyed considered the candidate dimensions to be associated with the harmonized dimensions. Also, we have highlighted how the outputs of the framework and the underlying ML models can be further translated into a decision support system, FS-ROAS. The FS-ROAS allows the prediction of the main characteristics of future African food systems against BAU conditions. Additionally, ML models provide an opportunity to capture interactions between different segregated components and the drivers of the African food system. The preliminary findings from the scenarios indicate that significant trade-offs between different food system outcomes must be accounted for to achieve a sustainable African food system. In the scenarios, there is the potential to increase the minimum dietary intake by 15.9 kcal/capita/day and reduce the number of people affected by undernourishment by 83.2 million. However, in achieving these targets, there is also the potential to increase the level of obesity by between 28.9 million and 37.2 million more people. While the potential for health benefits is rather grand, there are anticipated sustainability benefits and detriments that will coexist to achieve a sustainable food system within the short and long time frames.

CHAPTER 8

Economics of Climate Adaptation for Resilient Food Systems in Africa

Fleur Wouterse, Ismael Fofana, Racine Ly, and Amara Zongo

Introduction

Around 690 million people worldwide suffer from hunger daily, and two-thirds of people who are hungry live in rural areas. Meanwhile, the prevalence of undernourishment in Africa rose from 19.4 percent in 2021 to 19.7 percent in 2022, driven mostly by increases in northern and southern Africa. The number of people facing hunger in Africa has increased by 11 million people since 2021 and by more than 57 million people since the outbreak of the COVID-19 pandemic (FAO et al. 2023).

Climate extremes are the second leading cause of food insecurity in Africa, after armed conflict and before economic slowdowns and growing inequality (FAO et al. 2023). While there are significant uncertainties about Africa's climate future, models project that parts of northern, southwestern, and central Africa will continue to experience a drying trend—and almost all regions of the continent are expected to be struck by more frequent and more intense rainstorms, causing greater numbers of potentially devastating floods. Future warming will shorten growing seasons and increase water stress. A temperature increase of more than 2°C will result in yield reductions for staple crops across most of Africa, compared to 2005 yields (IPCC 2022). A temperature increase of 4°C or more above late-20th-century levels is expected to reduce maize and wheat yields in countries across Africa south of the Sahara by up to 50 percent (Mbow et al. 2019). Smallholder farming systems that continue to dominate the agriculture sector in many African countries have been recognized as highly vulnerable to climate change because farmers are heavily dependent on agriculture and livestock for their livelihoods (Mbow et al. 2019). African governments are well aware of the need to accelerate adaptation of the agriculture sector to a changing climate. Most have drafted National Adaptation Plans (NAPs) with the objective of integrating adaptation into new and existing national, sectoral, and subnational policies and programs, especially development strategies, plans, and budgets, and direct investments in strengthening the capacity of the population to cope with climate change.

The provision of food security and nutrition is one of three key functions of the food system, which comprises the entire range of actors, their interlinked value-adding activities, and the broader economic, societal, and physical environments in which they are embedded. Other functions of the food system include providing livelihoods for millions in agriculture and food production, as well as across the broader supply chain and complementary sectors, and contributing to the protection and enhancement of ecosystems (von Braun 2021). To build and sustain resilient, viable, and inclusive food systems, African countries are looking to galvanize the necessary set of individual and collective actions, including policy alignment and increased investments (African Union and AUDA-NEPAD 2021). Such a transformation of food systems has been linked to the aspirations of the 2063 Agenda and achievement of the Sustainable Development Goals (von Braun et al. 2021). Because these actions can only enhance the functioning of food systems if interventions account for climate risk, integrate the changes required to reduce climate risk to agrifood system–based livelihoods, and create the enabling conditions to implement these changes, the food system–climate change nexus needs further examination (African Union and AUDA-NEPAD 2021).

In this chapter, we examine this nexus, focusing on the food security function of food systems, and build the evidence base for policymakers to mainstream climate risk and adaptation solutions in food system transformation efforts. We discuss climate change in the next section, invoking the examples of Kenya and Mali. The third section addresses climate risk and its components using national-level examples from Kenya, Mali, Nigeria, and Senegal and farm-household-level data from Ethiopia and Niger. In the fourth section, we assess the economic implications of climate change for Kenya, Mali, Nigeria, and Senegal, followed in the fifth section by a discussion of the economic potential of two adaptive production strategies—soil and water conservation measures and use of improved seed—using the cases of Kenya and Mali. In the sixth section, we examine adoption drivers for these adaptive strategies and diverse environments using the examples of Ethiopia and Niger. In the seventh section, we develop a microregion climate risk typology and, using the examples of Ethiopia and Niger, discuss how such a typology could improve the targeting as well as the efficiency of interventions that reduce the risk of food insecurity. We conclude by drawing out four key findings for policymakers.

Climate Change

Africa's climate and weather are largely controlled by the El Niño–Southern Oscillation (ENSO), a weather system driven by changes in atmospheric and ocean circulation across the equatorial Pacific Ocean, and by two monsoons. The West African monsoon brings rain to the western Sahel from June to September, and the East African monsoon drops precipitation in eastern and central Africa from March to May and from October to December. In addition, Africa's east coast is regularly struck by strong cyclones. Variations in these large-scale climate phenomena have enormous implications for the amounts and patterns of rainfall and storms in individual African countries and have historically caused numerous natural disasters such as floods and droughts. Now, however, climate change is increasing the frequency and intensity of those extreme weather events. The number of floods in Africa has jumped fivefold since the 1990s, and many floods are more extreme. Droughts are becoming more intense as well. Asian monsoon lows, which draw warm, dry air from the Arabian Peninsula to North Africa, caused temperatures to rise to 47°C in Egypt in August 2021. Such dangerous heatwaves are becoming more frequent (GCA 2021). Regional integrated assessments in Africa south of the Sahara show that temperatures are expected to increase in all locations, and rainfall decreases are projected for the western portion of West Africa and southern Africa, while increases in rainfall are projected for eastern West Africa. Studies project that climate change will lead to yield decreases in key staple crops in large parts of the continent (Rosenzweig et al. 2014). Integrated assessments have found that climate change adds pressure to smallholder farmers across Africa south of the Sahara, with winners and losers within each area studied (Mbow et al. 2019).

In a recent paper, Wouterse and colleagues (2023) use remote sensing data to produce maps depicting climate change with a much higher spatial resolution than was previously possible. In Figures 8.1 and 8.2, we reproduce the results of the anomaly analysis for Kenya and Mali, respectively, for daytime land surface temperatures, rainfall patterns, and normalized difference vegetation index (NDVI) to reveal to what extent the climate is changing.[1,2,3]

Kenya is located in the Horn of Africa, and the country's seasonal climatic changes are controlled by the large-scale pressure systems of the Western Indian Ocean. The country has two main rainy seasons: March to May (long rains) and June to August (short rains). Panel A shows that in November, about 20 percent of the country's area experienced a temperature anomaly of between 4°C and 6°C and that about 14 percent of the country's area experienced warming of more than 6°C. Panel B shows that more than half of the country experienced a rainfall decrease of 20 to 50 mm compared to the average. Panel C shows that in November, half of the country's total area lost more than a quarter to a half of its usual level of NDVI.

Mali is in West Africa and experiences three main seasons: a dry season from March to June, a rainy season from June to September, and an off-season or cold season from October to February. Anomaly analysis reveals that in Mali in October 2021, a warming pattern (2°C–4°C) was observed as an extension of the hot season on about a quarter of the land area. This is depicted in Panel A of Figure 8.2. In March 2021, the country experienced its lowest level of warming, with only about a fifth of the country observing warming. Panel B shows that in March 2021, almost half the country experienced an increase in rainfall of up to 10 mm while panel C shows that almost half of the country experienced a modest increase in its level of NDVI. The latter anomaly was also observed in April and May, but only on about 40 percent of the country's territory.

Combining the panels, we can say that compared to the past 20 years, changing climate patterns can be detected in both Kenya and Mali but that these changes are very different. Large parts of Kenya experienced extreme warming in October and November of 2021. The warming pattern seems to have resulted from rainfall regime disruptions, as more than half of the country experienced reduced precipitation in November 2021. The decreased rainfall is associated with more than 50 percent of the country's total area losing more than a quarter to a half of its usual level of greenness. Mali, in contrast, experienced an increased level of greenness outside the rainy season, particularly in the months of March, April and May.

1 The data are scaled over 20 years (2001 to 2021), and the approach consists of three steps. First, for each year from 2001 to 2021, the data were averaged by month. The resulting dataset consisted of 240 raster files (20 years x 12 months). Second, the average raster was computed by month from the above dataset and for 2001–-2020, resulting in 12 average rasters (1 for each month). Third, each month's raster in 2021 was compared (difference) with the mean raster of the corresponding month generated in the previous step. The result was the deviation of the biophysical parameter (by month in 2021) compared to the last 19 years.

2 To estimate the variability of climate change, it is necessary to have access to the vulnerability mapping and assessment of each country.

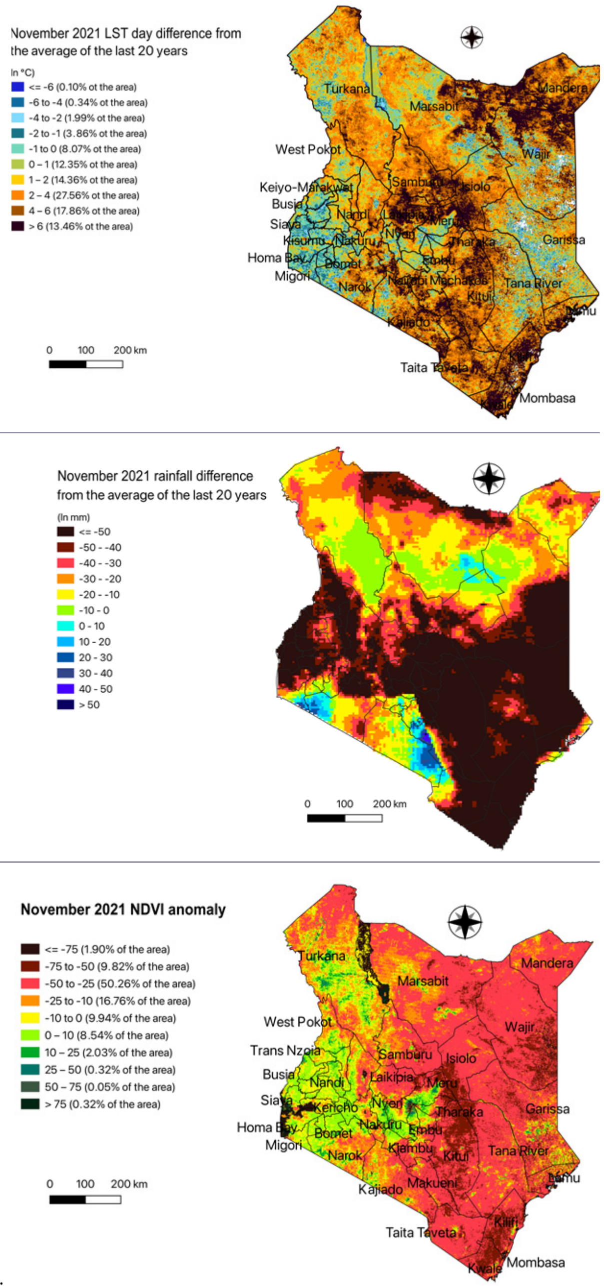
3 Remote sensing products have several advantages compared to field data, as (1) they allow coverage of large areas with a small number of samples; (2) the images are captured several times a year, therefore allowing monitoring of changes throughout the year; and (3) the spatial resolution allows observation of more details in the ground dynamics.

FIGURE 8.1—KENYA CLIMATE ANOMALY ANALYSIS, 2021

Panel A: Temperature

Panel B: Rainfall

Panel C: NDVI



Source: Fofana et al. 2023.

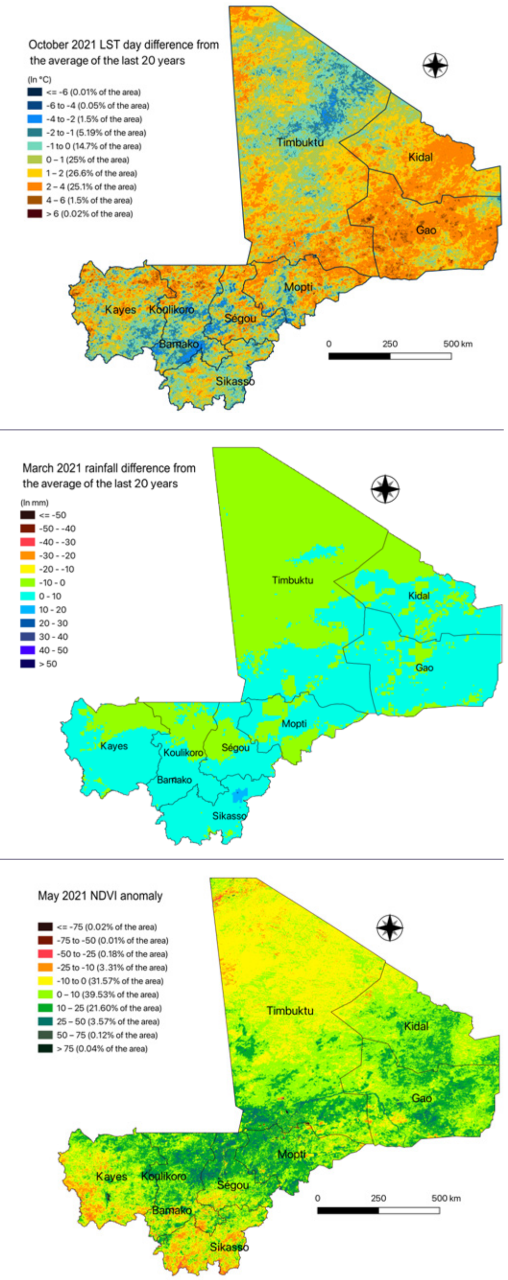
Note: LST = land surface temperature; NDVI = normalized difference vegetation index.

FIGURE 8.2—MALI CLIMATE ANOMALY ANALYSIS, 2021

Panel A: Temperature

Panel B: Rainfall

Panel C: NDVI



Source: Fofana et al. 2023.

Note: LST = land surface temperature; NDVI = normalized difference vegetation index.

There are major uncertainties about Africa's climate future. Whether or not certain regions will experience greater rainfall or suffer from more droughts is highly dependent on small changes in ENSO and the monsoons, which today's climate models cannot yet accurately predict. But many of the general trends are clear. By midcentury, average temperatures will be 2°C higher, or more, than preindustrial levels. The number of days with life-threatening temperatures above 41°C is projected to increase by 50 to 200 per year, depending on the region and the world's pace of cutting greenhouse gas emissions.

The climate models do project that parts of northern, southwestern, and central Africa will continue to experience a drying trend—and that almost all regions of the continent will be struck by more frequent and more intense rainstorms, causing greater numbers of potentially devastating floods. At the same time, higher temperatures, enhanced evaporation, and more erratic monsoons are expected to increase the number and severity of droughts. Meanwhile, sea levels are virtually certain to climb by half a meter by the end of the century and could rise nearly a meter unless greenhouse gas emissions are quickly curbed, while cyclones are expected to become more powerful. The combination of higher seas and stronger storms will mean that today's 100-year coastal flooding events will happen once every 10 to 20 years by midcentury (IPCC 2021).

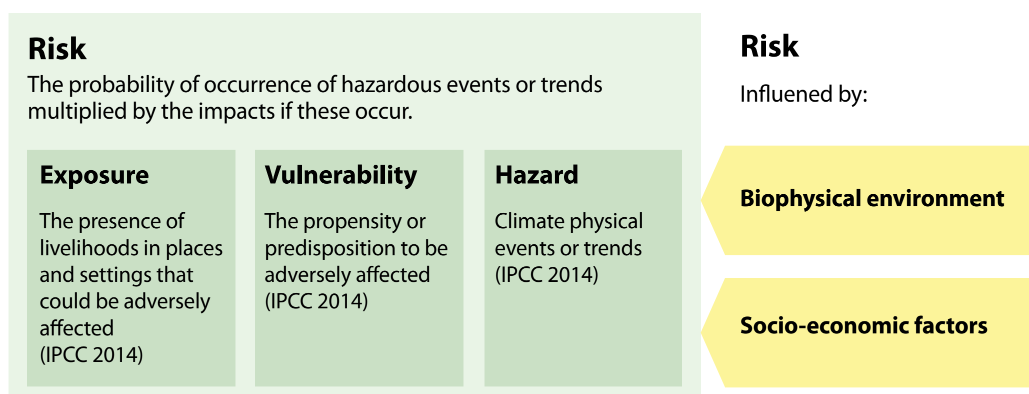
Climate Risk and Its Components

The previous section described current and future climate hazards and the physical phenomena associated with climate change, such as the mean temperature change and frequency or intensity of droughts, floods, or storms. As shown in Figure 8.3, hazards are one component of climate risk, which is defined as the probability of occurrence of hazardous events or trends multiplied by the impacts if these occur (IPCC 2014).

One of three representative key risks that have been identified for the African continent is land-based food insecurity. This risk is already present and is projected to increase in the medium term (2030–2040) and long term (2800–2100) (Niang et al. 2014). Due to a lack of connectivity to regional, national, or international markets, smallholders in Africa south of the Sahara tend to produce largely for subsistence and trade in local markets. This means that the risk of food insecurity tends to be relatively local and can be direct or indirect. To illustrate the impact of hazards, a 2016–2017 drought in Somalia caused US$1.5 billion in losses to agriculture, along with widespread malnutrition, and a 2019 drought lowered water levels behind the Kariba Dam, leading to US$200 million in lost production in Zimbabwe due to power shortages. Cyclone Idai destroyed 90 percent of the homes in the city of Beira in Mozambique and damaged 1.4 million hectares of arable land in Zimbabwe (GCA 2021).

In terms of the future risk for crop productivity, maize, rice, wheat, and soybean yields in tropical regions (20°S–20°N) are projected to decrease approximately 5 percent per degree Celsius of global warming in a multimodel ensemble (Rosenzweig et al. 2014; Franke et al. 2020). A synthesis of projected staple crop impacts across 35 studies for nearly 1,040 locations and cases shows, on average, decreases in yields across staple crops in Africa with increasing global warming, including when accounting for CO_2 increases and adaptation measures. For example, for maize in West Africa, compared to 2005 yield levels, median projected yields decrease 9 percent at 1.5°C global warming and 41 percent at 4°C, without adaptation (Mbow et al. 2019). However, uncertainties in projected impacts across crops and regions are driven by uncertainties in crop responses to increasing CO_2 and adaptation impacts, especially for maize in East Africa and wheat in North Africa and East Africa (Hasegawa et al. 2021). In terms of

FIGURE 8.3—CLIMATE RISK AND ITS COMPONENTS

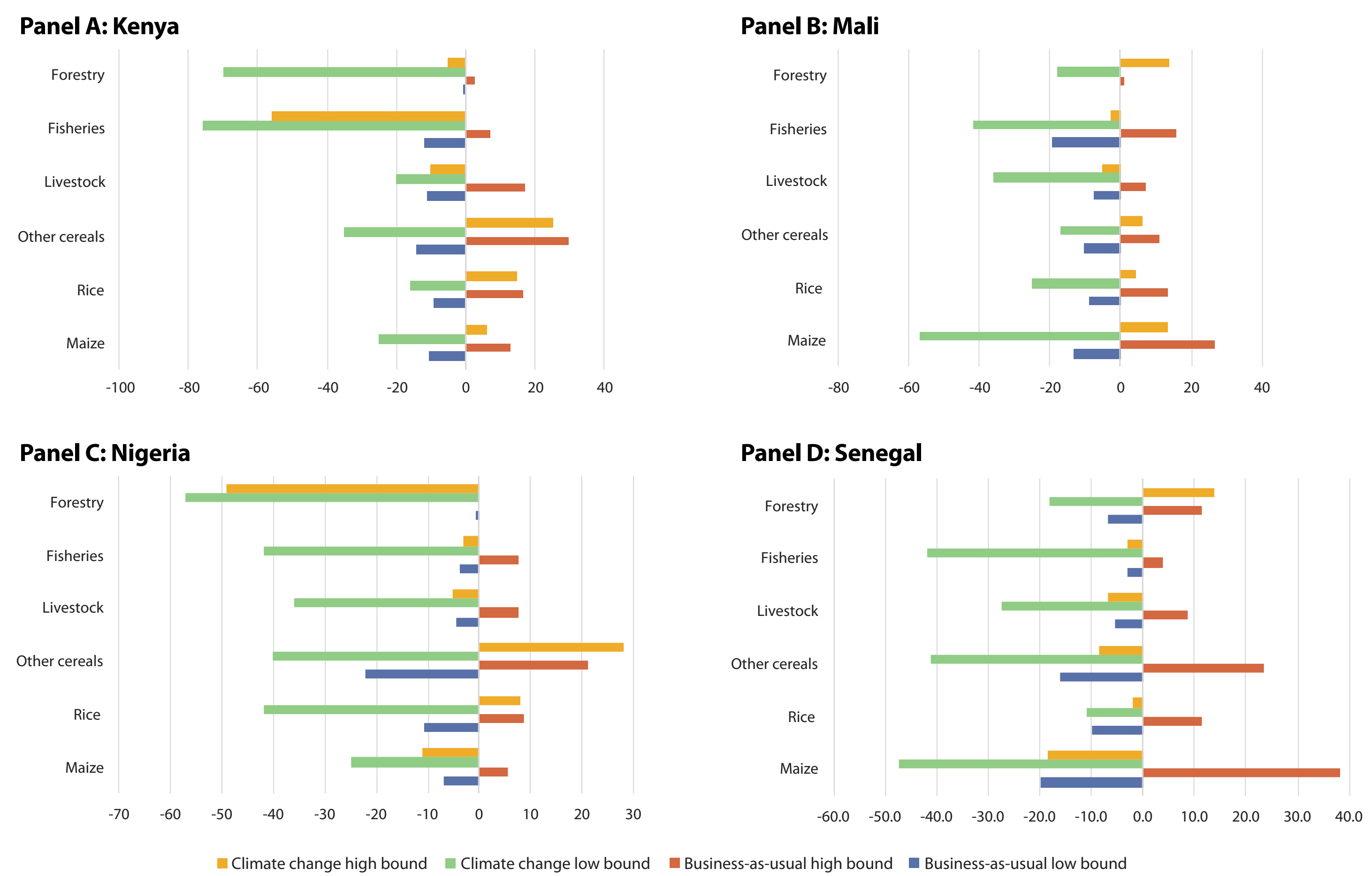


Source: Authors, based on IPCC (2014).

indirect impacts, in countries such as Burkina Faso, Chad, and Togo, more than 7 percent of all working hours are expected to be lost because of heat stress, which is likely to affect productivity.

Wouterse and colleagues (2023) have analyzed the agricultural yield trends of the past 20 years (2000–2019) for Kenya and Mali. Similar reports have been produced for Nigeria and Senegal. Figure 8.4 reproduces these results, labeled "business-as-usual," for Kenya, Mali, Nigeria, and Senegal. Low bounds are average values of negative changes of agricultural yields, while high bounds are average values of positive changes in agricultural yields. A climate change scenario (2020–2050) has also been constructed using existing empirical evidence for various levels of global warming (0.5°C to 5.5°C) and a range of projected precipitation levels. In Figure 8.4, this scenario is labeled "climate change" and here the low and high bounds are those predicted by the empirical studies used in the analysis.[4] Panel A of Figure 8.4 shows that in Kenya, fisheries and forestry are by far the subsectors most affected by climate change, with a decline of 66 percent and 38 percent on average, respectively, compared to business-as-usual. Panel B shows that in Mali, fisheries and maize production are the most affected by climate change, with a decrease of around 20 percent on average for both sectors

FIGURE 8.4—AGRICULTURAL YIELD CHANGES UNDER CLIMATE CHANGE, 2020–2050



Source: Authors' computations.

4 For each country, several peer-reviewed articles were considered. An overview is available from the authors on request.

by 2050 compared to business-as-usual. Panel C shows that for Nigeria, forestry, fisheries, livestock, other cereals, and maize are by far the subsectors most affected by climate change shocks. In Senegal (Panel D), the subsectors expected to be most affected by climate change as an average of the low and high bounds are maize (–34 percent), forestry (–23 percent), other cereals (–25.2 percent), and livestock. Clearly, climate change is expected to result in sizable negative effects on agricultural yields, although different sectors will be affected in each country.

In addition to hazards, Figure 8.3 shows that exposure and vulnerability are dimensions of climate risk. Exposure measures the presence of livelihoods in places and settings that could be adversely affected. Dryland agricultural areas, for example, are more exposed to changes in rainfall. Vulnerability is defined as the propensity and the predisposition of a system to be adversely affected by external shocks and is thus linked to the characteristics that determine a social-ecological system's or community's level of preparedness to anticipate or respond to risks (IPCC 2014; Sharma and Ravindranath 2019).

Agriculture in Africa is especially vulnerable to future climate change in part because production is overwhelmingly rainfed. At the farm household level, levels of exposure and vulnerability can be considered the outcome of changes in economic behavior to maintain welfare in the face of climate disruptions (Rising et al., 2022; Wouterse, Andrijevic, and Schaeffer 2022). Many smallholders have adopted changes in production and income-generating activities to reduce the vulnerability and exposure of their livelihoods to climate shocks (Di Falco, Chavas, and Smale 2007; Kato et al. 2011; Kosmowski 2018). There are a host of so-called climate-smart production technologies that are practiced on farms across the continent (see Box 8.1).

In Ethiopia, a country where around two-thirds of the population is dependent on rainfed agriculture, severe droughts regularly lead to production that falls short of basic subsistence levels for many farm households (Di Falco and Veronesi 2018). Tree planting on plots is an important soil conserving and conditioning measure in the country. The adoption of this climate-smart production strategy is also due to its promotion under Ethiopia's Productive Safety Net Program (Andersson, Mekonnen, and Stage 2011). Similarly, in Niger, where below-average rainfall—as in 2009, 2011, and 2013—has triggered a deceleration in growth (Wouterse and Badiane 2018), and where food insecurity is a concern even in years of average rainfall, zaï pits, which are small holes (20–40 cm in diameter and 10–20 cm deep) filled with compost and planted with seeds, are relatively common. Zaï pits have been shown to help increase both the agronomic and economic productivity and resilience of households (Wouterse 2017).

According to recent data, the use of improved seed has remained relatively low in both countries, with, respectively, 12 and 4 percent of farm households using improved seed in Ethiopia and Niger.[5] Income diversification strategies, in contrast, are relatively common in both countries. In Ethiopia, households earn income from selling processed agricultural products or from nonagricultural businesses or services such as shops and trading of goods on the street or in a market. Some households are involved in firewood collection, preparation, and sale and taxi/pickup truck services (Proctor 2014). In Niger, activities are more likely to be off-farm and include individual nonagricultural enterprises such as extraction, manufacturing, trading, and services (Dedehouanou et al. 2018).

BOX 8.1—CLIMATE-SMART PRODUCTION STRATEGIES

- Change the timing of specific farming activities or amounts of inputs applied
- Use insurance and other financial risk-management solutions
- Use new agricultural inputs (for example, climate-smart seeds)
- Adopt different production practices (for example, cover crops, residue management)
- Adopt new technologies (for example, soil testing, water management, controlled drainage, tree management)
- Transition to new farming systems and agroecological practices
- Diversify primary crops and livestock produced

Source: FAO (2017); CCAFS (2017).

5 Data are from the most recent wave of the World Bank Living Standards Measurement Study–Integrated Surveys on Agriculture (LSMS-ISA) survey, the 2015–2016 Ethiopia Socioeconomic Survey (ESS) in Ethiopia, and the 2014 Enquête Nationale sur les Conditions de Vie des Ménages et l'Agriculture (ECVMA) in Niger.

Engagement in wage labor is limited in both countries, accounting for less than 5 percent of rural income (Davis, Di Giuseppe, and Zezza 2018; Dillon and Barrett 2017). Households that have diversified their incomes are less exposed to direct impacts of droughts and floods, provided that their alternative income sources are neither correlated with rainfall nor directly or indirectly dependent on agriculture (that is, exposure falls to the extent that complementary sources of income and food are not covariates) (Devereux 2007).

An incomplete understanding of exposure and vulnerability and how they are produced may lead to adaptation efforts that instead increase, redistribute, or create new sources of vulnerability. This is referred to as maladaptation (Barnett and O'Neill 2013). The IPCC special report on the impacts of 1.5°C warming (2018) identified several ways in which adaptation efforts can increase economic, social, and environmental costs or undermine existing local adaptation strategies. For example, increased water harvesting upstream to cope with erratic rainfall may harm communities downstream and reduce their opportunities to manage their own risks.

Economic Implications of Climate Change

The agricultural yield changes associated with climate change, as outlined in the previous section, are likely to have strong repercussions on African countries' economies, given that they have remained heavily agriculture focused. A recent meta-analysis of 56 studies indicates that, compared to 1995–2005, economic welfare in the agriculture sector in North Africa is projected to decline 5 percent with 2°C global warming and 20 percent with 3°C global warming; in Africa south of the Sahara, the declines are projected to be 5 percent with 2°C warming and 10 percent with 3°C warming. The modeling results also suggest a highly complex connection between yield and welfare change, which is perhaps better analyzed on a per country basis (Moore, Baldos, and Hertel 2017). In what follows, we use the yield projections depicted in Figure 8.4 above to shock a computable general equilibrium (CGE) model combined with a microsimulation model in order to assess the effects of climate change on economic growth and employment as well as on poverty and food security in our four case study countries: Kenya, Mali, Nigeria, and Senegal.[6]

A CGE model combines economic theory and empirical data to capture the effects of economic policies and shocks. A CGE model captures the interdependencies between different sectors, agents, and markets in the economy and can therefore shed light on the wider economic impact of policies and shocks and sometimes reveal their indirect or unintended effects. We have adapted the CGE model developed by Decaluwé and colleagues (2012) to the climate change issue by adopting a long-term closure rule to consider more accurately the time dimension. In our CGE model, labor, agricultural land, and other capital are fully mobile between economic activities, which represents a long-term situation in which the economy has time to adjust. Current public expenditure and fiscal balance are fixed relative to gross domestic product (GDP). Thus, the integration of a compensatory mechanism through a tax or subsidy on household gross income makes it possible to capture the effects of the variation in government income, following the climate shock, on household welfare. All four countries are small in terms of their trading links with the rest of the world, meaning that none of the countries has an influence on the international prices of either imported or exported products, which remain fixed in the model. The foreign trade current account balance is kept fixed relative to GDP, thereby effectively linking external financing to the performance of the economy. The volume of investment is also kept fixed relative to GDP through household savings. Thus, the model is investment-driven in the sense that total investments determine total savings, that is, the sum of private, government, and foreign savings. This closure rule allows us to capture the full effect of the climate shock. In other words, intergenerational transfers of welfare are not allowed. Flexible prices equilibrate demands and supplies of domestically marketed domestic output, and the exchange rate is the numeraire in the model.[7] Below we describe the results for the four countries.

In Kenya, backward linkages measured by the input intensity—the ratio of input costs to value added—of the industry and services sectors relative to the agriculture sector were 17 percent and 5 percent, respectively, in 2018. Forward linkages measured by the shares of total demand for agricultural products by the industry and services sectors were 18 percent and 3.5 percent, respectively,

6 The macro and micro models communicate in a top-down fashion through a set of interrelated variables available in both models.

7 The CGE model uses the 2019 Social Accounting Matrix for Kenya and the 2018 Social Accounting Matrix for Mali, Nigeria, and Senegal. The microsimulation model uses household-level data from the 2015–2016 Kenya Integrated Household Budget Survey, the 2017–2018 Mali Living Standards Measurement Survey, the 2018–2019 Nigeria Living Standards Survey, and the 2018–2019 l'Enquête Harmonisée sur les Conditions de Vie des Ménages for Senegal.

in 2018. Due to the higher levels of backward and forward linkages for industry compared to the services sector, value added declines more in the former sector. Industrial subsectors that stand to lose in terms of value added as a result of climate change are wood and paper products.

In Mali, the industrial sector shows stronger linkages with the agricultural sector. The input intensities of the industrial and services sectors relative to the agricultural sector were almost 12 percent and a little over 4 percent, respectively, in 2018, representing backward linkages. Forward linkages were almost 24 percent and a little over 1 percent, respectively, in the industry and services sectors in 2018. Because of the integration of the industrial sector into the global economy, industry value added declines less than services value added under climate change. Public administration, health and social work, and education are negatively affected by climate change shocks on agricultural yields because of their linkages with the agricultural and food industries. Public administration, education, and health services play a crucial role in Mali's economy and are less exposed to external trade. Given the high intensity of agricultural inputs in this sector, a decrease in agricultural value added induced by climate change leads to a lower value added in tertiary and quaternary services. In Mali, several nonagricultural industries, such as metals and mining, stand to benefit from climate change shocks on agricultural yields through the real exchange rate depreciation effect, that is, the relative increase in domestic prices compared to external prices.

In Nigeria, the input intensities of the industrial and services sectors relative to the agricultural sector were 9.4 and 1.0 percent, respectively, in 2018, representing backward linkages. Forward linkages were 7.2 and 1.5 percent, respectively, in 2018. Under climate change, services value added declines less than industry value added (–0.9 against –2.5 percent, respectively), indicating the relative dominance and resilience of the services sector in the Nigerian economy compared to the industrial sector. Wood and paper products, accommodation and food services, and public administration are the sectors most negatively affected by climate change when compared to business-as-usual. The negative effect of climate change on wood and paper products is due to the substantial linkages of this sector with forestry activities. Accommodation and food services also have a strong linkage with the agricultural sector, explaining the poor performance of these subsectors in the face of climate shocks. Agricultural products represent 16 and 29 percent, respectively, of the total input costs of these industries. Public administration naturally contracts because of the fiscal policy effect arising from the underperformance of the economy. Some nonagricultural industries stand to benefit from climate shocks on agricultural yields because they do not require agricultural inputs. Other manufacturing industries, for example, would experience an increase in value added under climate change. Wholesale and retail trade industries do not consume any agricultural output as input and thus follow a similar pattern to that of the manufacturing industry.

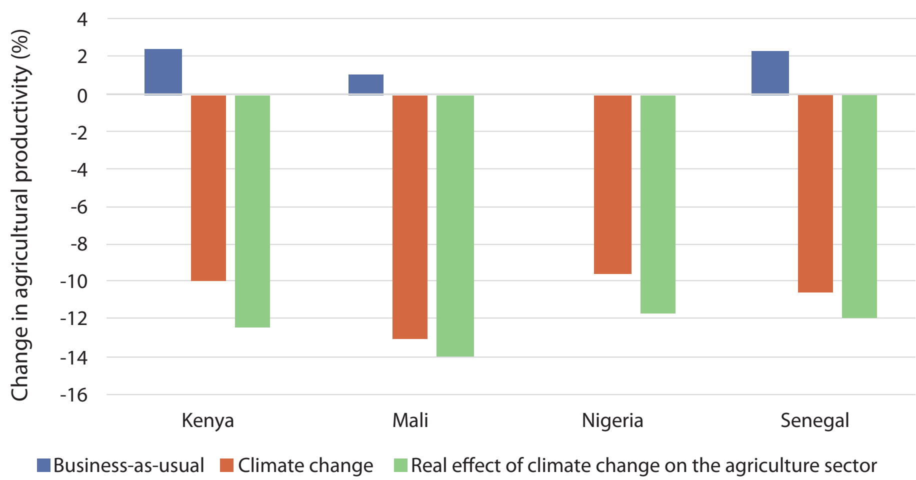
In Senegal, simulations indicate that the industrial sector could record a decline of about 1.5 percentage points, compared to a decline of 1.4 percentage points for services. Sectors that are affected by climate change are machinery, public administration, and hospitability. Some industries stand to benefit, for example, mining, chemical and oil extraction, and wholesale and retail trade.

Figure 8.5 shows that climate-induced yield changes result in a contraction of agricultural GDP compared to business-as-usual, of 10 percent in Kenya, 13 percent in Mali, almost 10 percent in Nigeria, and almost 11 percent in Senegal.

Given the agricultural productivity effects described above, we can assess the impact of climate change on GDP and employment. Figure 8.6 shows that under climate change, GDP is slated to fall by 6.5 and 8.3 percent in Kenya and Mali, respectively. In Nigeria, GDP is slated to fall by more than 4 percent and in Senegal by almost 2 percent. The smaller decline in Senegal is attributed to the fact that the country's economy is less agriculture based than those of the other three.

The effects of climate change on employment are sizable for all three categories of workers: low-, medium-, and high-skilled. Under climate change, the employment rate for low-skilled workers would fall by more than 5 percent and almost 7 percent, respectively, in Kenya and Mali. In terms of earnings, not shown here, high-skilled workers would be most affected by climate change, experiencing a drop of 2.5 percent and almost 2 percent in, respectively, Kenya and Mali. In Nigeria, changes in employment numbers due to climate change shocks on agricultural yields would be 2.5 percent for the medium-skilled employment category, against 1.9 and 1.1 percent for, respectively, high-skilled and low-skilled employment. Similarly, in terms of factor renumeration, not shown here, earnings of high-skilled and medium-skilled employees are less negatively affected by climate change shocks compared to low-skilled laborers. In Senegal, employment rates decline only marginally and not at all for high-skilled workers.

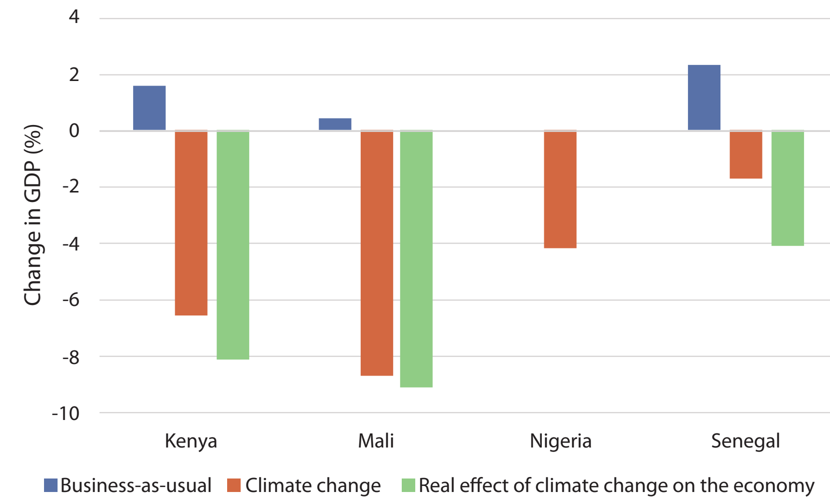
FIGURE 8.5—PERCENTAGE CHANGE IN AGRICULTURAL GDP UNDER BUSINESS-AS-USUAL AND CLIMATE CHANGE SCENARIOS



Source: Authors' computations.

Note: Real effect of climate change = business-as-usual plus climate change.

FIGURE 8.6—PERCENTAGE CHANGE IN GDP UNDER BUSINESS-AS-USUAL AND CLIMATE CHANGE SCENARIOS

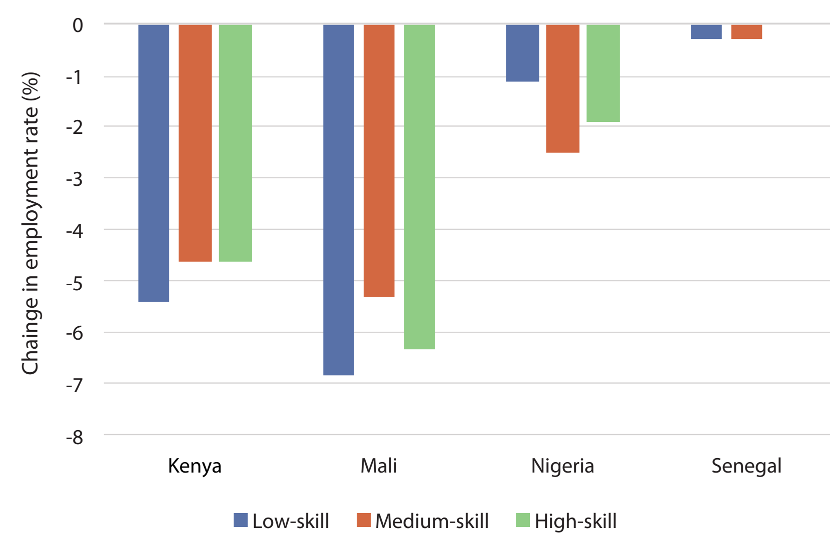


Source: Authors' computations.

Income changes from the macro model can be integrated into the microsimulation model to evaluate poverty and food security outcomes. Figure 8.8 shows that in Kenya the number of poor people—that is, individuals with total consumption expenditures below the national poverty line—would increase by 3.3 percent with climate change compared to business-as-usual. In Mali, the number of poor people would increase by about 1 percent in the climate change scenario relative to the business-as-usual scenario. For Nigeria, simulations reveal that as a result of climate change shocks, the poverty rate would increase by 2.1 percent overall and (not shown) by 2.9 percent for rural households, against 0.7 percent for urban households. With the occurrence of an adverse climatic shock, the poverty rate in Senegal would increase by more than 5 percent.

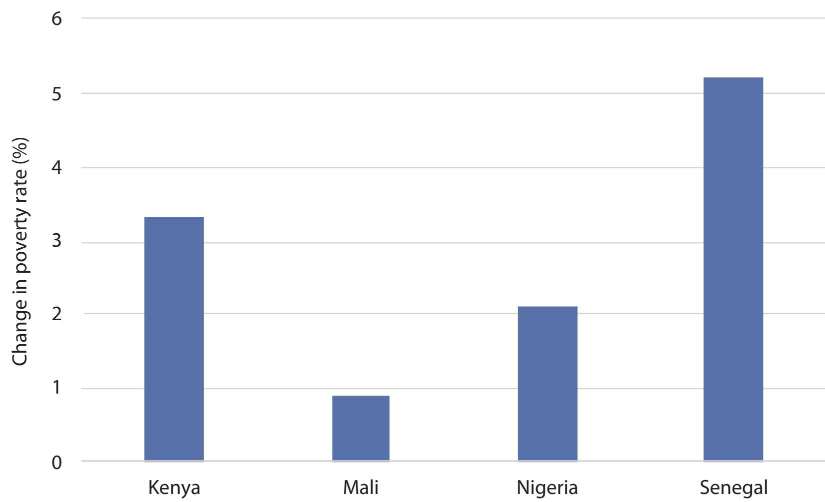
Although not shown here, for Nigeria the contraction of the economy due to climate change also leads to a drop in consumption expenditure, which is especially pronounced for rural households and those in the lowest income quintile.

FIGURE 8.7—PERCENTAGE CHANGE IN EMPLOYMENT RATE UNDER CLIMATE CHANGE



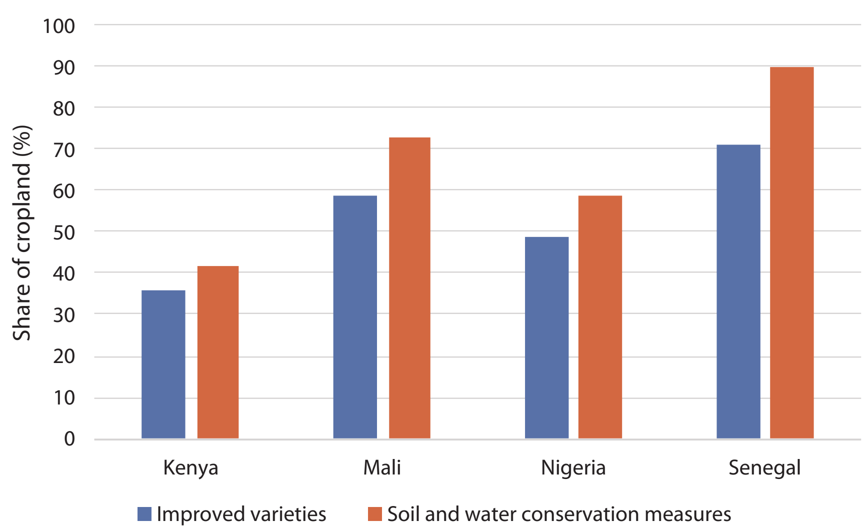
Source: Authors' computations.

FIGURE 8.8—PERCENTAGE CHANGE IN NATIONAL POVERTY RATE UNDER CLIMATE CHANGE



Source: Authors' computations.

FIGURE 8.9—ADDITIONAL SHARE OF CULTIVATED AREA THAT NEEDS TO BE COVERED BY CLIMATE-SMART AGRICULTURE STRATEGIES TO COMPENSATE FOR CLIMATE CHANGE



Source: Authors' computations.

The Potential of Adaptation Strategies

We also used the CGE model outlined above to simulate the shock-mitigating effects of two climate-smart agriculture strategies: soil and water conservation measures and use of improved seed varieties. Figure 8.9 shows that to mitigate the effects of climate change on the economy in Kenya, the share of cropland under improved varieties would need to increase by 36 percent compared to 2019 levels, while the share of land with soil and water conservation measures would need to increase by 42 percent. In Mali, the share of the area cultivated with improved varieties would need to increase by 59 percent compared to 2018, and the share of the area cultivated under soil and water conservation by 73 percent. In Nigeria, an additional 49 percent of total crop area would need to be cultivated using improved varieties to recover the GDP loss due to climate change shocks, and soil and water conservation would need to cover an additional 59 percent of total crop area. In Senegal, the share of cultivated area planted with improved varieties or under soil and water conservation measures would need to increase by, respectively, 71 percent and 90 percent in comparison to 2018. These are sizable increases that will also have important implications for public expenditure.

Beyond mitigating the climate shock, investments in the two climate-smart agriculture techniques yield economywide benefits. Figure 8.10 reveals that for Kenya and Mali, the contribution of agriculture to GDP growth increases as a result of the two adaptation strategies, although much more so in the former country. GDP, employment, consumption, and income increase as a result of the implementation of both strategies in Kenya. In Mali, only adoption of improved seed varieties is projected to yield positive returns beyond climate shock mitigation to GDP, consumption, income, and employment.

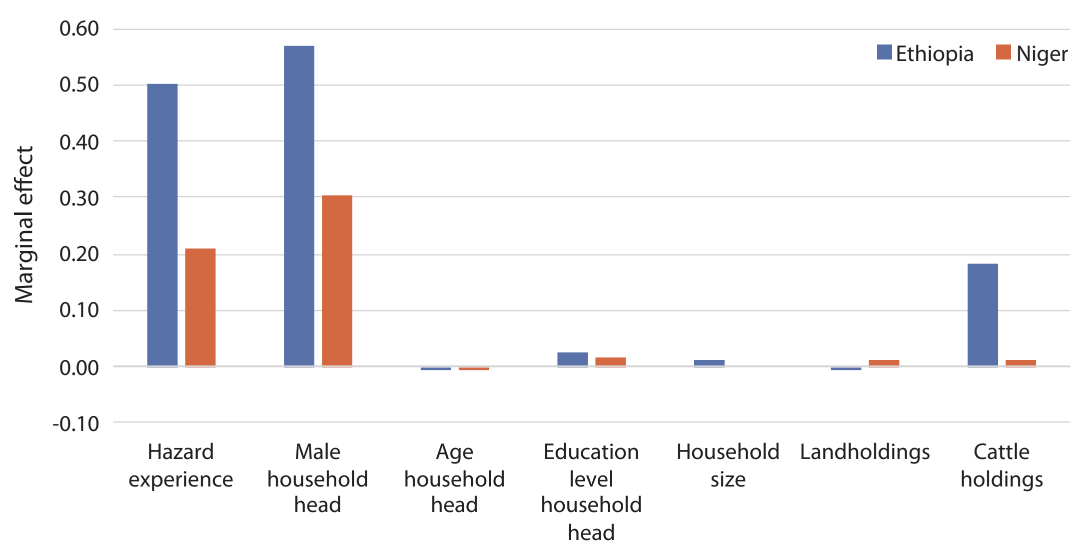
As shown in Figure 8.10, large-scale implementation of soil and water conservation measures and extensive use of improved seed both have the potential to mitigate the yield shocks projected to arise from climate change. These findings thus support the need for increased investments in these strategies, and such strategies already figure in many NAPs or the adaptation section of the Nationally Determined Contributions. But investments in these technologies do not necessarily equate adoption. To enhance sustained uptake, interventions must be designed in such a way as to account for the diverse needs of farm households and must leverage the main adoption drivers for these adaptation strategies.

FIGURE 8.10—ECONOMYWIDE EFFECTS OF CLIMATE-SMART AGRICULTURE STRATEGIES IN KENYA AND MALI (%)

	Soil and water conservation (Kenya)	Improved varieties (Kenya)	Soil and water conservation (Mali)	Improved varieties (Mali)
Agricultural value added	18.6	15.42	0.88	3.75
Gross Domestic Product (GDP)	8.78	7.22	0	1.43
Household consumption	7.68	6.35	-0.36	1.07
Employment	4.87	4.76	0.95	2.08
Household income	2.99	0.61	-0.15	0.66
Industry value added	2.98	3.17	-0.06	0.08
Services value added	2.47	3.18	-0.93	-0.28

Source: Authors' computations based on simulation results

FIGURE 8.11—DRIVERS OF ADOPTION OF ON-FARM ADAPTATION STRATEGIES



Source: Authors' computations based on Wouterse, Andrijevic, and Schaeffer (2022).

Adoption Drivers

At the farm household level, Wouterse, Andrijevic, and Schaeffer (2022) have used farm household data and regression analysis to uncover some of the drivers of adoption of on-farm adaptation technologies such as the ones outlined above.[8] The results are reproduced in Figure 8.11.

For Ethiopia, we see that hazard experience is positively correlated with the adoption of an adaptive production strategy. This finding implies that households that had experienced a drought or a flood in the 12 months preceding the survey were more likely to have engaged in on-farm adaptation. In terms of human capital, we find that better-educated household heads are more likely to have put in place on-farm adaptation measures or diversified their livelihoods through, for example, engagement in nonfarm activities. These results corroborate earlier findings that education is an effective enabler of adaptation (Walker and Salt 2012). Acquiring basic literacy, numeracy, and abstraction skills is thought to enhance individuals' cognitive capacity. Accordingly, more education is associated with greater risk awareness due to a better understanding of the consequences of pursuing adaptive strategies (Lutz, Muttarak, and Striessnig 2014). Figure 8.11 also shows that male household heads in Ethiopia are more likely to have put in place on-farm adaptation measures. In terms of productivity shifters, higher cattle holdings are associated with on-farm adaptation. This makes sense, as cattle can easily be liquidated to invest in on-farm adaptation, but higher cattle holdings may also make it more challenging to diversify, due to, for example, lack of available labor. Hazard experience in Niger is also associated with more on-farm adaptation. Again, the role of education as an enabler of adaptation is seen clearly, as better-educated

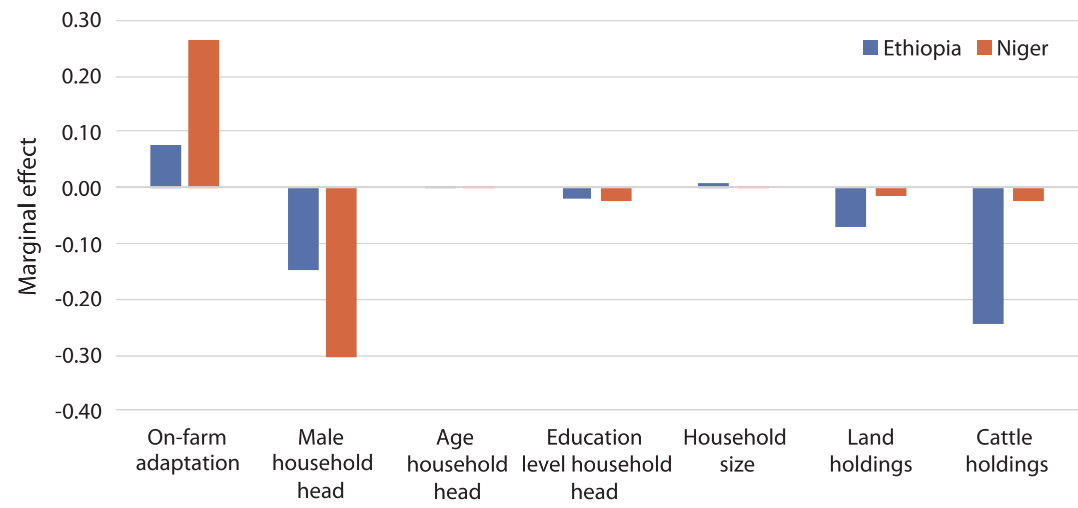
8 Data used for the regression analysis are the most recent wave of the World Bank LSMS-ISA survey, the 2015–2016 ESS in Ethiopia, and the 2014 ECVMA in Niger.

household heads are more likely to have engaged in on-farm adaptation. Female-headed households are less likely to have adopted adaptive productive strategies in Niger.

However, Figure 8.12, also based on the regression analysis of Wouterse, Andrijevic, and Schaeffer (2022), shows that on-farm adaptation is not associated with lower food insecurity in either country. Because data are cross-sectional only, reverse causality may be at play here, with more food-insecure households being more likely to have engaged in on-farm adaptation. In contrast, education is associated with lower food insecurity, as is being a male head of household. Cattle holdings and landholdings are also associated with lower food insecurity.

There are two main takeaways from this analysis. First, adaptive capacity—particularly in the form of land, livestock, and formal education—is important for uptake of on-farm adaptation strategies. Second, there is an important gender dimension to adaptation. In both countries, female household heads are less likely to have taken up adaptive production strategies and are also more food insecure. Perceptions of risk and experience with shocks and stressors also vary significantly between gender groups. For example, the underrepresentation of women in many spheres is said to influence risk prioritization and responses to shocks and stressors, such as the purchase of insurance (Quisumbing, Meinzen-Dick, and Njuki 2019). Delavallade and colleagues (2015) indicate that in West Africa, men tend to weigh risks to their farm activities more heavily, while women are more concerned about shocks affecting the health and schooling of household members. This points to a sharp difference in the kinds of shocks that men and women are likely to insure against, and their willingness to pay for a given coping instrument. This difference could be relevant here because of the relationship between hazard experience and adaptation, with female-headed households adapting much less. These findings also point to the fact that smallholder farmers' responses to climate-induced agricultural changes are not uniform but rather diverse.

FIGURE 8.12—ADAPTATION AND FOOD INSECURITY



Source: Authors' computations based on Wouterse, Andrijevic, and Schaeffer (2022).

Microregion Climate Risk Typology

Adaptation strategies are embedded in heterogeneous local agronomic, social, economic, and institutional conditions. Soil fertility conditions, for example, can vary at short distances, and enabling conditions for adaptive production strategies are variable (Van Lauwe, Coe, and Giller 2019). Also, due to a lack of connectivity to regional, national, or international markets, heterogeneous local-level food systems exist. Typology construction provides an efficient method to understand farmer diversity by delineating groups with common characteristics. A typology of microregions is an alternative way to classify and analyze very small areas within a country (see also Torero 2014). The typology presented below centers on the risk of food insecurity and its two components: exposure and vulnerability.

To develop a microregion climate risk typology for Ethiopia and Niger, we analyze the most recently available nationally representative dataset and consider a household as food insecure if it expressed a fear of not having enough to eat in the seven days preceding the survey.[9] Exposure takes the value of 1 if the household's livelihood is solely dependent on agriculture and 0 if the household has diversified its livelihood by engaging in migration or non- or off-farm activities. Vulnerability takes the value of 0 if the household uses improved seed and/or has put in place soil and water conservation measures or planted trees on plots and 1 if not (see also Wouterse, Andrijevic, and Schaeffer 2022).

Table 8.1 presents the various microregion climate risk types that were generated through cluster analysis. Five types of microregions can be distinguished: critical, high priority, medium priority with high exposure, medium priority with high vulnerability, and low priority. In critical areas, food insecurity is high, as are exposure and vulnerability. In high-priority areas, food insecurity remains high but livelihoods are less exposed and vulnerability is moderate. There are two types of medium-priority areas. In the first, exposure is still moderate or high, and vulnerability is low to moderate, meaning that livelihoods have remained largely based on agriculture but that households have engaged in some on-farm adaptation. The second type of medium-priority area is less exposed in the sense that livelihoods are diversified, but more vulnerable because less on-farm adaptation has taken place in these microregions. Finally, low priority areas have low food insecurity but can still have moderate exposure and vulnerability.

Figure 8.13 presents a visualization of the microregion climate risk typology and shows that, indeed, the impact of climate change in the form of food insecurity is unequally distributed. There is one department in Niger and four in Ethiopia that can be considered critical. These microregions have high food insecurity, and farmers are highly exposed and highly vulnerable to climate hazards. In Niger, the critical department is Tchin Tabaradene. This department in the north of the Tahoua region, which is partly in the Sahelian zone, is hyperarid and houses large numbers of transhumance and nomadic pastoralists; it was identified as experiencing stress in terms of food security by the Famine Early Warning Systems Network (FEWS NET) in 2014–2015. In Ethiopia, the critical zones are Nuer, Borena, and Liben. All three zones are in the lowlands and have a high share of pastoralists. Nuer is prone to flooding, and

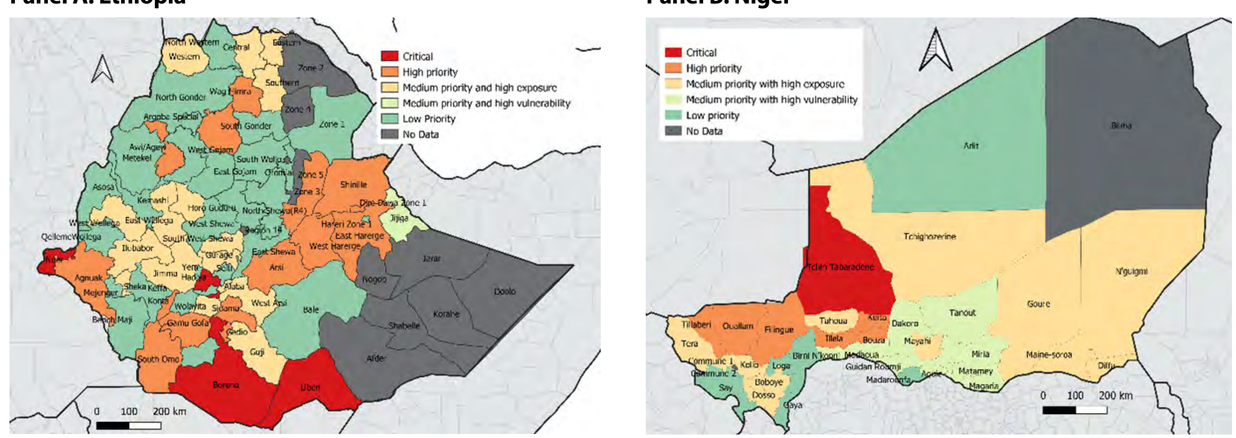
TABLE 8.1—MICROREGION CLIMATE RISK TYPOLOGY

	Microregion type	Food insecurity	Vulnerability	Exposure
1	Critical	High	High	High
2	High priority	High	Moderate	Moderate
3	Medium priority with exposure	Moderate	Low or moderate	Moderate or high
4	Medium priority with vulnerability	Moderate	Moderate or high	Low or moderate
5	Low priority	Low	Moderate	Moderate or low

Source: Wouterse, Andrijevic, and Schaeffer (2022).

FIGURE 8.13—MICROREGION CLIMATE RISK MAPS

Panel A: Ethiopia **Panel B: Niger**



Source: Wouterse, Andrijevic, and Schaeffer (2022).

9 Data are from the World Bank LSMS-ISA 2015–2016 for Ethiopia and 2014 for Niger.

Borena and Liben are at risk of drought. According to FEWS NET, in 2015 both Borena and Liben (though not Nuer) were stressed in terms of food insecurity.

Both countries also contain a high number of medium-priority regions with high exposure. In contrast to Ethiopia, Niger also counts a high number of medium-priority areas with high vulnerability. The low-priority microregion of Arlit contains uranium mines, which means that incomes are likely to be more diversified. The Niger River flows through the departments of Say and Gaya, allowing for flood recession agriculture and gardening. The departments of Birni N'Konni and Madarounfa border the seasonal Maggia River, and households there engage in irrigated cash cropping of primarily onions for urban areas of Nigeria.

Given their high level of food insecurity, critical and high-priority areas should be prioritized to accelerate adaptation. Because the typology contains two additional layers of information, on vulnerability and on exposure, the findings can also point to the types of interventions that would be appropriate in a particular microregion. Critical and high-priority regions would benefit from combined investments that reduce food insecurity in the short run, for example, in the form of a social protection scheme, and longer-term investments that reduce exposure and vulnerability. In medium-priority areas with high exposure, targeted investments, for example, through education programs, could enable households to diversify their livelihoods away from agriculture. For medium-priority microregions with high vulnerability, community work programs that include on-farm adaptation activities could help reduce vulnerability, as could the increased provision and improved quality of climate-informed advisory services. Big data technologies present an important opportunity to address the data barrier hampering the provision of these services. The use of big data technology enables timely and accurate climate risk prediction and impact assessment of extreme events with reduced uncertainties, thus making climate-informed advisory services more targeted. Finally, in low-risk areas, there would be a need to invest in a more anticipatory manner, with the objective of mitigating future climate risk—for example, through nature-based solutions and weather-index insurance, where penetration of the latter could be increased using big data technologies.

Conclusions and Policy Implications

Food systems are failing to produce the foods essential for healthy diets in sufficient quantity and at affordable prices (FAO 2023). Climate change is likely to further undermine the functioning of food systems in African countries, and food insecurity is one of the main risks associated with a changing climate. Despite its vulnerability, the agriculture sector holds enormous potential for mitigating the risk of food insecurity and strengthening food systems across the continent. But adaptation solutions (the changes required to reduce climate risk to agrifood-system-based livelihoods) as well as increased adaptive capacity (the ability to take advantage of the changes induced by climate change) need to be integrated into the effort to transform food systems.

In this chapter, we have examined the food systems–climate change nexus in six African countries focusing on the food security function to build the evidence base for policymakers to mainstream climate risk and adaptation solutions in food system transformation efforts. We can draw the following conclusions from our findings.

First, the economic implications of climate change are likely to be substantial across African countries. Through backward and forward linkages, changes in agricultural value added stemming from yield reductions will affect those in the industry and services sectors, although results differ by country. A sizable reduction in GDP by 2050 is expected in all four case study countries—Kenya, Mali, Nigeria, and Senegal—but is more pronounced for the former two, which have a larger agricultural sector. The contraction of the economy has implications for employment, poverty, and consumption expenditures. For Nigeria, the reduction in consumption expenditure is more pronounced for rural households and those in the lowest income quintile.

Second, climate-smart agriculture production strategies—soil and water conservation measures and improved seed—could mitigate the economic shocks associated with climate change in the four case study countries. However, the investments required are substantial, as, in the four case study countries, between 42 and 90 percent of arable land would need to be equipped with soil and water conservation measures and between 36 and 71 percent would need to be planted with improved seeds.

Third, findings from Ethiopia and Niger reveal that to ensure the sustained uptake of climate-smart strategies by farm households, there is a need to build their adaptive capacity, for example, through enhancing their asset base or enhancing human capital. Also, additional interventions may be required to induce female-headed households to implement adaptive production strategies on their farms. These interventions may also have a direct effect on food security.

Fourth, within a country, different areas have different needs for adaptation-related interventions, depending on their level of food security, exposure, and vulnerability.

These four findings could be used to align a country's policies and direct investments so that the planned food systems transformation is also resilient. Critical and high-priority regions would require combined short-term risk reduction and long-term productivity-enhancing investments, while medium-priority areas with high vulnerability would benefit from interventions supporting on-farm adaptation, and medium-priority areas with high exposure may benefit more from interventions that build up their human capital and allow them to diversify their sources of income. Mainstreaming the above-mentioned interventions into planned projects and programs around food system reforms and targeting them in the manner outlined above would ensure that interventions are both efficient and sustainable.

CHAPTER 9

Gender and Food Systems: Avenues for Transformation?

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Ruth Meinzen-Dick, Kalyani Raghunathan, Greg Seymour,
Simone Faas, and Emily Myers

Introduction

Worldwide, approximately 1.23 billion people are employed in agrifood systems, and 3.83 billion live in households that are linked to or reliant on these systems in some way (Davis et al. 2023). In Africa, experts estimate that between two-thirds and four-fifths of all jobs are in agrifood systems; nonagricultural agrifood system jobs account for only a small portion of this employment and are mainly concentrated in urban areas (Davis et al. 2023). Population growth and rapid urbanization, the growing risks of climate change, and persistent problems of malnutrition all mean that rural and urban African agrifood systems need to transform both substantially and rapidly to achieve the goals of sustainable, equitable, and healthy food systems.

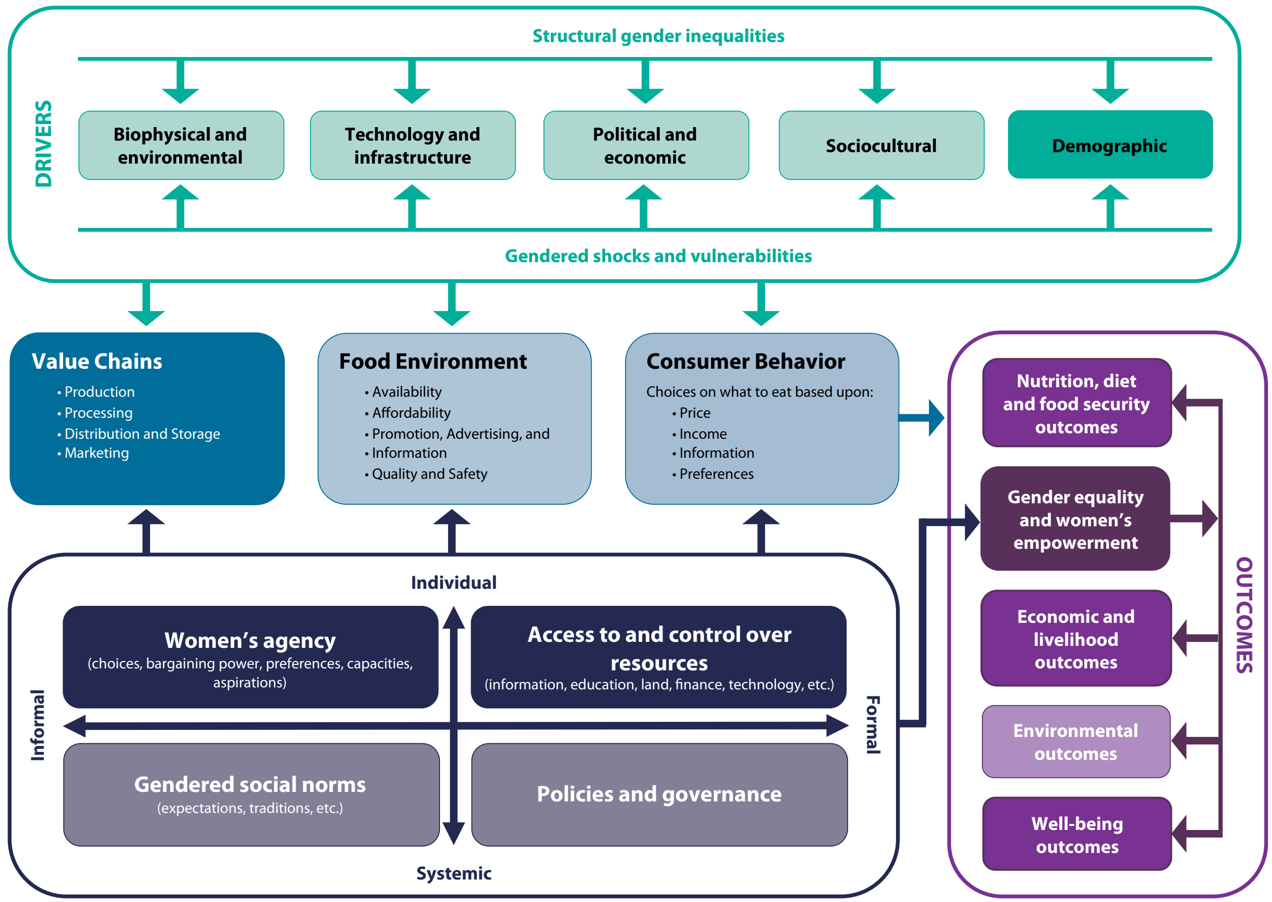
Widespread food system transformation is already occurring, both globally and in Africa, with mixed implications for welfare (Tschirley, Haggblade, and Reardon 2014; Reardon et al. 2021). If unchecked, some changes—such as rapid urbanization, increased commercialization, and a move to high-value nodes of the value chain—can easily perpetuate broader economywide inequalities, such as the exclusion of poor or marginalized farmers (Dolan and Humphrey 2000; Reardon et al. 2003; Reardon and Barrett 2000; Weatherspoon, Cacho, and Christy 2001), particularly in Africa. Woodhill and colleagues (2022) estimate that by 2050 almost all extreme poverty will be in Africa and will be concentrated among the rural population, the vast majority of whom rely on agrifood systems for their livelihoods.

Inequalities related to gender compound—and intersect with—those arising from poverty, with women's contributions to and participation in food systems often undervalued or unrecognized (FAO 2023; Quisumbing et al. 2021b). Women play a key role in African agriculture, often providing the bulk of the agricultural labor while simultaneously anchoring unpaid domestic and care work (FAO 2011, 2023; Folbre 2014). The dual burdens of productive and reproductive work exist both for women who are heads of households and for those in dual-adult households. How food systems transformation will impact gender relations is unclear. While increased market orientation and value chain specialization provide opportunities for rural households to diversify and increase their incomes, with positive implications for economic outcomes (Maertens, Colen, and Swinnen 2008; Maertens and Swinnen 2012; Maertens and Verhofstadt 2013; Minten, Randrianarison, and Swinnen 2009), these changes will not necessarily improve gender relations within and outside the household. In contexts where women are excluded from the more lucrative value chain activities or where the gendered division of unpaid labor disadvantages women, food systems transformation could exacerbate intrahousehold male-female inequalities (Barrientos 2014; Coles and Mitchell 2011; Hill and Vignieri 2014; Njuki et al. 2011). For example, commercialization is associated with decreased women's decision-making on use of harvest and control over revenue in Ethiopia and Nigeria, although women's control of revenue increases dietary diversity (Berhane, Abay, and Seymour 2022). Being able to disentangle the impacts on both absolute and relative measures of empowerment is crucial to our ability to answer the question: to what extent (if at all) is food systems transformation able to support or even catalyze transformation toward gender equality and women's empowerment?

Likewise, can greater women's empowerment or gender equality lead to more efficient, equitable, or productive food value chains in Africa? The answer to this is also not obvious. Access to key inputs such as land, livestock, and extension and financial services is highly gender-inequitable (FAO 2011, 2023; Quisumbing et al. 2014; Aguilar et al. 2015; Doss and Morris 2001; Kilic and Goldstein 2015), and women perform the lion's share of unpaid domestic and care work. On average, women spend at least three times as many hours as men on unpaid work, and women have a higher total work burden than men when both unpaid and paid work are considered (United Nations 2020). Increased women's empowerment and gender equality could result in a more equitable distribution of resources or of food-systems-related decisions, with positive consequences. There is also some evidence that women's empowerment is positively associated with agricultural productivity (Seymour 2017; Diiro et al. 2018; Anik and Rahman 2021).

In this chapter, we build upon the gender and food systems framework developed by Njuki and colleagues (2022) to assess the associations between measures of women's empowerment and specific food systems outcomes. Among the many ways to measure women's empowerment (see Elias et al. 2021 for a review), we focus on the Women's Empowerment in Agriculture Index (WEAI), an internationally validated multidimensional decomposable index (Alkire et al. 2013; Malapit et al. 2019; Malapit et al. 2017) that assesses both individual empowerment and household-level gender parity. We use measures of improved nutrition and food security, economic and livelihood outcomes, environmental outcomes, and well-being as our key food system outcomes. We then present our findings from a synthesis of mixed-methods evaluations of interventions with women's empowerment objectives to draw out implications for programs and policy. We conclude with policy recommendations to support gender-transformative food systems transformation.

FIGURE 9.1—GENDER AND FOOD SYSTEMS FRAMEWORK



Source: Adapted from Njuki et al. (2022).

The Gender and Food Systems Framework

The gender and food systems framework (Njuki et al. 2022) is our starting point for analyzing relationships between gender equality and food systems transformation. We expand the framework to include nutrition and food security outcomes along with dietary outcomes and make the interconnected relationships between the five food systems outcomes (lower right corner of Figure 9.1) more explicit.

In this framework, gender is conceptualized as an important lever for progress across all aspects of food systems. Food system drivers are anchored in a gendered social, political, institutional, and economic system with structural gender inequalities. Because of these underlying inequalities, risks and shocks affect men and women differently, resulting in differential vulnerabilities and capacities to adapt. These drivers in turn influence the three main components of food systems—value chains, food environments, and consumer behavior—and their outcomes. Details about the various components of food systems and their interactions across four dimensions—individual, systemic, formal, and informal—are presented in Njuki and colleagues' (2022) review.

The lower right quadrant of Figure 9.1 presents an array of food systems outcomes: nutrition, diet, and food security outcomes (including water, sanitation, and hygiene [WASH] outcomes); gender equality and women's empowerment; economic and livelihood outcomes (primarily in agriculture); environmental outcomes (interpreted to include natural resources outcomes); and well-being outcomes, such as life satisfaction and children's education.[1] We focus on these key food systems outcomes and use the framework to answer our two questions: (1) can women's empowerment and gender equality lead to better outcomes along the food system; and (2) can food systems transformation catalyze transformation toward gender equality and women's empowerment?

Linkages Between Women's Empowerment, Gender Equality, and Food Systems Outcomes: The Literature on Africa

Overview of the Synthetic Review

We draw on a recently completed synthetic review of relationships between women's empowerment, gender equality, and food systems outcomes (Myers et al. 2023) to explore these issues in the African context. Our measures of women's empowerment and gender equality are based on WEAI (Alkire et al. 2013; Malapit et al. 2017). Our measures of nutrition, diet, household food security, and WASH outcomes include anthropometric measures for children (height-for-age z-score, weight-for-height z-score) and body mass index (BMI) for women; individual dietary measures (child dietary diversity score, women's dietary diversity score, maternal dietary diversity score); household measures of dietary diversity and per capita calorie availability; and WASH practices. Because the WEAI measures were initially developed for the agricultural sector, our economic and livelihood outcomes pertain mainly to agriculture, including agricultural production, yields, crop choice, and technology adoption. The well-being outcomes included in our study are measures of life satisfaction and children's schooling, as several studies considered these linkages. We also included environmental and natural resources outcomes in our search.

Our search strategy is described in detail by Myers and colleagues (2023). We categorized each paper meeting the inclusion criteria according to primary food system outcome, study country, type of data (cross-section or panel) and sampling design, empowerment measure used, key findings, and whether the estimated relationships with empowerment measures were positive, negative, mixed, or null (coefficient estimates that were statistically insignificant). We also identified whether studies attempted causal identification or were primarily observational (that is, estimating associations rather than causal relationships).

The 30 publications meeting our inclusion criteria covered agricultural and mostly rural populations in nine African and five Asian countries, with two studies covering multiple countries. Counting each country in multicountry studies separately, there are a total of 39 country-study observations, with the three most studied countries being Bangladesh (30.8 percent of studies), Ghana (15.4 percent), and Nepal

TABLE 9.1—DISTRIBUTION OF PAPERS BY STUDY COUNTRY

Country	Number of papers	Distribution
Africa		
Ghana	6	15.4
Kenya	2	5.1
Malawi	1	2.6
Mozambique	2	5.1
Niger	3	7.7
Rwanda	1	2.6
Tanzania	1	2.6
Uganda	1	2.6
Zambia	1	2.6
Asia		
Bangladesh	12	30.8
Cambodia	1	2.6
India	2	5.1
Nepal	5	12.8
Timor-Leste	1	2.6
Total	**39**	**100.0**

Source: Authors.
Note: The number of papers exceeds the number of papers that met our selection criteria because some papers included multiple countries.

1 The Njuki et al. (2022) framework adapts the work of de Brauw et al. (2019), which in turn draws from HLPE (2017).

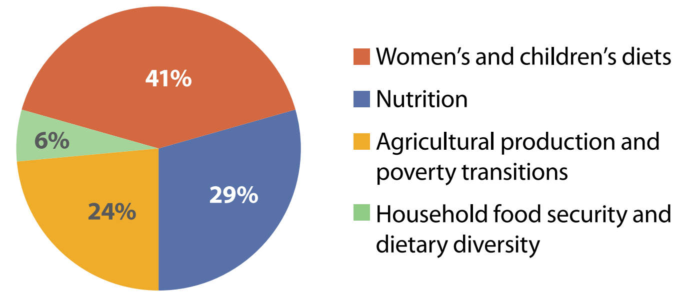
(12.8 percent) (Table 9.1). Nine African countries are included in our review, but no Latin American or Caribbean countries are included, indicating a gap in the literature.

Studies in the nine African countries addressed women's and children's diets (41 percent), nutrition (29 percent), agricultural production and poverty transitions (24 percent), and household food security and dietary diversity (6 percent) (Figure 9.2). We found no studies on life satisfaction or children's education using African data. Our discussion of the relationship between women's empowerment and gender equality and food systems outcomes will focus on the Africa studies but will also draw on the global results.

Nutrition, Diet, Food Security, and WASH Outcomes

The studies on Africa included in our review are summarized in Table 9.2.

FIGURE 9.2—DISTRIBUTION OF TOPICS IN STUDIES ON AFRICA (N = 18)



Source: Authors.

TABLE 9.2—RELATIONSHIPS BETWEEN EMPOWERMENT AND FOOD SYSTEMS OUTCOMES, AFRICA STUDIES[a]

Outcome	Study	Country	Type of data, sampling, and survey design	Empowerment measure(s)[b]	Results (statistically significant results only)	Positive, negative, mixed, or null results
Nutrition, diet, and food security outcomes						
Nutrition	Malapit and Quisumbing 2015	Ghana[c]	Cross-section. 2,027 women ages 15–49 and 1,437 children under 5. Data from Ghana FTF 2012.	Women's empowerment score Intrahousehold inequality score 10 WEAI indicators	Greater equality within the household favors boys' HAZ, for example, reducing the intrahousehold inequality score by 10 percentage points is associated with a 0.10 increase in boys' HAZ.	Positive; differential associations by child gender
	Quisumbing et al. 2021[c]	Bangladesh,[d] Cambodia, Ghana,[c] Mozambique, Nepal,[e] Tanzania	Cross-section. Data from BIHS in Bangladesh; Suaahara baseline in Nepal; and FTF surveys in Cambodia, Ghana, Mozambique, and Tanzania.	Women's empowerment score Intrahousehold inequality score 10 WEAI indicators	Women's empowerment score and gender equality are positively associated with child HAZ. Lower intrahousehold inequality is associated with lower women's BMI. A greater number of agricultural decisions, more autonomy in production, and a higher number of hours worked are associated with lower BMI; comfort with speaking in public and satisfaction with leisure are associated with higher BMI.	Mixed

continued

TABLE 9.2—RELATIONSHIPS BETWEEN EMPOWERMENT AND FOOD SYSTEMS OUTCOMES, AFRICA STUDIES[a]

Outcome	Study	Country	Type of data, sampling, and survey design	Empowerment measure(s)[b]	Results (statistically significant results only)	Positive, negative, mixed, or null results
	Ross et al. 2015	Ghana[c]	Cross-section. 2,405 women. Data from Ghana FTF 2012.	CI 10 WEAI indicators	Women's BMI[f] is negatively associated with autonomy in production and positively associated with ownership of assets, access to and decisions on credit, group membership, and leisure.	Mixed
	Zereyesus 2017	Ghana[c]	Cross-section. 1,629 households with children under 5 and women of reproductive age (15–49). Data from Ghana FTF 2012.	CI Principal components from principal components analysis of WEAI	Women's empowerment score has a positive effect on household health status (that is, the number of stunted children, the number of wasted children, and the number of underweight women).	Positive
	Zereyesus et al. 2017	Ghana[c]	Cross-section. 1,393 women under 50 with children under 5. Data from Ghana FTF 2012.	CI 10 WEAI indicators	There was no significant association between CI, the 10 WEAI indicators, and children's HAZ and WAZ.	Null
Individual diets	Kassie et al. 2020	Kenya	Cross-section. 711 farm households from 60 villages: 361 adopters of push-pull technology and 350 nonadopters. Study collected A-WEAI from women respondents only; adult males were not interviewed.	Women's empowerment score (based on A WEAI) 6 A-WEAI indicators	Women's empowerment score has a positive and significant effect on WDDS.	Positive
	Malapit and Quisumbing 2015	Ghana[c]	Cross-section. 2,027 women ages 15–49 and 1,437 children under 5. Data from Ghana FTF 2012.	Women's empowerment score Intrahousehold inequality score 10 WEAI indicators	Women's empowerment score is strongly associated with the quality of infant and young child feeding practices and weakly associated with child nutritional status. Adequacy in credit decisions is positively correlated with women's dietary diversity.	Positive
	Onah, Horton, and Hoddinott 2021	Uganda, Rwanda, Malawi, Zambia, Mozambique	Cross-section. 10,041 married women. Data from FTF surveys in Africa.	Women's empowerment score 10 WEAI indicators	Autonomy in production decisions, input in production decisions and activities, and comfort speaking in public are positively associated with WDDS. Improved autonomy in production and input in production associated with improved likelihoods of consumption of dairy products and fruits and vegetables, including vitamin A–rich produce.	Positive

continued

TABLE 9.2—RELATIONSHIPS BETWEEN EMPOWERMENT AND FOOD SYSTEMS OUTCOMES, AFRICA STUDIES[a]

Outcome	Study	Country	Type of data, sampling, and survey design	Empowerment measure(s)[b]	Results (statistically significant results only)	Positive, negative, mixed, or null results
	Quisumbing et al. 2021c	Bangladesh,[d] Cambodia, Ghana,[c] Mozambique, Nepal,[e] Tanzania	Cross-section. Data from BIHS in Bangladesh; Suaahara baseline in Nepal; and FTF surveys in Cambodia, Ghana, Mozambique, and Tanzania.	Women's empowerment score Intrahousehold inequality score 10 WEAI indicators	Higher workload is associated with more diverse child diets. Lower intrahousehold inequality is associated with a higher likelihood of exclusive breastfeeding. A greater number of agricultural decisions, greater autonomy in production, a greater number of agricultural assets owned, and a greater number of income decisions are associated with lower WDDS; greater confidence in speaking in public is associated with higher WDDS.	Mixed
	Ross et al. 2015	Ghana[c]	Cross-section. 2,405 women in northern Ghana. Data from Ghana FTF 2012.	CI 10 WEAI indicators	Women's dietary diversity is negatively associated with autonomy in production and positively associated with ownership of assets, access to and decisions on credit, group membership, and leisure.	Mixed
	Tsiboe et al. 2018	Ghana[c]	Cross-section. 2,642 households. Data from Ghana FTF 2012.	Women's disempowerment score	Women's carbohydrate, protein, and fat intake is negatively correlated with adequacy in income, production, and leadership indicators.	Positive relationship with empowerment (negative relationship with disempowerment)
Household dietary diversity	Quisumbing et al. 2021c	Bangladesh,[d] Cambodia, Ghana,[c] Mozambique, Nepal,[e] Tanzania	Cross-section. Data from BIHS in Bangladesh; Suaahara baseline in Nepal; and FTF surveys in Cambodia, Ghana, Mozambique, and Tanzania.	Women's empowerment score Intrahousehold inequality score 10 WEAI indicators	Autonomy in production, control over income decisions, and satisfaction with time spent or leisure are all positively associated with household dietary diversity score.	Positive
Economic and Livelihood Outcomes						
Agricultural production	Diiro et al. 2018	Kenya	Cross-section. 707 maize-farming households in western Kenya.	Women's empowerment score (based on A-WEAI) 6 A-WEAI indicators	Women's empowerment score significantly increases maize productivity. Female- and male-managed plots experience significant improvements in productivity when the women who tend them are empowered.	Positive

continued

TABLE 9.2—RELATIONSHIPS BETWEEN EMPOWERMENT AND FOOD SYSTEMS OUTCOMES, AFRICA STUDIES[a]

Outcome	Study	Country	Type of data, sampling, and survey design	Empowerment measure(s)[b]	Results (statistically significant results only)	Positive, negative, mixed, or null results
	Tankari 2018	Niger	Cross-section. 338 dual-adult households. Primary male and female adults interviewed, excluding co-wives, February–June 2016.	Whether household achieves gender parity (based on WEAI) Intrahousehold inequality score (based on WEAI)	Gender parity is negatively associated with adoption of inorganic fertilizers; gender parity is positively, but insignificantly, correlated with adoption of organic fertilizer. Results are similar for the empowerment gap: as women have lower empowerment scores than the primary man in their household, the household is more likely to use inorganic fertilizer.	Negative for inorganic fertilizer
	Wouterse 2017	Niger	Cross-section. 769 adults in 500 households. Surveyed in April–May 2015.	Average household empowerment score (average of women's and men's empowerment scores)	More empowered households are more likely to have *zai* pits (a type of planting pit common to the Sahel), and empowerment is associated with higher agricultural yields.	Positive
	Wouterse 2019	Niger	Cross-section. 769 adults in 500 households. Surveyed in April–May 2015.	Average household empowerment score (average of women's and men's empowerment scores)	Empowerment scores of the household positively affect the quantity of agricultural output. An increase of 1.0% in average empowerment increases output by almost 1.0%. Empowerment interacts positively with returns to equipment and negatively with returns to fertilizer.	Positive. Because outcomes and empowerment scores are at the household level, interpretation of returns to empowerment differ from other studies focusing on individual empowerment.

Source: Adapted from Myers et al. (2023).

Note: a Acronyms used in this table are defined as follows: BIHS = Bangladesh Integrated Household Survey; BMI = body mass index; CI = Composite Inadequacy Count index; FTF = Feed the Future; HAZ = height-for-age z-score; WAZ = weight-for-age z-score; WDDS: women's dietary diversity score.

b "Women's empowerment score" refers to the WEAI women's empowerment score, unless otherwise indicated. "Intrahousehold inequality score" is the difference between the men's and women's empowerment scores within the same household. Unless A-WEAI is indicated, all scores are based on the original WEAI.

c Ghana FTF: Northern Ghana Feed the Future Survey.

d BIHS (Bangladesh Integrated Household Survey), nationally representative of rural Bangladesh.

e Suaahara Survey.

f Although Ghana as a whole is at a phase of the nutrition transition where there are high rates of overweight and obesity in adult women, this is not the case for the sample used in this study. This study reports that 22.3 percent of women were underweight (BMI < 18.5), compared to only 6.2 percent of women nationally in the 2014 Ghana Demographic and Health Survey.

Nutrition

The strongest finding in our global review is the positive relationship between women's empowerment and children's nutrition outcomes; this relationship also holds in the Africa studies. While analyses using the aggregate empowerment score generally show positive associations, disaggregating empowerment into the component indicators shows that different indicators matter in different contexts. Moreover, both women's empowerment and intrahousehold gender equality matter for children's nutrition outcomes. Greater equality within the household is positively correlated with height-for-age z-score in Ghana (Malapit and Quisumbing 2015) and in a multicountry pooled study including Bangladesh, Cambodia, Ghana, and Nepal (Quisumbing et al. 2021c).

While there appear to be benefits to children's nutritional status associated with women's empowerment and intrahousehold gender equality, women's empowerment is not unambiguously positively associated with women's own nutritional status. For example, in Ghana, Ross and colleagues (2015) do not find a significant relationship between women's aggregate empowerment score and women's BMI in a Multiple Indicators, Multiple Causes (MIMIC) model.[2] However, decomposing the empowerment score into its component indicators reveals that all five indicators are significantly associated with higher BMI for women but with offsetting signs. *Asset ownership, credit decisions, group membership, and satisfaction with leisure* are all positively associated with women's BMI, but *autonomy in production* has an unexpected negative relationship. Upon further investigation, Ross and colleagues (2015) uncovered a significant unexpected negative association between autonomy and income, such that a woman in a higher income group has less autonomy in production. As women increase their economic activities and contribute more income to the household, they may feel pressure to make production decisions based on others' expectations to avoid conflict. Alternatively, such women may surrender some autonomy in production so they can focus on other activities that are more important to them.

Similarly, the most striking result from the six-country study by Quisumbing and colleagues (2021c) in Bangladesh, Cambodia, Ghana, Nepal, Mozambique, and Tanzania is the lack of significant association between the aggregate empowerment measures and most of the women's nutritional outcomes. However, analysis of the component indicators reveals more significant associations with offsetting signs, suggesting potential trade-offs between different domains of empowerment. The researchers find that greater *intrahousehold equality* (smaller gender gap), a greater *number of agricultural decisions*, more *autonomy in production*, and a higher *workload* are all associated with lower BMI, while comfort with *speaking in public* and *satisfaction with leisure* are associated with higher BMI. These trade-offs may arise because women's increased participation in agriculture, which increases some components of the women's empowerment score, comes at the cost of increased workload, which may impinge on BMI in low-BMI populations (Quisumbing et al. 2021c).

Individual (Maternal and Child) Diets

Similar to the results for nutritional status, both the aggregate empowerment score and specific aspects of empowerment matter for individual diets. The results for the individual indicators illustrate the trade-offs between different dimensions of women's empowerment and dietary outcomes. For example, higher *workload* (which contributes to lower empowerment scores) is associated with higher children's dietary diversity in Bangladesh, Cambodia, Ghana, Mozambique, and Nepal (Quisumbing et al. 2021c).

Nor can we assume that women's diets necessarily improve when they are more empowered in agriculture. Several studies document significant associations between women's empowerment indicators and women's dietary diversity scores across several African countries (see Kassie et al. 2020 for Kenya and Onah, Horton, and Hoddinott 2021 for Uganda, Rwanda, Malawi, Zambia, and Mozambique). However, the component indicators show mixed results. For example, Quisumbing and colleagues' (2021c) multicountry study finds that comfort with speaking in public is associated with improved women's dietary diversity, but the *number of agricultural decisions, autonomy in production, number of agricultural assets owned*, and *number of income decisions* are all associated with less diverse diets for women.

Household Food Security and Dietary Outcomes

The third category of nutrition-related outcome indicators comprises outcomes measured at the household level. They are broadly related to food security and

2 Although Ross and colleagues (2015) use BMI as a measure of health status, we treat it as an indicator of nutritional status.

include the share of specific types of food retained for home consumption, household dietary diversity, and household calorie availability.

Kassie and colleagues (2020) find positive associations in Kenya between the household dietary diversity score and women's aggregate empowerment score. Consistent with the findings on diets and nutrition outcomes, different component indicators matter in different contexts (Quisumbing et al. 2021c). Overall, the findings suggest that increasing women's empowerment and reducing intrahousehold inequality between women and men contribute to household food security, but household wealth, gender norms, and country-specific institutions are also of critical importance. Quisumbing and colleagues (2021c) find that a large proportion of the variance in household and women's dietary diversity is accounted for by country fixed effects and household wealth; women's empowerment accounts for only a small share. This pattern suggests that diet, nutrition, and food security outcomes cannot be expected to improve automatically without an effort to also address the underlying determinants of poor nutrition (Quisumbing et al. 2021c).

Economic and Livelihood Outcomes: Agricultural Production

The next category includes studies analyzing economic and livelihood outcomes, with a focus on agricultural production and productivity measures.

Several studies find positive associations between various empowerment measures and production indicators (Diiro et al. 2018; Wouterse 2017, 2019). Women's aggregate empowerment scores are positively associated with increased productivity among maize farmers in Kenya (Diiro et al. 2018). Diiro and colleagues (2018) find that women's empowerment in agriculture significantly increases maize productivity, with female- and male-managed plots both experiencing significant increases in productivity when the women who tend them are empowered.

Wouterse's (2017, 2019) studies in Niger examine relationships between the average empowerment in a household (the average of men's and women's empowerment scores) and agricultural outcomes. Wouterse (2019) finds that average empowerment scores are positively associated with agricultural output, and that an increase of 1.0 percent in average empowerment increases output by almost 1.0 percent. She also finds that empowerment interacts positively with returns to equipment and negatively with returns to fertilizer (Wouterse 2019). In another study, Wouterse (2017) finds that more empowered households are more likely to have *zai* pits (planting pits), and empowerment is associated with higher agricultural yields.

These studies indicate that women's empowerment and gender equality are associated with improved food systems outcomes, but not all dimensions of empowerment matter for good nutrition. Importantly, there may be trade-offs between some dimensions of empowerment, such as women's workload and their increased involvement in agriculture.

Can Food Systems Interventions Be Designed to Promote Women's Empowerment and Gender Equality?

The Reach, Benefit, Empower, and Transform Framework

The discussion thus far has focused on the instrumental gains from women's empowerment and gender equality. Recently, increased recognition of the intrinsic value of women's empowerment and equality, evidenced by their recognition as one of the United Nations (UN) Sustainable Development Goals (SDG5), has led to the design of projects and interventions with women's empowerment as one of their explicit objectives. Recent impact evaluations of these projects have uncovered some key elements that are essential for the achievement of these empowerment objectives. We draw from syntheses of impact evaluations conducted under the Gender, Agriculture, and Assets Project, Phase 2 (GAAP2); the UN Joint Programme on Rural Women's Economic Empowerment (JP RWEE); and Agricultural Technical Vocational Education and Training for Women (ATVET4W).

To assess whether projects achieve their empowerment objectives, we use the "Reach-Benefit-Empower" framework (Johnson et al. 2018), which was subsequently expanded to include "Transform" objectives (Quisumbing

TABLE 9.3—THE REACH, BENEFIT, EMPOWER, AND TRANSFORM (RBET) FRAMEWORK

	Reach	Benefit	Empower	Transform
Definition	Include women in program activities	Increase women's well-being	Strengthen the ability of women to make life choices and put them into action	Go beyond the woman and her household to change gender norms and systems on a larger scale
Objective	Ensure that women have the same opportunity to access the program activities as men: • *Address barriers to participation, such as program information, timing, or location of meetings and training*	Require more than reaching women: • *Women value the intervention* • *Direct benefits accrue to women* • *Women's needs, preferences, and constraints are considered in the intervention design*	Go beyond reaching and benefiting women: • *Increase women's agency* • *Shift gender norms and attitudes among participants*	Go beyond empowering individual women: • *Involve men* • *Change gender norms at the community and societal levels* • *Address structural and institutional barriers* • *Mobilize the power of the collective*

Source: Quisumbing et al. (2023), adapted from Johnson et al. (2018).

et al. 2023). In this RBET framework (Table 9.3), projects that reach women include them in program activities; those that benefit them improve women's well-being outcomes, including income, health, and nutrition. Typical indicators for "reach" include the number of women and men attending training or extension programs; "benefit" indicators include income earned by women or women's nutritional status indicators. But neither "reach" nor "benefit" objectives explicitly address increasing women's agency, their ability to make strategic life choices (Kabeer 1999) and to act on them, and many projects that claim to empower women only have strategies to reach or benefit them. Finally, gender-transformative approaches "emphasize interventions that aim to *transform constraining gender norms, attitudes and behaviors* towards those that support gender equality" (Pyburn and van Eerdewijk 2021, 23) and typically adopt a holistic approach to change gender norms at the community and societal levels, address structural and institutional barriers, and mobilize the power of the collective.

Insights from Quantitative Impact Evaluations

Impact evaluations of projects with explicit women's empowerment objectives provide evidence on what works to empower women and close the empowerment gap. We draw on a synthesis of impact evaluations conducted across the GAAP2 (Quisumbing et al. 2022) and JP RWEE (Quisumbing et al. 2023) portfolios, focusing on the African projects in these portfolios, and the ATVET4W program in Benin and Malawi (Eissler et al. 2021; Ragasa et al. 2021).

The GAAP2 portfolio comprises 13 agricultural development projects that co-developed the project-level WEAI (pro-WEAI) (Malapit et al. 2019) and used it to evaluate their projects' impacts on women's empowerment and gender equality. All projects completed qualitative studies prior to the COVID-19 pandemic, but this synthesis is based on the 11 projects that completed endline data collection before December 2020. These completed evaluations were implemented in South Asia (Bangladesh [three], India, and Nepal), West Africa (Burkina Faso [two], Ghana, and Mali), and East Africa (Ethiopia and Tanzania). All but one of the partner projects worked through nongovernmental organizations; most of them used group-based approaches, though they did not work exclusively with women's groups. For this chapter, we focus on the African projects, all of which used pro-WEAI, which has three domains and 12 indicators, in their quantitative impact assessments.[3]

The first phase of JP RWEE, implemented by the Food and Agriculture Organization of the United Nations, the International Fund for Agricultural Development, UN Women, and the World Food Programme, covered seven countries, of which four conducted mixed-methods impact assessments using WEAI-based measures. The JP RWEE Ethiopia project was part of the GAAP2

3 Pro-WEAI has three domains, covering instrumental agency, intrinsic agency, and collective agency. The instrumental agency (power to) domain has the most indicators: (1) productive decisions, (2) asset ownership (including land), (3) access to credit and financial services, (4) control over the use of income, (5) work balance, and (6) visiting important locations. The intrinsic agency (power within) domain has four indicators: (1) autonomy in income decisions, (2) self-efficacy, (3) attitudes toward intimate partner violence against women, and (4) respect within the household. Finally, the collective agency (power with) domain has two indicators: (1) group membership and (2) membership in influential groups.

portfolio; the other African country is Niger. For comparability across the JP RWEE projects, we computed impact estimates using A-WEAI, which has five domains and six indicators, the thresholds of which were adjusted to be consistent with pro-WEAI cutoffs for the synthesis study.

The GAAP2 projects aimed to improve women's empowerment and nutrition outcomes, and some projects also aimed to improve incomes. Many of these were nutrition-sensitive agriculture (and livestock) programs that included such activities as homestead food production, with emphasis on nutrient-dense crops, provision of nutrition information, and nutrition behavior change communication. Strategies used to empower women were broadly classified as (1) providing goods and services, (2) strengthening organizations, (3) building knowledge and skills, and (4) influencing gender norms—though there was considerable variability in the content of programming within each of these categories.

Most GAAP2 projects provided goods and assets to beneficiaries (for example, goats, financial services, improved seeds, technology packages) or facilitated the acquisition thereof (for example, small-scale irrigation pumps). Although this type of project strategy is expected to affect instrumental agency, such programs could potentially affect aspects of intrinsic agency as well. One such project was a microfinance intervention delivered through rural savings and credit associations in Oromia, Ethiopia. Among the project beneficiaries, a subgroup maintained access to credit between baseline and endline, while a subgroup lost access to credit provided because of nonrepayment or because they left the group. Hillesland and colleagues (2022) found that those beneficiaries who maintained access to credit experienced a positive impact on the *respect within the household* indicator.

Most projects also used group-based approaches. Membership in these groups can affect aspects of collective agency and provide access to different types of resources such as information, technology, credit, and other inputs. In Burkina Faso, savings group members who received a comprehensive intervention package reported an increase in the average number of empowerment indicators with "adequate" scores, while the comparison group saw a decrease in average adequacy over time (Crookston et al. 2021).

Training and the building of knowledge and skills were also important parts of the GAAP2 projects' strategies; evidence suggests that the mode of providing extension matters. For example, findings from an impact evaluation of a pilot project in Bangladesh that randomized the provision of agriculture, nutrition, and gender-sensitization training to husbands and wives jointly (Quisumbing et al. 2021a) indicate that the positive impacts of all types of training on women's empowerment outcomes may have arisen from implementation modalities that provided information jointly to both husbands and wives. None of the African projects tested alternative delivery strategies within the same program, an important area for future work.

Approaches to changing gender norms varied across the portfolio. Some projects worked only with women (such as a self-help group project in India), whereas two projects in Bangladesh worked with both women and men, as well as with community leaders and influential household members. Except for one project that was focused on small-scale irrigation (iDE in Ghana), the African projects in the GAAP2 portfolio implemented training that attempted to change gender norms and increase women's agency, using gender dialogues (Grameen in Burkina Faso), training women on financial literacy and entrepreneurship (JP RWEE in Ethiopia), and training on household budgeting and gender awareness (Maisha Bora in Tanzania).

In contrast, JP RWEE Phase 1 had a more explicit women's empowerment focus in working toward four interrelated outcomes: (1) improved food and nutrition security, (2) increased income to sustain livelihoods, (3) enhanced participation and leadership, and (4) a more gender-responsive policy environment for rural women (FAO, IFAD, UN Women, and WFP 2021). JP RWEE implemented its projects with adaptations to specific country contexts. In Ethiopia, JP RWEE strengthened the technical capacity of women-run rural savings and credit cooperatives that offer financial products to women farmers. In Niger, program interventions were delivered through Dimitra Clubs, or community listener clubs. Rural radio stations raised awareness of themes identified and requested by the clubs themselves and became a platform for community-level groups to promote dialogue and a safe place for both men and women to talk about their challenges openly. JP RWEE projects used strategies to involve other household members, commonly called "household methodologies." One country that employed the household methodologies approach through the Gender Action Learning System (GALS)—Kyrgyzstan—demonstrates the gains from involving men (Quisumbing et al. 2023). In Kyrgyzstan, two types of household methodologies—GALS and an adaptation of GALS with business training—promoted behavioral change for gender justice, improved planning of livelihood strategies, equitable workload distribution within households, management of income-generating activities, and women's entrepreneurship. These resulted in increases in women's empowerment as well as in the likelihood of attaining gender parity.

Figure 9.3 presents, for the African projects in the GAAP2 and JP RWEE portfolios, the distribution of project impacts on women's and men's empowerment scores, their respective empowerment status (whether the individual was empowered), and whether the household achieved gender parity. Although all these projects had empowerment objectives, most of the impacts on women's (and men's) empowerment were insignificant, and most projects did not have a significant impact on gender parity (Figure 9.3).

A closer look at the individual indicators reveals similar patterns (see Quisumbing et al. 2022, 2023), with most of the significant impacts in the GAAP2 portfolio observed on instrumental agency indicators, possibly because these are more easily targeted and monitored by projects.[4] Several instrumental agency indicators are significantly affected: (1) the types of activities for which the woman controls income, (2) the types of assets she controls (including land), and (3) the types of credit or financial services that she makes decisions about. Reflecting on the group-based approaches used in these projects, there are positive impacts on the number of types of groups to which a woman belongs. Very few projects have impacts on aspects of intrinsic agency. Although there are very few significant impacts on men's indicators, it is important to note any negative impacts on men, because they may indicate possible backlash against women's empowerment projects.

An important finding from the JP RWEE synthesis is the need to pay attention to workload. Although impacts on women's aggregate workload were minimal, productive work may have increased at the expense of reproductive work (Quisumbing et al. 2023). In the Ethiopia sample, women who maintained credit access did not experience significant impacts on overall workload. However, the increase in productive work hours was offset by reducing reproductive work and time spent on secondary childcare (time spent caring for a child while doing a primary activity). In contrast, women who lost access to credit increased their total and reproductive workload and decreased their time spent on childcare as a primary activity. In the Niger sample, beneficiary women's productive work hours did not increase but reproductive work hours did.

FIGURE 9.3—DISTRIBUTION OF PROJECT IMPACTS ON WOMEN'S AND MEN'S EMPOWERMENT SCORES, EMPOWERMENT STATUS, AND HOUSEHOLD GENDER PARITY, AFRICAN PROJECTS IN GAAP2 AND JP RWEE PORTFOLIOS

Source: Authors.

Insights from Qualitative Work

Project teams working with IFPRI researchers conducted qualitative assessments in all the GAAP2 studies and the JP RWEE Ethiopia project (which was also

4 We analyzed a different version of the indicators, namely the continuous versions on which adequacy cutoffs were based. Thus, they are defined slightly differently from those in footnote three, but capture the same concept.

part of GAAP2), as well as in conjunction with studies linked to an ATVET4W program implemented in Benin and Malawi, which were part of the development of pro-WEAI for Market Inclusion (pro-WEAI+MI) (Malapit et al. 2023). The qualitative studies elicited a nuanced understanding of *how* projects affected empowerment that went beyond the quantitative indicators.[5]

Findings from the GAAP2 qualitative studies in Burkina Faso, Ethiopia, and Mali reveal that beneficiaries perceive capacity-building projects as having a strong, positive influence on their self-efficacy (Meinzen-Dick et al. 2019). Overall, many women beneficiaries described feeling more confident and directly attributed their increased confidence to the program activities. Notably, women beneficiaries in the Grameen project in Burkina Faso shared that their participation in a savings group encouraged norm change around women's ability to contribute to household income at the community level (Kieran, Gray, and Gash 2018). This aligns with the emic notion of women's empowerment as being able to do things for others (Meinzen-Dick et al. 2019). Similarly, in the ATVET4W Benin study, participants explained that the training increased women's financial independence, which led to increased intrinsic agency and self-confidence (Eissler et al. 2021).

The qualitative studies conducted in the GAAP2 projects in Burkina Faso, Ethiopia, and Mali also find that gender norms constrain women from participating in decisions about agricultural production overall. For instance, in Burkina Faso, focus groups showed that men are considered the head decision-makers around poultry production and marketing. But beneficiary women in a poultry value chain intervention said raising poultry increased their self-confidence in their skills and capacities; gaining financial independence was critical, as they no longer needed to rely on their husbands' permission or direction on how to spend money (Eissler et al. 2020). In Malawi, many women are tied by the norms dictating the role of a "good wife" who often must defer to her husband. Similarly, norms about women's roles when away from home may also sometimes limit their ability to engage in agricultural business activities (Ragasa et al. 2021).

The qualitative data provide more nuanced insights on aspects of collective agency that are not necessarily captured in the indicators of group membership and membership in influential groups. The qualitative studies that examined perceptions of group membership (Ethiopia and Tanzania projects) affirm the improvements in collective agency as well as the interlinkages with other aspects of empowerment. Qualitative studies on projects that emphasized group formation and strengthening in Ethiopia and Tanzania showed that constraints on participation in groups, such as a lack of spousal support, a lack of transportation, or time poverty (which are aspects of instrumental and intrinsic agency), limited the participation of some women in the overall project.

Qualitative studies further show how different types of agency are interlinked (Meinzen-Dick et al. 2019). Freedom of movement, work balance, and intrahousehold respect are all important for women to be able to participate in groups (collective agency), which gives them confidence to speak in public, while a study among the Masai in Tanzania found that fear of intimate partner violence (IPV) constrained women from participating in groups (Krause et al. 2018). Participation in microfinance groups provides access to credit and enables women to contribute to household income, which leads to control over income and input into productive decisions. Women in the Grameen program reported that their role in their savings group not only empowered them individually but also contributed to changing norms regarding women's ability to contribute to household income (Kieran, Gray, and Gash 2018). Similarly, in the qualitative study of the Malawi ATVET4W program, decision-making and work balance are strongly linked, especially in producer households in which deciding what tasks to do cannot be disentangled from when to do them. This is especially the case for married women, as unmarried women do not need to consult with their husbands (Ragasa et al. 2021). Meanwhile, in the Benin study, the findings highlight the interlinkage of time use and women's ability to participate in income-generating activities, as well as training to strengthen their contributions to income-generating activities (Eissler et al. 2021).

Thus, some base level and forms of agency may be necessary for women to be able to participate in project activities that would benefit them or increase their empowerment. Identifying these linkages and baseline information about each of the aspects of empowerment can help projects to adapt their strategies, such as by ensuring that women have freedom of movement if they are expected to attend group meetings or training.

5 No qualitative study was conducted in Niger, the other Africa study in the JP RWEE portfolio.

Looking Beyond Agriculture to Market Inclusion

Our review of evidence draws from impact evaluations of gender- and nutrition-sensitive agricultural development projects. Yet, food systems go beyond agriculture and include processing and marketing of agricultural projects. Studies on women's empowerment in other nodes of the value chain are more limited, partly because of data limitations. We briefly highlight aspects discussed in Quisumbing and colleagues (2021b) and introduce new evidence from our efforts to develop pro-WEAI+MI (Malapit et al. 2023).

Njuki and colleagues (2022) find considerable evidence on the link between the consumer behavior component of food systems and women's empowerment and gender equality, especially women's roles in consumption and traditionally female activities such as food preparation and feeding children. The existing evidence on the food environment component, which includes food availability and affordability, as well as women's access to markets, points to women's relative poverty and limited freedom of movement as the primary factors constraining women's empowerment and gender equality. This conclusion suggests that successful value chain–focused interventions could also expand women's access to the food environment. However, evidence on value chains, the third component of food systems, and how they relate to women's roles, women's empowerment, and gender equality, is scarce (Coles and Mitchell 2011; Rubin, Manfre, and Barrett 2009). This is not surprising, because existing tools have focused mostly on the agricultural part of food systems. The limited literature focusing on women's involvement in value chains, both in traditional and high-value crops, has identified pathways whereby food system commercialization can increase women's involvement in specific activities, but this literature has not necessarily determined whether this leads to increased empowerment.

Interventions often aim to (1) enhance women's roles in agricultural value chains where they already operate, for example, by increasing their involvement in specific nodes or stages of the value chain with the potential for value addition, such as processing or marketing, and/or (2) expand opportunities for women to start operating within new value chains. While increasing opportunities for women's engagement in food system commercialization can improve equality and empowerment and is often correlated with increasing their control over income and, relatedly, bargaining power within their households (Rubin, Manfre, and Barret 2009; Getahun and Willanger 2018), the link between market inclusion and women's empowerment is not automatic. Moreover, it may be difficult for resource-poor women to fully participate in market-focused interventions, particularly without the support of asset transfers (Heckert et al. 2023).

It is therefore strategic to focus on how the value chains component of food systems relates to women's empowerment and gender equality. We draw on our studies in four countries with very different structural and social contexts (Bangladesh, Benin, Malawi, and the Philippines), where we use pro-WEAI+MI to analyze links between empowerment and value chain factors. Details of these studies are found in Malapit and colleagues (2023).

Our analysis across the four countries suggests that entrepreneurship is not necessarily empowering for rural women. In our Bangladesh sample, men in entrepreneurial households are more likely to be empowered, but women in those households are not. This may relate to gender norms in Bangladesh as well as the scale of the enterprise in which women entrepreneurs are involved. Small-scale enterprises with low returns (such as trading) may not be empowering. Greater involvement in the market is also not necessarily associated with gender equality. For example, in our Benin sample, a decrease in the amount of the household's main commodity sold was correlated with higher gender equality. Some commodities may provide more opportunities for empowerment. For example, high-return export sectors (such as seaweed in the Philippines) or commodities that do not require large-scale operations or that can be grown close to the home (such as swine in the Philippines), could reduce trade-offs between market work and domestic and care work.

In our samples, training and extension services are usually associated with greater empowerment but may differentially benefit men and women. In the Philippines, access to extension services had a stronger correlation with men's than women's empowerment. In Benin, receiving ATVET4W training was associated with a higher likelihood of only the man being empowered. In Malawi, receiving the ATVET4W training was not significantly associated with individual men's and women's empowerment, but it was associated with a higher likelihood that the woman is more empowered and that the man is less empowered, which may be a consequence of the proximity of the training to the survey and the types of couples selected for the program. In the Malawi sample, receiving other types of agricultural training was positively correlated with the probability of being empowered, with higher empowerment scores for both men and women, and with greater gender parity.

All in all, culture and context determine whether participation in value chains—and which node of the value chain—is empowering. This suggests that food system and value chain interventions that seek to empower women should consider the social and cultural contexts in which these food systems operate, so that interventions "do no harm" and do not exacerbate existing gender inequalities.

Implications for the Design of Gender-Sensitive Food Systems Interventions[6]

Although the GAAP2 and JP RWEE portfolios are quite different, and findings from pro-WEAI+MI are still emerging, there are common threads. First, intentionality is important if food systems interventions are to achieve their women's empowerment objectives. The large number of insignificant impact estimates highlights the need for projects to focus explicitly on empowerment rather than assume that projects aiming to reach and benefit women will automatically empower them. The two cases with negative aggregate impacts—a project in Bangladesh that had minimal gender content and JP RWEE beneficiaries in Ethiopia who lost credit access—underscore the importance of deliberate strategies to ensure that projects "do no harm" to women's empowerment. Comparing across regions, projects in South Asia were more likely to show significant impacts on women's empowerment than those in Africa, perhaps reflecting a longer history and more experience with designing programs to address particular forms of women's disempowerment. The negative impact on men's aggregate indicators in some African projects may be cause for concern, if these create potential for backlash.

Our findings also reinforce the need to pay attention to both project implementation and context. The mixed results of projects on tolerance of IPV illustrate the importance of both. In the homestead food production project in Mali, beneficiaries reported an increased number of instances in which IPV was not justified, indicating a heightened critical consciousness of what is (and is not) acceptable in spousal relationships. In the other projects, women's identification of fewer instances in which IPV is unjustified may indicate that women are willing to tolerate more instances of IPV in exchange for other types of freedoms. Qualitative findings from the Grameen project found that empowered women are perceived to be "autonomous" yet "submissive" to their husbands and families (Kieran, Gray, and Gash 2018). This is similar to Mosedale's (2014) finding that among the Afar in Ethiopia, women gain social status by submitting to IPV without protest, and that increase in status is associated with empowerment.

Moreover, programs may need to provide sustained exposure to the intervention to maximize the potential for projects to benefit and empower women. Those that are not sufficiently intensive in their approaches, such as community-based programs with selective uptake of multiple project components, may not provide sufficient exposure and have more limited empowerment outcomes, as may have been the case with a poultry project in Burkina Faso and a nutrition intensification program in India (Heckert et al. 2023; Kumar et al. 2023). Some base level of not only empowerment but, more importantly, resources needed to take up the interventions (time, material, information, and financial resources) may also be needed for projects to succeed. Findings across relatively "light-touch" projects suggest that in exceptionally poor contexts, women and their households need a baseline level of resources or potentially asset transfers to be able to benefit from or be empowered by agricultural development projects. This is particularly true in livelihood-focused projects that require significant capital investments.

We note that empowerment is also an ongoing and iterative process in which each stage in the process contributes to further empowerment; if this process is interrupted, then women may have difficulty further empowering themselves (Dupuis et al. 2022). The negative outcomes for women who lost credit access in the Ethiopia JP RWEE project provide a cautionary note in this regard.

Lessons learned from applying the RBET lens to evaluating the empowerment impacts of JP RWEE reinforce those learned from the GAAP2 portfolio. Similar to GAAP2, the JP RWEE synthesis suggests that future projects can *build on the successes of group-based approaches*. In all the countries, women's groups have been core to the success of the programs, helping women build social capital, participate in public spaces, and provide opportunities to express their views.

All development interventions also need to be *mindful of workload implications*. Many project designers assume that women have time to participate in

6 This section draws heavily from Quisumbing et al. (2022) and Quisumbing et al. (2023).

development interventions. Yet, even if impacts on total workload are largely insignificant, workload remains a barrier to empowerment, and women often reduce reproductive work to take on program activities. Promoting labor-saving technologies for reproductive work, providing childcare as a program component, and encouraging men to do care work may help reduce women's reproductive workload.

There is also suggestive evidence of the need to involve men in these approaches. Both portfolios (with a few exceptions) emphasized women's groups and creating a safe space for women to develop their skills and confidence. Where the intervention strategy explicitly included men, as with ANGeL in Bangladesh (Quisumbing et al. 2021a) and the Kyrgyzstan JP RWEE project (Quisumbing et al. 2023), we see strong impacts on women's empowerment. If men feel excluded from development programs that target women, there is a potential for backlash, with implications for program sustainability and empowerment results. Gender norms cannot be transformed by women alone, and future work should experiment with modalities that involve men actively.

Finally, designers of agricultural development programs should recognize that empowerment is multidimensional and that interventions that target only some aspects of empowerment may not achieve their empowerment objectives. To measure progress toward these goals, these programs should include empowerment measures as part of regular monitoring and evaluation activities; this will also allow practitioners to flag potential problems as they arise. Moreover, these measures should, like WEAI, be nuanced enough to detect differences across multiple dimensions of empowerment. Additional indicators may be needed to capture transformation of gender norms at the household and, more importantly, at the community and societal levels. Moving along the continuum from "reach" and "benefit" to "empower" and "transform" may increase the effectiveness of programs that seek to empower not only rural women but also their families and communities.

Policy Implications and Recommendations

Food systems transformation is catalyzing profound changes in many aspects of society, including both positive and negative effects on women's empowerment. In turn, there is growing evidence of the importance of women's empowerment for strengthening food systems, particularly in terms of child nutrition and diets and agricultural production (the evidence regarding women's own nutrition and diets is somewhat mixed). A better understanding of these linkages is important in designing interventions that support, rather than undermine, gender equity, leading to more productive and equitable food systems. The expanded gender and food systems framework (Njuki et al. 2022) identifies key factors to consider in understanding how structural gender inequalities can affect value chains, the food environment, and consumer behavior. The framework also calls for consideration of how women's agency, access to and control over resources, gendered social norms, and policies and governance arrangements affect the outcomes of food systems.

To achieve productive and gender-equitable food systems, interventions must go beyond reaching women to ensuring that women benefit, creating opportunities for empowerment, and ultimately contributing to gender-transformative changes in norms and systems. The evidence from quantitative and qualitative impact assessments shows that this is not easy, but intentional programming and investments that build on an understanding of the particular gendered constraints in each society can achieve results over time. While there is no single formula that works, gender-transformative programs work with both men and women to address harmful gender norms and systemic barriers that prevent women from fully contributing to—and benefiting from—food systems as producers, processors, and consumers.

Collecting gender-related data on the distribution of the costs and benefits of food systems transformation, as well as on women's empowerment at both the national level (for peer review, mutual learning, and accountability) and the project level (for evidence-based planning, implementation, and monitoring and evaluation, as indicated in the Malabo Declaration), is important for building the evidence base on what works (or does not work) and guiding future programming to be more effective in supporting women's empowerment as food systems transform.

CHAPTER 10

Bioeconomy: A Path to African Food Systems Transformation

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Background

Over the years, Africa's food systems have contributed to social and economic growth, creating avenues for job creation and employment, satisfying regional food and nutritional needs, promoting industrialization, and generating revenue to support regional efforts to advance and thrive. Currently, the food system employs more than 60 percent of Africa's labor force, with agriculture alone employing more than 225 million smallholder farmers, enhancing livelihoods and contributing to poverty alleviation (African Development Bank 2023; Galal 2023). Moreover, approximately 15–35 percent of Africa's gross domestic product originates from food systems activities, which are projected to increase in response to rapidly expanding agricultural activities (World Bank 2018). These contributions and the progressing dependence of the local economy on the food system amid increasing urbanization, demographic changes, and dynamics in consumer demands call for a transformation of Africa's food systems for increased resilience and continuous economic growth. While this food systems transformation agenda evolves, knowledge of the interlinkage between food system practices and the global sustainability crisis has revised the paradigm. Thus, the African food systems transformation agenda is currently restructured to run as a facilitative action that fosters resilience and supports economic and social growth without compromising efforts for intergenerational ecosystem conservation, that is, to enhance resource availability while supporting human and ecosystem health (Malabo Montpellier Panel 2022; APHRC 2021).

The complexity, overlapping and interlinked challenges, and heterogeneity of the food system mean there is no silver bullet to improving its sustainability. However, among the plethora of feasible solutions, bioeconomy has been marked as a pivotal trajectory for enhancing the food system's productivity potential and delivering sustainable products and services (Gatune, Ozor, and Oriama 2021; Nyarko et al. 2021). The narrative around bioeconomy has evolved, and the current metadiscourse positions it as a growth pattern that applies science, technology, and innovation (STI) for the sustainable production and valorization of biological resources and the creation of innovative products, processes, and biodiversity services across economic sectors (Kruger et al. 2020; Bugge, Hansen, and Klitkou 2016). Bioeconomy adoption is rapidly progressing globally due to the potential benefits of growth and sustainability in agricultural systems. Its global economic potential is valued at US$7.7 trillion[1] between now and 2030. Also, successful adoption is expected to promote industrialization and social change while minimizing planetary damage (von Braun et al. 2023; Ronzon et al. 2020). Some regions, such as the European Union, have already charted significant successes in bioeconomy adoption, with approximately 17.5 million new jobs generated and €614 billion accrual of value added in 2017 (Ronzon et al. 2020). Similar trends are noted for North America and Asia, which are advancing practices for the favorable social and economic benefits that bioeconomy attaches to their green economy pursuits (von Braun et al. 2023; Patermann and Aguilar 2018).

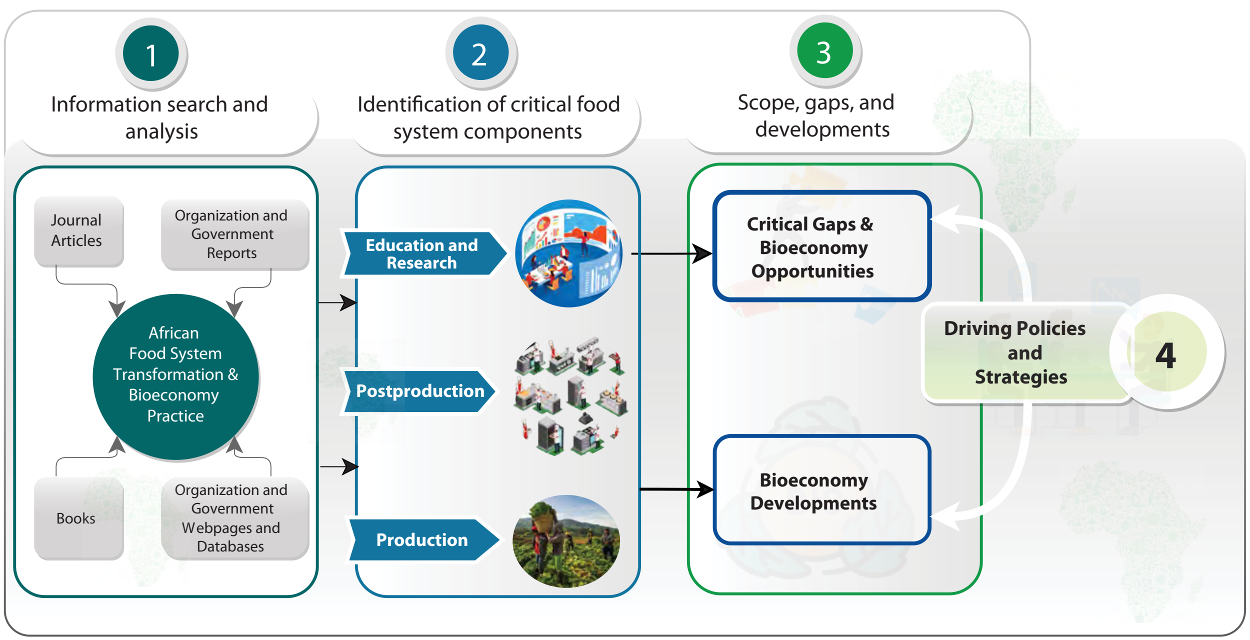
These discussions emphasize the prospects of the bioeconomy, encouraging Africa to embrace the concept in its sustainable food systems transformation agenda. Improved bioeconomy adoption can contribute to food and nutrition security, energy security, and economic and social growth. It could enable strategic policies and initiatives to align Africa's food systems transformation with local and global sustainable development commitments (Ronzon et al. 2020). The production and utilization of bioresources are not entirely new to the African continent. For instance, Africa has been a central agricultural hub, contributing immensely to the production, consumption, and export of major biomass such as cassava, yam, cocoa, coffee, sugarcane, cashew, livestock, and poultry (Erdaw 2023; Amole et al. 2022). Moreover, analysis of aggregated and regional economic data demonstrates Africa's agriculture and agrifood system as a core driver of economic growth (Fields 2023). These data reveal a regional readiness and potential to kick-start actions toward reinforcing continental bioeconomy engagement. Recent reports emphasize a growing interest in bioeconomy adoption in Africa, with structural reorientation, policies, and strategic actions leading efforts to accelerate practice (Malabo Montpellier Panel 2022; Ariom et al. 2022; East African Community 2022). For instance, South Africa, East Africa, and some parts of West Africa are promoting bioeconomic actions, including developing dedicated bioeconomy policies or strategies. However, actual fiscal investments are relatively low. Progress in some of these subregions has proliferated interest, prompting national and regional efforts to harmonize geographic advantages in bioresource abundance, research potentials, policies, innovations, and favorable

1 All dollars are US dollars.

demographic dynamics into designing and implementing bioeconomy models for a more sustainable food systems transformation (Bracco et al. 2018; Gatune, Ozor, and Oriama 2021; Oguntuase and Adu 2020).

In this chapter, we intend to ascertain the current direction of the African bioeconomy pursuit and identify the opportunities for advancing regional adoption and practice to augment the sustainability of the food system. The chapter is structured into three major parts. The first part briefly elaborates on the critical components of the African food system, highlighting current practices, systemic gaps, and bioeconomic actions driving revolutions in these components. The second part entails a region-wide overview of existing and emerging policies, strategies, and commitments to promote bioeconomy practice. The third and concluding part consolidates thoughts from local and global practice to underscore feasible recommendations for regional bioeconomy practice toward sustainable food system transformation. Figure 10.1 provides a graphical summary of the structural flow of this chapter. The findings in this chapter will be of regional interest, especially to African governments, policymakers, the private sector, development institutions, researchers, and other food system stakeholders interested in developing and implementing a robust bioeconomy framework for Africa's food system transformation and overall economic development.

FIGURE 10.1—STRUCTURAL FLOW OF THE CHAPTER



Source: Authors.

Critical Gaps and Bioeconomy Solutions in the African Food System

One strategy for successful bioeconomy adoption is the regional assessment of systemic gaps (Lühmann and Vogelpohl 2023; McCormick and Kautto 2013; Ronzon et al. 2020). Thus, understanding the current gaps in the African food system should be a priority in efforts toward successful bioeconomy adoption and practice. In this section, gaps in the African food system are discussed under three critical components, namely, research and education, production, and postproduction, guided by the classification of the food system wheel described by the Food and Agriculture Organization of the United Nations (FAO) (Nguyen 2018; APHRC 2021; Mitchell et al. 2021). Additionally, this section expounds on relevant regional bioeconomy pursuits to showcase how bioeconomy is being engaged to address the identified gaps.

Research and Education Gaps

Food system education entails augmenting knowledge acquisition, distribution, and practical implementation that drive the food system's health, sustainability, and resilience (Valley et al. 2020; Ebel et al. 2020). It follows conventional knowledge- and skill-dissemination methods, including developing and formalizing suitable curricula to enhance availability and access to food system knowledge and expertise. This formalized-curricula approach includes the theory-dominant curricula and the technical and vocational education and training curricula (Valley et al. 2020; Kirui and Kozicka 2018). The second method is through collaborative research, where experts or groups of interested stakeholders endeavor to diagnose the food system, gather information and evidence, and explore discoveries that can reshape policy actions and instigate innovations toward sustainable transformation (den Boer et al. 2021). Next is the informal distribution of this information through skills training programs, community engagements, and other outreach and extension programs targeting relevant food system stakeholders (Parmar et al. 2019; Ma et al. 2023). Regardless of the mode of dissemination, education is recognized as a significant component for catalyzing sustainable food system transformation, taking its provisions in building capacities of the local workforce and enabling inventions, businesses, and entrepreneurship for adaptation and success (Ebel et al. 2020).

Previous investment in African food systems transformation has not adequately harnessed the power of formal and informal bioeconomy education and research, directing little attention to related developments. These untapped developments include revising academic curricula, pedagogical structures, training systems, and collaborations to align food system educational structures with evolving bioeconomic plans and visions. For instance, a broad range of food-and-agriculture-related academic programs in several academic institutions are generic, static, and theory oriented; they are limited in enhancing the problem-solving, critical thinking, leadership, ingenuity, and managerial competencies of the local human resources for contemporary innovations and strategic bioeconomy development (Agbaje 2023; Mukhwana, Kande, and Too 2017). Moreover, the few with these characteristics have also suffered significant setbacks due to fiscal, infrastructural, and policy gaps in facilitating actions. A typical example is the current deficit in investment in complementary academic facilities, limiting practical experiences and appreciation of essential theories for real-world problem solving (Daniel and Bisaso 2023; Nwosu et al. 2023). Another critical concern with food system education is the relatively low participation of public and private institutions in informal food system knowledge extension and capacity building. Outreach, extension programs, and vocational and informal training are comparatively low, leaving most smallholder farmers, small and medium enterprises (SMEs), and other bottom-level bioeconomy players with little to no knowledge about the potential of the bioeconomy, ultimately limiting their interest and active participation (Greenberg 2017). Without a quick resolve to extend and sustain bioeconomy education to these stakeholders, the evolving African bioeconomy trajectory would risk stagnancy, given the domination of these smallholder farmers, SMEs, and bottom-level players in Africa's food system. This may be partly responsible for the slow uptake slow of the bioeconomy in the African region and the mounting pressure to source external expertise for regional bioeconomy development.

Aside from the shortfalls in bioeconomy education, Africa faces a critical gap in bioeconomy research, with a few subregions—particularly South Africa, East Africa, and some West African countries—gradually setting a new research paradigm. Most research engagements struggle to transfer insights or innovations to direct policy and strategic actions for addressing challenges in food security, ecosystem conservation, and sectoral sustainability. Driving these are the low regional investment in research and related infrastructure and existing friction in academic research and industrial needs. To support food system transformation and reinvigorate the needed economic diversification, the African food system research landscape should generally evolve as a supportive system that can strengthen the uptake and transferability of research outcomes in addressing real-world food system challenges (den Boer et al. 2021). Research policies and institutions should facilitate a transition from the traditional research approach into a policy-tailored and industry-relevant process. Fortunately, the growing political will and positive institutional response signals an opportunity to expedite this agenda. Moreover, the increasing number of well-trained and connected researchers and the gradually evolving pedagogical structure would support this research revolution (Daniel and Bisaso 2023). Africa must take the educational and research revolution head-on and invest heavily in fine-tuning the current academic and research structure to facilitate a competitive, progressive, and more sustainable food system transformation culture. This should be done purposely to support training in critical thinking, problem solving, and creativity and align the regional educational forum with regional bioeconomy and food system transformation goals, wherein capacity building for small- and medium-scale farmers, young people, and businesses should be anchored in such development. Next is a more elaborate discussion of the bioeconomy research outlook in Africa.

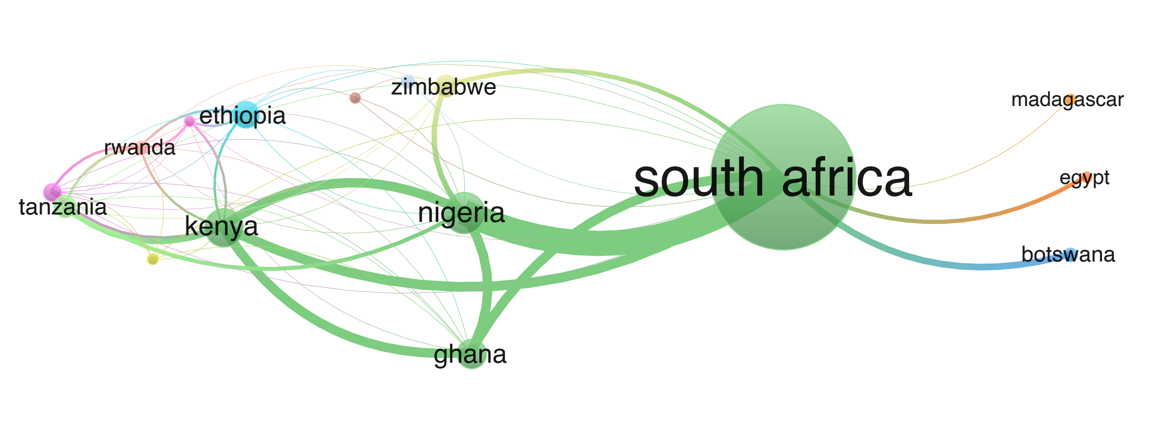
Current Research Outlook

A traditional bibliometric analysis was conducted to visualize the bioeconomy research outlook across Africa. Following recommendations on the reliability and comprehensiveness of the Web of Science, a systematic search was performed using search terms including *bioeconomy, biobased economy,* and *Africa*, computed using Boolean OR and AND binary operators (Wang et al. 2021; Raghuram et al. 2019). The initial output of approximately 8,000 literature works was further short-listed using customized searches to exclude non-African studies, conference presentations, proceedings papers, and other literature works irrelevant to the scope and subject matter. A text file with a total of 152 literature works compiled from published books, book chapters, review articles, and original research with information on the title, authors, abstract, keywords, citation counts, country, and organizations was exported and uploaded into the VOS viewer (version 1.6.19) to ascertain the knowledge structure of the retrieved literature. The insights drawn from the bibliometric analysis are visualized in Figures 10.2 and 10.3 and further elaborated in the following subsections.

Spatial Distribution

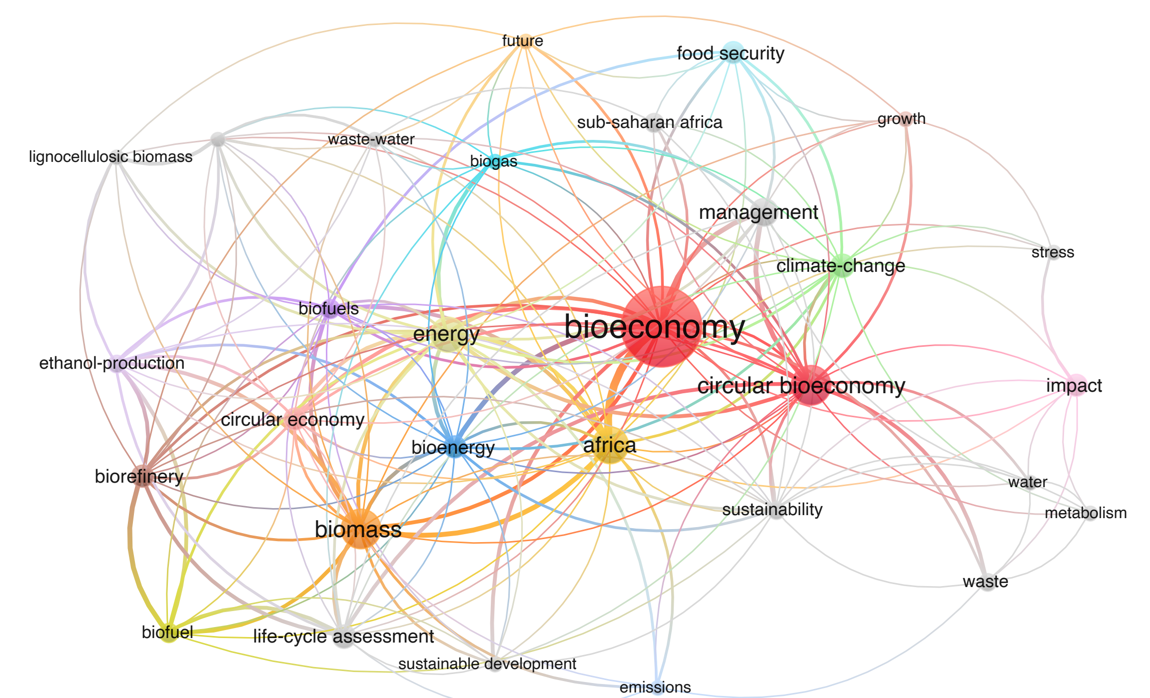
Figure 10.2 displays a regional bioeconomy research outlook, clearly depicting country-wise densities and link strengths. The diagram shows South Africa to be leading African bioeconomy research, with strong interconnection with other regions. Nigeria, Kenya, and Ghana are gradually following suit, and other regions, such as Tanzania, Ethiopia, Zimbabwe, Botswana, Rwanda, Egypt, and Madagascar, are slowly progressing. Although the identified trend shows that the bioeconomy is not entirely new to the African economy, it adequately contextualizes continental research loopholes. An imbalance in pursuit is captured through the high concentration of research activities in South Africa. Several driving

FIGURE 10.2—SPATIAL DISTRIBUTION OF BIOECONOMY RESEARCH IN AFRICA



Source: Authors.

FIGURE 10.3—KEYWORDS FROM BIOECONOMY STUDIES IN AFRICA



Source: Authors.

forces could be interlinked with such disproportionality, including governmental lack of interest in prioritizing research and development (R&D) in public policies and strategies, inadequate research support from governmental and nongovernmental organizations, lack of research infrastructure and/or expertise in the field of bioeconomy, and regional variances in food system priorities. The latter presents an interesting perspective on the bioeconomy discussion in Africa, highlighting possibilities of disproportionate regional adoption subject to variabilities in economic growth priorities, geopolitical inclination, and food system strengths. For example, regions with scarcity and economic stresses may prioritize adopting a bioeconomy to revolutionize their local food systems compared to those with thriving economies. Regardless, the prudence of centralizing bioeconomy as a practical sustainability and resilience action in the evolving African food system revolution is indisputable. Beyond its vitality in addressing waste issues, its criticalness as a feasible economic regime for predisposing food value chains to regenerative thinking should be emphasized in the emerging food system agenda.

Keyword Segmentation: Direction and Perception

The use of terminologies such as *circular bioeconomy, circular economy, sustainability, sustainable development, life cycle assessment, food security, management,* and *growth,* as shown in Figure 10.3, present essential viewpoints on the direction and perception of the bioeconomy in Africa. Regarding direction, using terms such as *circular bioeconomy* and *circular economy* aligns thoughts with the increasing inclination of the bioeconomy as a circular approach in the African context. Explicably, research seems to position bioeconomy as a narrative for breaking economic systems from the dominant linear economy. It appears to be a remediative solution for reducing the linear economy's overexploitation and waste generation nature by lengthening the materials' flow loop. Moreover, there seems to be a strong interconnection between the bioeconomy, economic growth, and sustainable development goals. The prominence of terminologies such as *growth, sustainability,* and *sustainable development* justifies this context. It reinstates the promotion of bioeconomy as a promising approach for achieving sustainable economic growth. Additionally, terms such as *food security* rightly capture the notion of using bioeconomy to improve the availability, accessibility, and utilization of food in Africa.

Progress in Bioeconomy Research and Education

Africa strives to be at the forefront of knowledge acquisition, transfer, and innovations concerning bioeconomy for transforming food systems. As such, several countries have made significant steps in integrating bioeconomy education and research into their educational streams to dissolve the knowledge gap and make education beneficial to their economies. Recent efforts have led to several reformations in the African educational system and talk of the ongoing restructuring to streamline curricula; deliver practical learning experiences; and equip local human resources, including students and workers, to lead relevant innovations (Malabo Montpellier Panel 2022). In this regard, a strong aptitude has been realized in designing an array of agriculture-related programs, including undergraduate and graduate curricula in agricultural engineering, agribusiness and economics, food engineering, food technology, and food science and technology, disproportionately distributed across African higher education institutions, that engage practical pedagogical approaches in their delivery (Malabo Montpellier Panel 2022).

Moreover, national actions are being implemented to foster vital collaboration between governments, academic and research institutions, and the food industry to align educational activities with national and regional interests in reforming policies, building human capacity, and promoting industry. For example, Namibia is gradually diffusing bioeconomy education and research through joint partnerships between universities and research institutions. A typical success is the collaboration between the Namibia University of Science and Technology and the Biodiversity Research Centre, which have successfully integrated relevant conservation topics into their academic programs and developed biodiversity-related research projects of national interest. The same is noted for the University of Namibia, which has also directed efforts into expanding biobased research that explores the therapeutic advantages of certain local plants in producing functional products for local food and health applications (Malabo Montpellier Panel 2022). In Ghana, the Food Research Institute of the Council for Scientific and Industrial Research (CSIR) is advancing bioeconomy knowledge and technological transfer from collaborative research projects to stakeholders such as the food industry, farmers, and entrepreneurs as part of their ambition to accelerate the adoption of innovative processes and efficient services for food system transformation. Generally, the African outlook portrays gradually progressing commitments to enable regional competencies in bioeconomy education and research, with a growing investment in facilities, equipment, and capacity building. However, there is a need to continually revise actions and realign engagements for education and research to constantly deliver the knowledge, competencies, and innovations needed to sustain the progress of the bioeconomy and enhance interest in related career fields.

Production Gaps

The food production and supply crisis in Africa is not unknown. Despite having the highest share of global arable land area and broad potential to expand production, Africa still faces extreme production inefficiencies, exacerbating food and nutritional insecurity, and an unstable food supply chain (Armstrong 2022; Giwa and Choga 2020). The situation interlinks strongly with several challenges, including unfavorable farm inputs, poor farm management practices, insufficient infrastructures, limitations in innovative production technologies, changing climate and land topographical dynamics, limited smallholder farmer access to services and support systems, and knowledge gaps among farmers. Gaffney and colleagues (2016) and Goedde, Ooko-Ombaka, and Pais (2019) highlight how the slow adoption of hybrid crops has interfered with the potential to maximize yield and satisfy food demands. The poultry and livestock sectors are also struggling to maintain pace with the growing global and local demand for animal-based products against a backdrop of inadequate feed production, poor market structure, inadequate investment and support systems, climate-change aggravation, and subtle herder-farmer frictions (Amole et al. 2022; Balehegn, Ayantunde, et al. 2021; Erdaw and Beyene 2022; Nkukwana 2019). A typical implication of climate change is the recent situation in East Africa, where approximately 2 million livestock were lost in a year due to recurring drought and marginal regional climate adaptation strategies (Dessalegn and Eziakonwa 2023).

While evolving trends project a tripling in food demand in Africa amid population growth and growing food insecurity (APHRC 2021; Dessalegn and Eziakonwa 2023), it is vital to innovate strategies to change current production dynamics and subvert strains on critical economic, environmental, and social boundaries as a timely action to enable a resilient, inclusive, and more sustainable regional bioeconomy. Goedde, Ooko-Ombaka, and Pais (2019) and Pius, Strausz, and Kusza (2021) project the potential to triple Africa's agricultural outputs across all commodities and increase global cereal and grains by 20 percent by increasing use of hybrid crops and fertilizer; raising investment in irrigation, storage, and other infrastructure; and improving regional trade. A regulated bioeconomy would deliver these benefits while respecting planetary boundaries (Sage 2021). The following subsections address some bioeconomic interventions to address the production challenges in Africa.

Bioeconomy in the Production Value Chain

A progressive bioeconomy plan encompasses intensified production and an adequate supply of raw materials. In this regard, several strategies have been developed in Africa to build local resource capacity for a thriving regional bioeconomy. This subsection discusses relevant production-related developments in the African food system that benefit crop yield, minimize sustainability challenges, improve farmers' livelihoods, and reinforce the capacity to supply the needed resources and services for a robust national and regional bioeconomy.

African Climate-Smart Agriculture

Climate-smart agriculture is a multibeneficial bioeconomy practice for increasing the resilience of agricultural systems amid climate change while reinforcing the capacity to catalyze national food security and economic development goals (Ariom et al. 2022). It is characterized by the potential to incorporate agriculture into social development negotiations by enabling a safe working environment for local farmers while alleviating poverty through income stability strategies. Climate-smart agriculture has gained significant traction in Africa, galvanized by the drive to enhance sustainable and regenerative agriculture. Minor but significant adaptation steps have been made by countries such as Algeria, Benin, Ethiopia, Ghana, Nigeria, Senegal, South Africa, and Zambia, with significant national variabilities in adoption rates, driven by the diversities in agricultural practices, inaccessibility to fiscal and technological resources, and other cultural factors (Persha, Stickler, and Huntington 2015). Such adaptations have popularized conservation agriculture, sustainable livestock production, forest and farmland regeneration practices, and weather and climate information services (WCIS) as effective bioeconomy practices for sustainably addressing the production, environmental, and knowledge access challenges in the African production chain.

Conservation Agriculture

Conservation agriculture entails minimizing the overexploitation of natural resources during agricultural production through integrated management approaches (Hobbs 2007; Kumawat et al. 2023). Through improved farming practices and technologies, it prioritizes the efficient use of soil, water, biological resources, and external agricultural inputs such as fertilizer and pesticides. Current practice involves minimum soil tillage, crop rotation, and cover cropping or mulching (Ariom et al. 2022). Several African countries have adopted this strategy in their agricultural systems. For instance, Benin is slowly substituting conventional farming methods with conservation agriculture, with the recent adoption and subsequent recommendation of no-tillage strategies in upland rice farming in northern Benin (Dossou-Yovo et al. 2016). Substantial benefits have been reported in net carbon loss, fertilizer use minimization, and minimized air and soil pollution using the no-tillage farming method. Similarly, Nigeria, Senegal, and Zambia have adopted conservation agriculture to address the exacerbating impacts of soil degradation and low fertilizer and pesticide inputs on crop yields and environmental pollution. Techniques such as composting, crop rotation, and no-tillage are expanding in regional adoption for their efficiency in improving crop yields even on poor soils while minimizing toxicity strains on the biosphere. In Zambia, for instance, mulching and crop rotation have been used to improve maize yield by approximately 21–38 percent. Regional adoption is widely increasing, with more than 250,000 farmers in Zambia practicing conservation agriculture (Ariom et al. 2022). Sack farming, wherein used storage sacks are used as pseudolands for vegetable farming instead of dumping, is also a prominent conservation agricultural practice in countries like Nigeria, with extended benefits in improving food availability, reducing climate impacts associated with landfilling and land use, and enhancing circular resource use systems (Ariom et al. 2022). The succulent production bioeconomy strategy is also noted in Namibia, aimed at improving soil health and increasing biomass availability by growing succulent plants on semiarid and degraded lands for food, energy, and material production (Malabo Montpellier Panel 2022). Overall, conservation agriculture has great potential to contribute to sustainable production and agricultural diversification and would benefit from increased investment and action.

Sustainable Livestock Production

Despite its low contribution to global livestock needs, African livestock production contributes significantly to global greenhouse gas emissions. For example, dairy milk production in Africa represents only 4 percent of the global market but contributes close to 10 percent of global methane emissions from the dairy industry (Balehegn, Kebreab, et al. 2021). This has triggered the increasing adoption of strategies that minimize greenhouse gas emissions from livestock production. The intent is to make livestock production as sustainable as possible to achieve bidirectional benefits in improving food and nutrition security and enhancing planetary health. Strategies such as seasonal migration of livestock into areas with natural forage and water abundance (pastoralism) (Koura et al. 2015), forage preservation for utilization in off-seasons (Jimoh et al. 2021), feed formulation from alternative feedstocks to minimize overexploitation of pasturelands and forestlands, livestock breeding programs to improve livestock resistance and productivity (Wilson 2018; Mohamed-Brahmi et al. 2022), and increased livestock health strategies such as live vaccination (Ezihe, Ochima, and Iorlamen 2020; Koura et al. 2015) are prominent bioeconomy strategies for improving sustainable livestock production in African regions. For instance, Benin, Nigeria, and Senegal are facilitating robust livestock vaccination campaigns to improve animal health and enhance production yield and quality. In addition, spatial livestock mobility practices have been adopted in these regions to manage grazing, reduce resource use, minimize demand for feedstock production, and lessen associated environmental and economic impacts. Algeria, Ghana, and Zambia also facilitate programs such as livestock breeding to enhance disease resistance and livestock growth and shift production systems that intermittently reshuffle breeds and production systems for continuous productivity. They also run an agropastoral farming system to manage grazing, minimize organic waste, and improve housing and feeding. There is also a renewed interest in biobased medicine innovations for livestock production in East Africa, wherein medicinal trees such as Prunus africana and Warburgia ugandensis are explored to deliver solutions to several livestock diseases (Virgin et al. 2022). The Kenya Agricultural and Livestock Research Organization is also leading the adoption of biobased pest and insect management techniques, such as the development of tsetse fly repellents and attractants from compound extracts from waterbuck to control tsetse fly proliferation (Virgin et al. 2022). These and many other emerging strategies demonstrate a progressive bioeconomy adoption in regional livestock production. However, regulated regional intensification plans are needed to expand adoption and balance national success (Ariom et al. 2022; Balehegn, Kebreab, et al. 2021; Wilson 2018).

Insect Farming

In Africa, insects have historically been a bioresource for food, feed, and other nonfood or feed applications. Recently, several African countries have explored the potential of insects to address the mounting pressure on the African food system to provide adequate and accessible food/feed against the backdrop of climate change and food insecurity (Babarinde et al. 2020). More than 500 insect species are currently consumed in Africa (Smith et al. 2021). Insect farming in East Africa is promising, given the growing national interest and political will to expand it as a climate-sensitive solution to satisfy the increasing protein needs for human food, aquaculture, poultry, and livestock production. The results from a recent survey implied a strong knowledge distribution among poultry and fish farmers (70–80 percent) in East Africa (Chia et al. 2020). Likewise, more than 75 percent of farmers and feed millers were willing to adopt insect farming as a climate-smart and profitable enterprise in feed production. The favorable legal environments for insect farming in East African countries support these interests. Currently, Kenya and Uganda have approved all potential edible insect species for food and feed applications and developed well-documented legal standards to facilitate mass rearing. This is anticipated to activate millions of dollars in economic benefits and enable several upcycling streams in feed, biofertilizer, and energy production from insects and their resulting bioresidues (Tanga et al. 2021). Rwanda is following suit, with legal approval and standard development under way (Tanga et al. 2021). In West Africa, Nigeria is gradually boosting entrepreneurship across the insect value chain, with several species, including palm weevil, cricket, bee, and black soldier fly, evolving in mass rearing for food and feed production (Ibitoye, Kolejo, and Oyetunji 2019). Ghana currently hosts about nine types of insect in this trajectory, and interest in farming and consumption is high. Southern Africa is gradually building momentum in the global insect trade, with mopane worms alone holding more than $85 million in market worth (Raheem et al. 2019).

Generally, insect farming is gradually rising in Africa as a sustainable farming culture for improving protein security while creating additional revenue and employment streams for farmers and industries. In ongoing practice, Africa is supposed to generate more than $2.6 billion and $19.4 billion worth of insect-based crude protein and biofertilizer from the rearing of black soldier flies (Tanga et al. 2021; World Bank 2021). This emphasizes the growing interest in the insect farming enterprise in Africa and an opportunity to back regional advantages in species abundance by enabling the business environment, partnerships, legal standards, and investment to enhance entrepreneurial interest and guide regional propagation of interest. Regarding partnerships, international organizations such as the International Centre of Insect Physiology and Ecology, researchers, and other farmers and farmer organizations have demonstrated efforts to guide adoption and drive progress (Chia et al. 2020; Tanga et al. 2021).

Forest and Farmland Regeneration Practice

Regenerative agriculture, claimed to be a net-positive environmental and social footprint option for agricultural intensification, is a gradually evolving practice in African agriculture (Amede et al. 2023; Newton et al. 2020). Countries such as Ghana, Kenya, Senegal, South Africa, and Zambia have recently deployed regenerative agricultural solutions to regulate climate adaptation, nutrient recovery, and resource use in agriculture and forestry. Strategies such as assisted natural regeneration, a promising long-term restorative approach that combines active human planting and passive restoration in recovering forestlands and minimizing soil erosion; agroforestry (silvopasture and agrisilviculture); tree crop planting; and biobased pest and disease control and nutrient management (such as neem pesticides, biofertilizers, biopesticides) are prominent in the evolving regional bioeconomy strategies (Kpolita et al. 2022; Nyasimi et al. 2014; Virgin et al. 2022). Benin, Senegal, and Zambia are leading an agroforestry trend that has adopted the planting of trees such as Faidherbia albidia and eucalyptus trees with crop production to improve soil health and crop protection while enhancing biodiversity and farm decarbonization (Fadina and Barjolle 2018). For instance, approximately 35 percent of every 120 farmers in southern Benin are engaged in practicing agroforestry and perennial planting, leveraging their sustainability benefits in land value recovery, yield enhancement, biodiversity improvement, and carbon emission reduction. Additionally, more than 11 million Faidherbia albidia trees are distributed across the Kaffrine region in Senegal as part of their regenerative agriculture and agroforestry agenda (Nyasimi et al. 2014).

Tree crop farming is also thriving as a green resolution to combat rapid soil and land integrity loss, characteristic of the traditional annual agricultural method (Molnar et al. 2013). Herein, perennial tree crops such as cocoa, oil palm, coffee, and cashew, which are more resilient, climate adaptive, and nutrient efficient, are cultivated on landscapes, mainly to restore or maintain their integrity (Gockowski 2019). In more recent developments, practitioners are exploring mixed-production tree crop systems and integrated tree crop, animal, and/or traditional annual agricultural farming systems as more sustainable strategies for meeting the expanding food and energy needs of the rapidly increasing global population (Roberts 2017; Gockowski 2019). This farming system is gaining significant traction in modern agriculture due to its restorative advantages, such as nutrient recycling and conservation, improvement of soil structure, water management, and natural carbon cycling, as well as its potential to contribute to satisfying rapidly expanding food and energy demand (Molnar et al. 2013). Currently, approximately nine African countries, including Cameroon, Côte d'Ivoire, Ghana, Guinea, Liberia, Madagascar, Nigeria, Sierra Leone, and Togo, have adopted tree crop farming systems at various scales, fueled by supportive research, investments, and regulations (Gockowski 2019). Considering the prospect of tree crop farming and the whole regenerative agriculture trajectory in a successful bioeconomy, it is expedient for Africa to set and enforce properly designed local strategies, policies, and associated commissions and enable a public-private interaction to instigate the regional drive.

Weather and Climate Information Services

There is surging regional interest in adopting improved weather and climate information services (WCIS) and geographic information systems to optimize crop yield and resource use (Ariom et al. 2022). Some countries are leveraging the potential of WCIS in sustainable fishing and livestock breeding, while others are expanding its benefits to smallholder farmers to streamline agricultural practices and maximize productivity. In close partnership with local and international agencies, Ghana and Senegal have also launched climate information services (CIS) to augment accessibility to climate and weather information. Complementary consultation and training programs to build the adaptive capacities of smallholder farmers to climate discrepancies and extreme weather conditions are also in action. The Senegalese Institute for Agricultural Research and CGIAR World Agroforestry Center, in partnership with government extension officers, are currently using an updated version of CIS, known as the Participatory Integrated Climate Services for Agriculture, which utilizes historical climate information, participatory decision-making tools, and seasonal climate forecasts to generate exclusive climate and weather information relevant to end users (Ariom et al. 2022; CCAFS 2015; Dayamba et al. 2018). Benin also uses a geographic information system–based CIS that evaluates and integrates biophysical factors in selecting suitable watering and irrigation strategies for improved crop yields (Danvi et al. 2016). However, many other African countries have not given sufficient attention to CIS. Taking the prospects of these systems in facilitating the national bioeconomy, regions that have not yet commenced exploration are encouraged to adopt such strategies in their bioeconomy plans. Overall, trends in WCIS adoption suggest a significant digitization gap in Africa's evolving bioeconomy, presenting an opportunity to incorporate digital innovations into enhancing regional bioeconomy development. Governments, policymakers, researchers, and other food system stakeholders could prioritize these digital trends in ongoing and subsequent bioeconomy strategies to enhance agriculture, fisheries, aquaculture, and forest activities and sustain these developments in a digitally evolving world.

Postproduction Gaps

Storage, Value Addition, and Waste Recovery

Postharvest losses are enormous due to inadequate infrastructure such as transport, storage, cooling, and processing facilities. For instance, about 30–50 percent of all foods produced in Africa south of the Sahara alone do not reach consumers' tables, primarily due to poor postharvest storage. Such losses are equivalent to the caloric requirement of approximately 48 million people and about $940 billion in annual economic loss (Intelligence Report 2017; Affognon et al. 2015). Reducing these losses could contribute enormously to addressing food insecurity in Africa as well as providing farmers opportunities to engage in price negotiation and increasing incomes. A thriving continental bioeconomy would demand significant efforts to revolutionize the postharvest value chain. Innovations for energy-efficient local storage, sustainable processing, advanced infrastructures, and waste upcycling to complement such evolution in bioresource generation cannot be overemphasized (Briter Intelligence 2022). For instance, Africa operates beneath the required storage capacity, with innovations and interventions slowly emerging due to financial and energy constraints.

Underperformance in the agro-processing sector spurs the exportation of most raw and semiprocessed agricultural outputs to advanced industrial regions and net importation of processed products at exorbitant prices into the local market. This denies Africa fiscal and social benefits that a robust value-addition chain can provide (Badiane et al. 2022). A typical example is the situation in the cocoa industry, wherein although Ghana and Côte d'Ivoire alone produce approximately 65 percent of global cocoa beans, less than 10 percent of total revenue from the cocoa value chain comes to Africa as a result of weak continental value-addition structures (Odijie 2021).

Another significant gap in the African postproduction chain concerns the underdeveloped waste value recovery component (Kissoon and Trois 2023). For instance, organic waste (food and green waste) represents approximately 40 percent of the total waste generated in Africa south of the Sahara—about 174 million tons annually as of 2016. This value is expected to triple by 2050 (Kaza et al. 2018). However, only a fraction of this waste biomass is utilized in high-value upcycling despite its vast potential for biobased food, feed, energy, and pharma products, with approximately 90 percent disposed of at uncontrolled dumpsites and landfills (United Nations Environment Programme 2018). Most African countries lack clearly defined value extraction patterns for utilizing such biomass, continually magnifying the consequences of waste generation, underutilization, and resource overexploitation on climate change, resource depletion, and biodiversity loss (Silva et al. 2023; Rubagumya et al. 2023). In the evolving African food system transformation, negotiating a revolutionary turn in postharvest storage, agro-industrial processing, and waste recovery actions would significantly advance the trajectory to promote a regional bioeconomy paradigm (Badiane et al. 2022).

Reliance on Unsustainable Materials and Energy

Until the recent surging exploration of modern energy to improve the sustainability of the gradually increasing agro-industry in a rapidly warming continent, traditional biomass has been the dominant energy source for most African small-scale industrial and household processing. For instance, in South Africa, approximately 96 percent of rural households and 69 percent of low-income urban households depend on fuelwood to cook and satisfy other energy needs (Shackleton et al. 2022). In East Africa, the rural population relies predominantly on traditional biomass such as fuelwood, animal dung, charcoal, and crop residue for more than 90 percent of total energy consumption (Wassie and Adaramola 2019). Likewise, Ethiopia sources 91 percent of its total energy demand from traditional biomass. The emerging aversion toward this current energy supply trend does not lie only in the apparent environmental impact on biodiversity, land use, and climate change boundaries but critically captures the aggravating implications on human health. For instance, indoor pollution from traditional fuel use in Kenya causes about 15,000 deaths annually of women and children, necessitating urgent intervention (Virgin et al. 2022). Aside from energy, packaging presents significant postharvest threats to the African food system. Currently, Africa consumes enormous quantities of plastics in food packaging and other economic activities, with regional annual estimates of approximately 20–32 million tons, of which synthetic plastics represent more than half of the supply (Babayemi et al. 2019; Africa Business Page 2022). This paradigm has a strong causal relationship with the rising incidence of global warming, biodiversity loss, and resource scarcity in the current African food system, connected strongly with the overexploitation of finite fossil resources for manufacturing such products.

In subsequent sustainability engagements, developing and implementing intelligent technological innovations would be necessary to cement the future of sustainable energy and plastic supply for African food systems. Unfortunately, a small percentage of investments are directed to the postproduction revolution, with current investments heavily sponsoring production intensification programs and actions. Africa needs to revise its investment and food system spending strategies. Regional investments in bioeconomy actions regarding storage innovations, sustainable material and energy production, and local value-addition strategies should be initiated, prioritizing the convergence and harmonization of intersectoral and multistakeholder capacities for radical success and growth. With these as core considerations in the ongoing transformation, several sustainability, economic, and socioeconomic benefits could be charted.

Bioeconomic Developments in the Postproduction Chain

As a complementary strategy to enhance the utilization of the increased bioresource and biomass availability stemming from improved production practices, some African regions are making quantum leaps toward adopting biobased practices and interventions (Bryne 2022; Pachón et al. 2018). This subsection discusses beneficial bioeconomy developments in the postproduction component of the African food system. It focuses on waste valorization and storage technologies, taking their preeminence in African postharvest challenges.

Agrifood Waste Recovery Strategies

Uganda hosts Africa's pioneering—and the world's third largest—green biorefinery plant under the EU African Bio4African project, which converts locally grown elephant grass into sustainable protein feeds (Bryne 2022). This plant has presented several economic, social, and sustainable growth opportunities. Through the successful replacement of expensive soy imports with locally produced high-quality protein sources in sustainable livestock feed production, the competition between feed production and human food needs has been minimized, offering advantages in improving food and nutritional security in the region. It has also created an additional national revenue stream and stabilized income for smallholder farmers and businesses by promoting local industry and enabling the trade of often undervalued waste. A similar biorefinery is expected to be established in Ghana as part of the Bio4African project, hinting at a rapidly expanding bioindustrial system in Africa (Bryne 2022).

Conversion of biobased materials into sustainable bioplastics is profitable in derisking plastic production from exploiting finite fossil resources and associated climate and biodiversity implications. Africa is strategically exploring the potential for sustainable food packaging with increasing regional engagements and acceptance of bioplastics in green economy negotiations (Olatunji 2022). For instance, the Council for Scientific and Industrial Research of South Africa has initiated a biodegradable plastic production pathway with novel bioplastic technology currently undergoing commercial licensing (CSIR 2023). The technology is expected to enhance the national drive to reduce plastic waste burdens and minimize dependence on fossil products in food and other industrial packaging (Malabo Montpellier Panel 2022).

There is also a growing regional drive toward sustainable energy supply, with significant success charted in establishing biofuel industries. For instance, Kenya is converting a dormant petroleum refinery in Mombasa into a biorefinery that would explore national vegetable oil waste for producing more than 250 kilo tonnes (kt) of aviation fuel and hydrogenated vegetable oil diesel per year (Financial Times 2023). This can significantly minimize food system carbon emissions through its consumer waste recovery strategy and provisions for substituting fossil fuels with low-carbon-emitting biofuels. Additionally, the biorefinery is expected to create more than 400 jobs and multiple income streams upon successful completion. In addition to the refinery conversion plan, the government of Kenya is supporting the establishment of a 50-kt-per-year bioethanol plant that would also utilize agricultural waste to produce low-carbon fuels, offering similar benefits in minimizing expenditure on fossil fuel importation, expanding organic upcycling and catalyzing the decarbonization of the national agrifood system (Financial Times 2023). In Kampala, Uganda, the popular Kampala City Abattoir, in collaboration with BioInnovate Africa and scientists from Makerere University, is running a novel pilot-scale upcycling technology for converting slaughterhouse wastewater into biogas as a sustainable waste recovery strategy. The technology produces approximately 60 cubic meters of biogas per day, enabling a monthly energy cost offset of approximately $3,000, among other environmental and social benefits (Virgin et al. 2022). Clearly, Africa is making giant strides in exploring the bioeconomy for postproduction resilience and sustainable transformation. However, there is a stronger need to address the standing imbalance in regional participation through defined regional strategies and responsible distribution, capacity harmonization, and well-regulated investments.

Innovative and Emerging Storage Innovations

Several companies have recognized the vitality of developing locally adaptable innovations to curb the long-standing gap in Africa's postharvest storage landscape. In the current technological ecosystem, the dominant smallholder farmers and SMEs cannot afford the upfront cost and energy demands of securing efficient cold storage facilities, hindering adoption and exacerbating postharvest loss. In bridging these financial and energy barriers, companies such as Solar Freeze, InspiraFarms, and Sokofresh of Kenya; Coldbox Store, Koolboks, and ColdHubs of Nigeria; FreezeLink and Akofresh of Ghana; and Kivu Cold Group of Rwanda, among others, have doubled their actions toward creating sustainable storage solutions to augment postharvest storage (Briter Intelligence 2022). Adding on to these technological breakthroughs are beneficial business models to enhance farmer patronage and stabilize the incomes of smallholder farmers and businesses. In Nigeria, Koolboks, a solar refrigeration service provider, pioneered a "cooling as a service" model that allows farmers to access efficient cooling services without worrying about the exorbitant upfront cost (White and Kore 2022). Through a lease-to-own strategy prefinanced by the company, smallholder farmers and SMEs can access services of efficient storage systems and distribute expenses across 24 months, after which they fully own the facilities. Additionally, the company provides exclusive postharvest management training to its clients to maximize storage efficiency, reduce postharvest loss, and stabilize incomes. Kivu Cold and Solar Freeze in Kenya run a similar model with varying value propositions. For instance, Solar Freeze has built mobile solar-powered cooling facilities that allow smallholder farmers and businesses in rural Kenya to access efficient cooling services at competitive prices (Briter Intelligence 2022; Kenya Climate Innovation Centre 2019). These trends promise a postharvest storage revolution to facilitate regional bioeconomy practice. However, the current trend demonstrates limitations in complementing the expected increase in production yield in a bioeconomy model, prompting regional investment into expanding existing storage innovations and models or establishing larger storage infrastructures to expedite postharvest storage actions for a successful regional food system transformation.

Bioeconomy Policies and Strategies

At this point, most African countries are in the early stages of developing the bioeconomy. However, the accelerating trend at the global level toward advancing the bioeconomy for sustainable development suggests the need to expedite actions in the African trajectory (Ronzon et al. 2020; von Braun et al. 2023). Lessons from regions such as Europe, Asia, and the United States have highlighted a strong correlation between successful practice and efforts in developing robust strategies, programmatic interventions, and radical symbiosis. These lessons emphasize the certainty of a dynamic and enabling policy environment for steering a thriving bioeconomy in Africa. A few successful bioeconomy strategies in advanced practicing regions include objective-oriented policy formulation; high investment in research, education, and innovation; multistakeholder capacity building; dynamic private-sector-mediated innovation; enabling an entrepreneurship environment; strategic bioeconomy trade and market management; and flexible regulatory framework development. By replicating, contextualizing, and scaling up these insights, African governments can develop robust and feasible frameworks that can face the complexities and diversities in practice and drive a more sustainable paradigm. A regional scan of Africa's bioeconomic development demonstrates an evolving momentum toward policy formulation and programmatic actions. Thus, this section provides a brief outlook of regional policy and strategy dynamics and highlights some relevant considerations that could stimulate success, learning from working actions in other regions.

Current Regional Policy and Strategy Outlook

The growing understanding of the prospects of long-term and stand-alone bioeconomy plans has spurred national and regional actions and renewed commitments toward developing robust bioeconomy plans, policies, or strategies that would advance participation in global biomass trade, foster integration into the global green economy, and reinforce actions toward economic and social freedom. Thus, several countries, including Ethiopia, Ghana, Kenya, Rwanda, South Africa, and Uganda, are transcending the mere integration of bioeconomic actions into general development plans, to develop stand-alone bioeconomy plans that drive properly designed policies and strategies to direct focus and accelerate short- and long-term success.

East Africa has demonstrated particular leadership, with its well-documented East African Bioeconomy Plan that captures the creation of new and improved biobased products, enhancing value addition and innovative utilization of bioresources and creating alternative sources of food and feed, health bioenergy, and ecosystem services in its scope. This plan binds East Africa's food systems transformation agenda to a defined bioeconomy model, focusing on and accelerating strategic actions to address pertinent challenges. The South African Bioeconomy Plan portrays a similar drive, positioned to contribute in a major way to the national gross domestic product by creating and growing novel industries that generate bioresources and develop biobased products, services, and innovations (East African Community 2020). Following the developments in East Africa, West Africa could leverage the growing national interest to develop a West African Bioeconomy Plan that would guide national adoption and practice and expedite progress through joint actions and partnerships. West African countries such as Ghana, Nigeria, and Senegal are already on a promising path to developing stand-alone national plans. While these segregated plans are useful, it is even more prudent and beneficial to consider bioeconomy adoption at theat the regional and continental scales. Thus, Africa should envision a continental bioeconomy plan that harmonizes national capacities into an interconnected and adaptable regional bioeconomy forum for driving a shared regional food system transformation and overall economic growth, which could be defined as a shared African bioeconomy plan.

Embedded in these bioeconomy plans are several tailored policies and strategies to drive the success of the multicomponent regional bioeconomy structure. For instance, Benin, Ghana, Namibia, Nigeria, and Senegal have developed and are pursuing tailored bioeconomy-related policies and strategic frameworks to enhance crop and animal production and sustainable utilization. In Ghana, the Ghana Shared Growth and Development (I and II, 2010–2017), Food and Agricultural Sector Development Policy (I and II), and Climate Smart Agriculture and Food Security Action Plan closely explore bioeconomy visions in sustainable food system transformation (Malabo Montpellier Panel 2022). Namibia's Vision 2030, National Biodiversity Strategies and Action Plan, and National Development Plan 5 outline patterns for modernizing agriculture, sustainably utilizing bioresources, and improving intra- and interregional trade and markets (Malabo Montpellier Panel 2022). Africa Sustainable Livestock 2050, a policy initiative for exploring attainable actions to regulate the economic, public health, environmental, and social benefits of the African livestock sector, is also at play in Burkina Faso, Egypt, Ethiopia, Kenya, Nigeria, and Uganda (FAO 2023). This agenda is steering significant success in the African livestock industry, considering improvements in production and productivity and improved investment in sectoral value chain research, innovation, and development since its inception (FAO 2020, 2021, 2022).

Also in action is the Science, Technology, and Innovation Strategy for Africa 2024, which is developing priority STI strategies to lead a knowledge-based and innovation-driven economy (Kahn 2022; van Heerden and Mulumba 2023; Makinda 2023). However, the strategy expires in 2024, making it prudent to consider the design of bioeconomy-targeted policy actions for STI development. Otherwise, such an idea could be incorporated into the renewal of the Science, Technology, and Innovation Strategy for Africa to create a definite direction for driving STI in the bioeconomy and other economic dimensions. This would enable a more tailored forum for knowledge creation and transfer, technology development, and innovations to direct a sustainable and progressive bioeconomy transition in the food, health, energy, and other sectors within the bioeconomy frame.

Sustainable Continental Bioeconomy Design

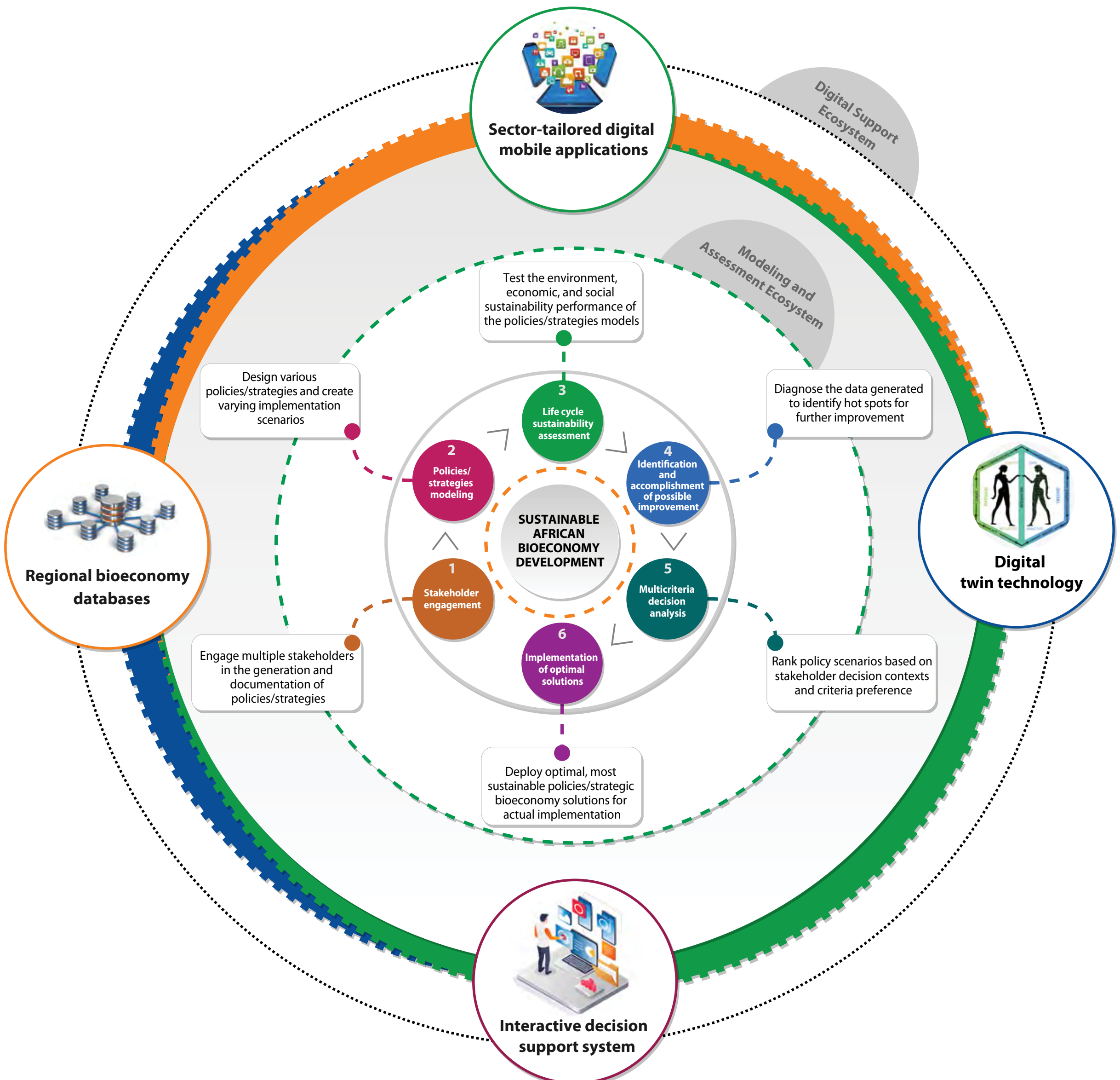
Whereas the previous sections have alluded to the potential sustainability benefits of a regional bioeconomy, it is essential to mention that the intersection of bioeconomy and sustainability is characterized by deliberate actions to deploy mechanisms and tools that would foster such sustainability (Malabo Montpellier Panel 2022; Aidoo, Romana, et al. 2023; Agyemang, Kwofie, and Baum 2022). Bioeconomy is not intrinsically sustainable; suitable approaches and decisions are required to activate and drive its sustainability potential. Thus, the discussion on bioeconomy in Africa should transcend the mere conceptual commitment to understand how to align practice with sustainability goals. Supporting this are the works of Aidoo, Kwofie, and colleagues (2023), Aidoo, Romana, and colleagues (2023), and Agyemang and colleagues (2023), which highlight the benefits of modeling and multidimensional analysis in improving the sustainability performance of intervention programs. In the authors' opinions, optimal and sustainable designs can be achieved when systems are robustly designed and tested multidimensionally. A summary of their mechanisms for sustainable policy decisions, system design, and intervention strategy involves the merger of stakeholder engagement, life cycle sustainability assessment, trade-off analysis, and multicriteria decision analysis, supported by interactive and statistical decision support frameworks and digital intelligence in optimal solution development and implementation. Engaging these mechanisms in the development of a robust African bioeconomy plan sounds promising and relevant considering their potential to enable optimal, feasible, and more sustainable bioeconomy solutions. Figure 10.4 visualizes the mechanisms that could be leveraged in developing a robust and sustainable African bioeconomy plan.

Bioeconomy Management System

A sustainable bioeconomy is as strong and relevant as the backing management system. Therefore, while regional momentum evolves toward bioeconomy development, it is vital to design and adopt a strategic management system to steer the delivery of economic, environmental, and social advantages. In this regard, important lessons can be learned from the evolution of economic management, which has emphasized the up and down sides of the two prominent management systems, top-down and bottom-up approaches, and underscored the positive interactions, compromises, and contrasts that exist for rethinking management in every system (Zuluaga et al. 2022; Kubickova and Campbell 2018; Cowell, Bissett, and Ferreira 2020).

Lessons from the current direction of economic management strongly compel the relevance of integrating the strengths of both top-level and bottom-level

FIGURE 10.4—AUGMENTING BIOECONOMY DEVELOPMENT WITH POLICY MODELING, SUSTAINABILITY ASSESSMENT, AND DIGITAL INTELLIGENCE



Source: Authors.

regional players in designing and executing a hybridized bioeconomy management system that would enable maximum participation and collaboration between public and private stakeholders, also called the co-management approach (Cowell, Bissett, and Ferreira 2020). This hybridized system could facilitate the establishment of regional public and private commissions that will harmonize their capacities in a regulated manner to drive sustainable and rapid adoption of bioeconomy. However, such a hybridized system should carefully consider the extent of stakeholder inclusion, available compromises, and geographic ideals to properly design objective-oriented policies and strategies backed by strictly enforced and flexible regulatory frameworks. In summary, subsequent bioeconomy engagements should consider the regulation of stakeholder interactions, be locally favorable, and be more objective oriented. They should also provide an enabling environment to stimulate grassroots initiatives, be appropriately coordinated, and encourage the joint emergence and diffusion of local bioeconomy innovations.

Conclusion and Recommendations

This chapter highlights the prospects of the bioeconomy in augmenting food system transformation and aligning food system actions with global sustainability commitments. It reveals critical loopholes in the African food system, underscoring significant production, postproduction, education and research, and policy gaps. Additionally, it outlines relevant bioeconomic interventions tightly bound to changing the dynamics in these components and fostering a progressive and sustainable food system transformation. Africa has shown immense progress in bioeconomy practice, given the expanding adoption of related actions in promoting agricultural production, value addition, and the development of adaptable technologies and services to drive resilience and sustainability in the food system. However, the regional distribution of engagements is skewed to a few countries, demonstrating enormous untapped potential in many regions and encouraging the need to nudge national engagements to strengthen sustainable economic and social development.

While accelerating national adoption is vital, an adaptable regional bioeconomy approach will enable cooperation, knowledge sharing, and technology transfer and interconnect biomass availability, biobased products, and services into a common bioeconomy forum. Thus, Africa should embrace the effort to integrate competing national efforts, harmonize fragmented national strengths, and proactively address geopolitical variabilities to develop an integrated African bioeconomy plan or strategy that enables a shared regional bioeconomy drive for sustainable food system transformation and employment generation. The prospects of the recommended integrated development can be likened to the success of the European Bioeconomy Strategy, wherein the shared bioeconomy goal among European countries has driven tremendous economic success, amounting to approximately €614 billion in value added and about 17.5 million related jobs.

Developing an Africa-wide bioeconomy strategy and accelerating successful implementation would require a series of national and regional diagnostic exercises, such as discerning and addressing the forces that exist at the innovation niche, sectoral regimes, and societal landscape, alongside the participation of regional stakeholders in driving policy actions, investments, and innovations. Governments and policymakers must be willing to take a hybridized approach that allows bottom-level but dominant stakeholders such as peasant farmers, SMEs, and young entrepreneurs to contribute to strategic and relevant policy development, regulations, and strategic bioeconomy actions. The national budgets must reflect the ambitions of regional bioeconomy development and subsequent implementation, and governmental actions must be directed toward enabling the political environment for a progressive change paradigm. The private sector, nongovernmental and civil organizations, research and academic institutions, and industry must similarly cooperate and radically collaborate to develop and drive a functional system that creates and utilizes innovative biotechnologies for continuous bioresource generation and creation of sustainable services and products. These would strengthen Africa's position in the global bioeconomy paradigm.

A regional strategy also informs the need to energize the innovation system to enhance investments in education and R&D. Such a strategy should consider science, technology, engineering, and mathematics (STEM) subjects, sustainability education, technical and vocational education and training, and indigenous knowledge as integral components of a regional bioeconomy structure that empowers students, young people, farmers, and enterprises with the knowledge and practical capacities to participate meaningfully in the evolving bioeconomy practice. Africa would benefit from directing targeted regional efforts, investments, and joint actions to reinforce region-specific, bioeconomy, technical and vocational education and training. This should be tailored to facilitate the development of relevant work- or skill-based competencies to complement the dominant knowledge-oriented workforce on the continent. Also, closer collaboration between higher education, research institutions, and the private sector can be facilitated to nurture research ideas and innovations into commercially valuable forms. In this regard, enhancing the financial sustainability of national research institutes through hybrid funding models that accommodate private-sector services and international development partners would be necessary for facilitating such collaborations across sectors and among stakeholders to augment bioeconomy research design and outcomes. It is important to stress the relevance of increased investment in R&D for the evolving African bioeconomy paradigm, given the knowledge demand for a more functional bioeconomy. Prioritizing and increasing R&D investments is needed to expedite and sustain a local knowledge and innovation cycle that consistently provides the relevant insights to create and enhance a more tailored, resilient, and inclusive regional bioeconomy.

Sustaining a regional bioeconomy drive would demand flexibility to adjust and realign focus to achieve desired sustainability outcomes. This includes embracing life cycle sustainability assessment, decision analysis tools, and other digital innovations in the development and implementation of a regional bioeconomy plan. The above discussions reflect the work required in a shared African bioeconomy plan, accentuating the significance of strategic management, wherein a hybridized bioeconomy management approach is suggested. With financial commitments, collaborative efforts, increased R&D investment, and leveraging of national and global experiences, Africa will be well-equipped to design and implement an African continental bioeconomy agenda.

CHAPTER 11

Data Challenges and Opportunities for Food Systems Transformation in Africa

Greenwell Matchaya, Tsitsi Makombe, and Neli Georgieva Mihaylova

Introduction

African food systems began to transform during the last decade in response to higher agricultural productivity growth, rising per capita incomes, a growing middle class, and rapid urbanization. Africa's emerging food systems transformation was also driven by changes in food consumption patterns (dietary transformation) and the growth of small and medium enterprises operating in downstream and midstream segments of food supply chains such as processing and distribution (Tschirley, Haggblade, and Reardon 2014; Reardon et al. 2015). These changes have contributed to greater availability and consumption of highly processed and high-calorie foods, which have been significant drivers of the growth in overweight and obesity and related noncommunicable diseases on the continent (Ecker and Fang 2016), as well as having far-reaching implications for nutrition and the sustainability of African food systems as a whole.

Today, the evolution of African food systems is being shaped by various exogenous shocks and challenges that range from extreme weather events and more frequent and damaging effects of climate change to recurrent pests and disease outbreaks, a growing number of conflicts, global economic and health shocks, and natural resource and environmental degradation. The COVID-19 pandemic and the Russia-Ukraine war have further laid bare the fragility and vulnerability of Africa's food systems through disruptions in global supply chains and trade, higher food prices, losses in incomes and jobs, and declines in dietary diversity that have exacerbated food insecurity and poverty (McDermott and Swinnen 2022; Badiane, Fofana, and Sall 2022). In 2022, the number of people experiencing hunger in Africa rose to about 282 million, which is almost 57 million more since the start of the pandemic (FAO et al. 2023). Africa as a whole is not on track to meet the Malabo Declaration's agricultural transformation goals by 2025 and the UN Sustainable Development Goal (SDG) 2 on ending hunger by 2030. Furthermore, progress toward food systems transformation has also been hampered by limited representation of indigenous and traditional knowledge systems, gender inequality, gaps in knowledge on the interactions among food system activities and components, incoherent policies, divergent interests and values among different food system actors, and the low prioritization of sustainability issues (von Braun et al. 2023; Singh et al. 2021).

Sustainably transforming Africa's food systems will not only require urgently addressing the above shocks and challenges but also harnessing the opportunities brought on by rising incomes, a growing middle class, dietary changes, an increasing youth population, and advances in digital technologies and technical innovation. Understanding what is meant by both food systems and food systems transformation is therefore critical to realizing this transformation. Food systems are defined as the range of all actors and interactions along the food value chain—from input supply and production to transportation, processing, retail, wholesale, preparation, consumption, and disposal of foods, as well as the enabling policy environments and cultural norms pertaining to food (IFPRI 2023). Furthermore, food systems transformation entails moving food system outcomes from a suboptimal state to a more optimal state by having food system actors adapt their activities in response to changing policy signals (Ingram and Thornton 2022) and thus help to ensure sustainable and resilient livelihoods and healthy, safe, nutritious, and affordable diets.

Transforming food systems requires a change in the mindsets and behavior of food system actors as they adapt their activities and assess (or reassess) food system policies. Likewise, the transformation of food systems will need to be buttressed by making data and analytics available and accessible to drive innovation and guide decision-making by food system actors across all food system activities, components, sectors, policies, and outcome areas (Nguyen 2018). More specifically, sustainable food systems transformation demands timely, high-quality, and reliable data and analytics that span the entire food system to (1) inform adaptation of food system activities by food system actors; (2) guide shared agendas, goals, and performance indicators around food systems; (3) enable evidence-based design, coherence, coordination, implementation, assessment, and reform of food system policies; and (4) guide review, dialogue, learning, monitoring, mutual accountability processes, and performance assessments of the transformation, including progress toward attaining desired outcomes.

Data and analytics are also critical for bridging knowledge gaps in food systems transformation, and science-policy interfaces (SPIs)[1] can play a critical

1 Science–policy interfaces (SPIs) are defined as social processes that include relationships between scientists and other actors in the policy process, and allow for exchange and co-development of knowledge with the aim of enriching decision-making (Van Den Hove 2007).

role therein. Singh and colleagues (2021) call for more efficient SPIs that (1) generate, collect, and integrate knowledge; (2) support forward-looking forecasting, modeling, and scenario building to support multistakeholder dialogues; (3) facilitate transferable lessons across food systems; and (4) spur global and local institutional capacity building. In turn, these SPIs should be anchored by the key principles of having credible data, peer review and reporting, a legitimate and inclusive process, the active participation of all stakeholders, and a focus on achieving multiple benefits (Singh et al. 2021). In light of the complexity of food systems, ensuring sustainable transformation will require not only available, accessible, and usable data but also SPIs that are well coordinated and coherent to guide activities, interactions, policies, trade-offs, and synergies across the food system.

However, the extent of data availability and gaps in data to inform food systems transformation remains an understudied area. Given the urgency of sustainably transforming food systems and the undeniable need for timely, transparent, and high-quality data to inform decision-making around the transformation process, this chapter assesses the data requirements for food systems transformation (that is, data demand) as well as key existing data initiatives and databases (that is, data supply) that can inform food systems transformation. More specifically, the chapter seeks to (1) highlight the importance of timely and high-quality data; (2) examine main data needs; (3) assess selected current data efforts; (4) highlight data gaps, challenges, and opportunities; and (5) provide recommendations for closing data gaps, addressing challenges, and harnessing opportunities in order to improve data for decision-making in food systems transformation.

Data Requirements for Food Systems Transformation

This section highlights the minimum data needed to effectively transform African food systems. This discussion is important for identifying gaps between the data required to transform food systems and the data that are currently available.

As highlighted in the introductory section, the concept of food systems transformation refers to transforming food system outcomes by way of food system actors adapting their activities in response to ever-changing signals and policymakers reassessing how policies are affecting signals that influence the behavior of food system actors (Ingram and Thornton 2022). Thus, food systems transformation is about fundamental changes that occur at various nodes or components of the food system as a result of several factors, including urbanization and population pressures as well as changes in incomes (Tschirley, Haggblade, and Reardon 2014). Data and analytics are needed to understand important food system dynamics including (1) changes in urban populations and per capita incomes; (2) large changes in consumption patterns and diets; (3) rapid changes in midstream and downstream segments of food supply chains such as processing, marketing, and regulating agrifood trade; (4) growth in rural factor markets, especially for agricultural services; and (5) changes in agricultural technology and in the size distribution of farms (Reardon 2013; Tschirley, Haggblade, and Reardon 2014).

Better data and analytics can also be useful in understanding any changes in the four pillars of the food system, namely: (1) food security, nutrition, and health; (2) socioeconomic factors; (3) environment; and (4) territorial balance and equity (see David-Benz et al. 2022). At a very basic level, therefore, a drive to transform food systems necessitates gathering data and undertaking analytics to track and examine the activities along the food value chain, from inputs to consumption, as well as how they interrelate.

This implies that understanding the food systems transformation requires specific data to assess various aspects of the food system, as well as what should transform, why it should transform, who should transform it, and how it should transform within the food system. Therefore, data and analytics are needed on (1) impacts of the food system on food security, nutrition and health, environment and climate change, socioeconomic factors, and territorial balance and equity; (2) causes of the impacts, including drivers and activities; and (3) stakeholders and actors that influence both positive and negative impacts on the food systems (see Mkwambisi et al. 2021) and all activities along the food value chain.

For example, with good data and analytics, the pervasive issue of environmental degradation and damage to ecosystem services—some of which can be attributed to aspects of food production, processing, and consumption—can be better understood, and through policy levers, food systems transformation can be engineered to minimize such negative externalities. Policies that enable the private sector to establish agribusinesses along all nodes of the value chain in response to changing consumption demands and patterns can speed up transformation with important positive implications for the entire food system. Food systems transformation also demands other sets of human capital skills, for example, in food processing, food labeling, and rapid food delivery. Timely data and analytics can facilitate policymakers' understanding of the state of human capital skills for food systems, which in turn, is important for a faster and more desirable food systems transformation.

Other relevant drivers of food systems transformation include access to water, access to information, and markets. Researchers and policymakers need data on access to food and information about food types, access to markets and financial resources for smallholder farmers, and the capacity of individuals and vulnerable groups to withstand shocks and stresses in the food system. In addition, the following issues will all need attention if the United Nations Food Systems Summit (UNFSS) action track propositions (see next section) are to be implemented successfully: metrics and measurement, human resources, governance, multisectoral planning capability, applied interdisciplinary research, and systems change capabilities (UN 2021c).

Data and Analytics to Inform Food System Action Tracks and National Food Systems Transformation Pathways

Timely data and analytics are needed for countries to successfully implement their national food systems transformation pathways and the UNFSS action tracks. The UNFSS developed five relevant action tracks to guide countries' and other players' thinking on food systems (UN 2021c). These action tracks represent some of the desired outcomes that should emerge from a transformed food system and also the shifts that must be undertaken to achieve transformation. The five tracks are (1) increase access to safe and nutritious food for all; (2) shift to sustainable food consumption; (3) boost nature-positive production; (4) advance equitable livelihoods; and (5) build resilience to vulnerabilities, shocks, and stress. Guided by the action tracks, several African countries have developed national food systems transformation pathways that will require data and analytics to inform their effective implementation.

For instance, to successfully transform food systems such that there is an increase in access to safe and nutritious food for all, countries need data and analytics that inform decision-making around the types of food eaten by different subsets of the population; their affordability, safety, and accessibility; and all the indicator groups outlined in Table 11.1.

Similarly, up-to-date and closely monitored data on food policies, food environments, and food loss and waste (Table 11.1) are all critical to understanding whether food systems are transforming toward sustainable consumption. Assessing this is critical for corrective action.

Further, if governments and stakeholders in general are to understand and make good decisions about their progress in transforming food systems toward boosting nature-positive production, then monitoring and evaluation is critical and, therefore, good data must be collected and analyzed on greenhouse gas (GHG) emissions from the food system, ecosystem health, energy use, production, and all the activities in the food system value chain. Similarly, there can be no successful advance toward equitable livelihoods in food systems without guiding data and analytics for decision-making. To achieve this transformative shift, data and analytics on livelihoods for different subpopulations, employment types, inclusion, income distribution, and other areas are needed to guide decisions. Last but not least, better and timely data are needed if countries are to achieve the ambition of transforming food systems toward building resilience to vulnerabilities, shocks, and stress. Thus, analyses and data on household resilience over time, during different crises, and across different geographical locations (Table 11.1) are critical to understand whether such a shift toward food system resilience to vulnerabilities and stress is happening, and to take corrective decisions if not.

Food System Levers of Change

For food systems to transform, the policies, technologies, and science affecting them must change, leading to shifts at each stage of the food value chain (production, processing, distribution, and consumption). A lever of change can be understood as an area of work that has the potential to deliver wide-ranging positive effects beyond its immediate focus. In the context of the UNFSS, four levers of change have been identified: human rights, gender equality and women's empowerment, finance, and innovation (UN 2021b). The levers are fundamental in establishing pathways to sustainable and equitable food systems by 2030.

To move toward transformed food systems, policymakers need to understand the status of these policy levers in addition to the action tracks, outcomes, and drivers of change. This implies that analysis of data on levers of change is needed to capture the state of these elements over time, across groups of stakeholders, and across other disaggregated categories in order to make informed decisions.

A minimum amount of data is needed for each of the highlighted UNFSS action tracks and levers of change, including those summarized in Table 11.1. Table 11.1 is critical for food systems transformation because it highlights some of the key types of data that should be tracked to understand what should change in food systems (diets, consumption patterns, nature of production patterns, equity and distribution, and resilience to vulnerabilities), as well as how the change should happen (using levers of change). Similarly, Table 11.2 presents key types of data needed to analyze and understand where the changes should take place in the food system (food system activities including production, food processing and packaging, distribution and retailing, and consumption).

Production requires data on inputs, technology, and land laws, among others, while food processing and packaging require information on raw materials, standards, storage, and other types of technologies. Food distribution and retailing require data on means of transportation, roads, and information technology, among others, and food consumption requires data on acquisition

TABLE 11.1—DATA NEEDS FOR FOOD SYSTEM ACTION TRACKS AND LEVERS OF CHANGE

Action tracks					Levers of change			
Access to safe and nutritious food for all	**Shift to sustainable consumption patterns**	**Boost nature-positive production**	**Advance equitable livelihoods**	**Build resilience to vulnerabilities, shocks, and stress**	**Human rights**	**Gender equality and women's empowerment**	**Finance**	**Innovation**
• Access to nutrition information • Prevalence of over-/ undernutrition • Access to nutritious food • Share of vegetables and fruits in diet • Cost of a healthy diet • Diet quality • Nutrient supply and demand • Food safety	• Food waste • Postharvest food losses • Affordability • Sustainability of diets • Food environment and policies	• GHG emissions from agriculture • Forest land being deforested for agriculture • Food loss across supply chain • Regeneration of ecosystems • Biodiversity and habitat index • Gene banks • Water footprint of foodstuffs and commodities	• Income inequality • Gap between farmgate price and wholesale price • Gender equity • Women's empowerment • Employment equity groups • Wage equity • Land tenure and security • Water access • Access to markets • Storage infrastructure • Social protection • Financial inclusion	• Household resilience capacity • Risk distribution by gender • Access to macro- and microcredit financial services • Government social security budget • Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index • Food production diversity • Incidences of storm surges, floods, droughts, and disease • Poverty and unemployment • School enrollment • Crop and livestock insurance	• Presence of food systems–related governance bodies and mechanisms • Political governance indexes • Transparency indexes • Corruption indexes • Land laws and institutions • Coordination among government systems • Skills in food systems	• Share of women empowered in agriculture (Women's Empowerment in Agriculture Index) • Youth as a share of population • Youth in agriculture • Gender inequality • Share of youth in high-value value chains (e.g., macadamia nuts, cashew nuts, cotton, tea, coffee, ornamental plants, and others)	• Financial inclusion for food system players – Share with access to finance – Share with bank accounts – Share with access to microfinance – Loan availability • Share of public spending on agriculture • Agriculture foreign direct investment	• Agricultural patents • Shares of improved crop varieties and livestock breeds in circulation • Investment in leadership, technology, and human resource capability • Investment in mechanization of production • Scaling up of sustainable technologies such as cold chain • Investment in nutritious dietary options

Source: Authors' compilation.

TABLE 11.2—INDICATORS FOR FOOD SYSTEM OUTCOMES, ACTIVITIES, AND DRIVERS

Food system outcomes			Food system activities				Food system drivers		
Social welfare	**Food security**	**Environmental security / natural capital**	**Production**	**Food processing and packaging**	**Food distribution and retailing**	**Food consumption**	**Biophysical drivers**	**Socioeconomic drivers**	**Natural drivers**
• Agricultural income per capita • Employment rates • Inequality • Wealth • Social capital • Human capital • Political capital • Over-/ undernutrition • Women-managed farm share • Share of food income to women • Share of women working in high-value crops • Life expectancy • Disease prevalence • Policies with institutions/ legislation support • Energy security	• Food availability • Amount of food production – Amount of food trade – Dietary diversityFood access – Price of food – Cost of a healthy diet – Inequality in food access – Share of land with fruits – Share of land with vegetables • Food security – Food utilization – Nutritional value – Proportion who consume nutritious foods – Food safety – Social value of food – Malnutrition	• Ecosystem flows • Ecosystem stocks • Ecosystem services available • Access to natural capital	• Natural resources • Inputs • Fertilizer per hectare • Labor productivity • Land productivity • Share of expenditure on agriculture • Technology • Agriculture patents, breeds, and varieties • Irrigation • Subsidies to agriculture • Market systems • Land laws and institutions • Food waste and loss	• Raw material availability • Quality standards • Storage infrastructure • Labeling and tracing • Strategic grain reserves • Supply chain robustness • Electricity availability and access • Processing capacity • Share with electricity • Postharvest technology • Food waste and loss	• Transport infrastructure • Marketing boards / mechanisms • Advertising prevalence • Status of value chain development and transport networks • Efficiency of food distribution systems • Postharvest technology • Food waste and loss	• Acquisition ease • Preparation ease • Nutrition content • Food and nutrition education • Food loss • Food waste • Access to a nutrient-adequate diet • Cost of a healthy diet	• Land cover and soils • Atmospheric composition • Water availability and quality • Climate variability • Notre Dame Global Adaptation Initiative (ND-GAIN) Country Index • Nutrient availability and recycling • Biodiversity • Temperature changes • Floods • Agriculture subsidies • Share of agriculture commercialized • Share of modern seeds in agriculture	• Demographics • Incomes • Inequality • Sociopolitical context • Cultural context • Science and technology • Input markets • Storage and transport infrastructure • Farming practices • Agriculture productivity • Gender differences • Agriculture research spending • Policy environment • Information gaps • Access to funding/finance • Commercialization of food production • Trade and other policies • Food price volatility • Land tenure insecurity • Macroeconomic stability • Climate change • Extension systems • Agricultural terms of trade • Governance and corruption • Illiteracy	• Volcanoes • Solar cycles • Floods • Droughts • Pests and diseases

Source: Authors' compilation.

of food, preparation, food loss and waste, food messaging, and costs of food, among others (Table 11.2). All these types of information are needed to engineer or understand food systems transformation and correct its trajectory if needed.

Table 11.2 also highlights key data needed to understand exogenous and internal drivers (in addition to the levers of change presented in Table 11.1) that can be leveraged to engineer changes in food system activities. The outcomes of a food system are shaped by many drivers that may fall into three broad categories, namely, biophysical drivers, socioeconomic drivers, and natural drivers. Biophysical drivers are those related to land cover and soils, atmospheric composition, water availability, climate variability, and temperatures, whereas socioeconomic drivers include all those related to actor characteristics, economic characteristics, trade, markets, employment, gender, and many others. Finally, natural drivers relate to phenomena that are exogenous and that actors cannot prevent from happening within a food production and consumption cycle—for example, volcanoes, solar winds, cyclones, and some floods. For food systems to be moved from their current trajectories, which are characterized by poor access to nutritious food for some people, stakeholders need evidence on which drivers can help spur production of the desirable goods, and, thus, data for these food system drivers are critical (Table 11.2). All these data must be collected and analyzed to understand and make decisions about whether the state of these drivers align with societal goals for food systems transformation.

Finally, Table 11.2 also highlights data that should capture the main outcomes of food systems transformation (improved social welfare, food security, environmental security/natural capital) to help understand whether transformative efforts resulting from stakeholders' use of drivers and levers of change across all food system activities are yielding better or desired food system outcomes. Any food system ought to be organized such that it can deliver certain objectives. These objectives may include the achievement of the five action track goals and other transformation pathways. Food system outcomes that are consistent with achieving many of these objectives can be grouped as social welfare, food security, and environmental security. Food system outcomes related to social welfare include those related to life expectancy, incomes of farmers, nutrition outcomes, and others (Table 11.2), whereas food security outcomes include those related to food access, food availability, and food utilization. Outcomes that fall under environmental security include those related to ecosystem flows, ecosystem stocks, available ecosystem services, and access to natural capital, among others (Table 11.2). To ensure that society understands whether food system changes are progressing in the right direction and whether better outcomes are emerging, tracking and analyzing the data types highlighted under the food system outcomes in Table 11.2 is critical, and stakeholders should maintain current databases for data in those categories, the specifics of which may depend on the stakeholders' actual food systems. The bottom line is that data and analytics on food system components are crucial for corrective action and general decision-making within food systems.

Data are also needed to assist decision-makers in understanding the trade-offs associated with their choices of solutions to the wide range of challenges facing food systems. This is important because each decision brings with it both benefits and costs, and analyzing those in advance can be useful in shaping food systems to maximize gains. Examples of these information needs include the need to increase and focus investments in targeted education (for example, around the advantages and disadvantages of different dietary patterns), as well as to ensure that relevant information is provided. Information should help all concerned to assess the value of different options, such as prioritizing producer livelihoods over regenerating natural resources, or saving the best produce for export rather than using it for domestic consumption (UN 2021a).

It is important to note that the indicators in Table 11.2 can be disaggregated at various levels, including national, provincial, community, and district levels, depending on data availability. Ultimately, for food systems transformation to be achieved, tracking this information at various levels of society is critical. Since the universe of indicators useful for food systems transformation is large, narrowing down the priorities from the lists provided here is a task that should be accomplished by each country in consultation with experts and stakeholders in the area.

Data and analytics are essential for decision-making in other ways, too. For example, when nationwide production of nutritious crops is low compared to consumption demand, better food system analysis using data from food system databases could serve to guide policymakers on the extent of this deficit and the location-specific variations in food availability within the country. This information could be used to make decisions about what levels of food imports or in-country distribution the country might need, as well as where to distribute it to meet the deficit. Further, in cases where it is important to maintain sustainable production of food, rich datasets on what food products a country or locality produces, what inputs are used, and to what degree such inputs are used can help in calculating GHG emissions and water consumption by production activities. Equipped with such calculations, policymakers can make decisions on what to grow more or less of in order to transform production to nature-positive levels. Without better data or deliberate efforts to gather food systems data, such transformations may not be feasible. At the farm and agricultural commodity aggregator level, data on variety-specific productivity, technology effectiveness, costs, transportation margins, infrastructure, markets, access, and affordability are all important for driving decision-making. For example, if available seed varieties are of low productivity, but real-time data reveal that neighboring markets have better and adapted varieties, farmers can use this information to acquire better seeds.

Biermann and colleagues (2021) provide further pointers on how food systems data can be used. Some examples of the usefulness of food systems data and their analysis include situations in which data inform policies to control poverty and food insecurity. Carefully analyzed data can shed light on the characteristics of households with the lowest levels of well-being, and interventions can be developed to target such households. Food systems data may also be used to prioritize policies that support hugely diverse smallholder farming systems by identifying generic patterns (Frelat et al. 2016). Again, through the use of machine learning and artificial intelligence, food systems data can be analyzed to predict future food production, thereby helping policymakers to make decisions in advance about food imports and input purchases, and in the process reduce the strain on food systems (see, for example, Ly, Matchaya, and Dia 2023).

Food System Actors and Stakeholders

Food systems transform as a result of decisions (coordinated or not) of actors carrying out activities, either as policymakers or players across the various nodes of the food system value chain. One challenge with the current state of food systems is that stakeholders take a siloed approach, and, more often than not, other key actors are not involved in making decisions that have systemwide repercussions. Food systems are largely structured by private sector actors, be they farmers, food manufacturers, traders, retailers, or food service providers. Key stakeholders include actors at the various nodes of the value chain, including input suppliers, producers, processors, transporters, retailers, consumers, and policymakers at various levels of government. It is important to collect data on who these stakeholders are and their influence and roles at various nodes of the food value chain in order to understand the degree of stakeholder coordination and increase the likelihood of leveraging them to advance a healthier food system. Stakeholder data may also help in identifying the components of the food system that each actor is involved in and individual interests in policy changes. Data that can help track food system actor decisions and activities are crucial for achieving food systems transformation.

Cross-Cutting Food System Issues

Various cross-cutting issues and themes also need due attention, such as gender and youth, trade, and policies. Data for such cross-cutting issues are necessary to analyze issues that may advance or undermine food systems transformation. In particular, gender- and sex-disaggregated data are important for assessing the contributions of women and girls to food systems and improving their welfare and gender equality. Yet, according to Open Data Watch (2023), gender data are much less available than nongender data categories. Thus, improving the availability and accessibility of gender data will require a concerted effort, including collecting data at both the household level and the individual level to better capture intrahousehold inequalities; prioritizing sex-disaggregated data in data collection and analysis; providing technical assistance to help countries collect and analyze sex-disaggregated indicators; and linking data producers and users to improve data use (Buvinic and Carey 2019).

Selected Data Initiatives and Databases: Strengths and Limitations

The need for accurate and timely data and statistics has grown as the world increasingly adopts a food systems approach to development that endeavors to recognize the importance of many sectors and actors acting together to determine food outcomes. Despite their vital importance, statistical data on the agrifood sector are scarce in many countries, with partial coverage and quality issues. African countries and their development partners are working together to produce more reliable data and statistics as well as to make them more accessible.

The analysis of food systems and their transformation requires many types of data beyond those related to the production of agricultural commodities and use of inputs. The following section discusses selected data initiatives and databases that can inform food systems transformation, with a brief overview of their strengths and limitations.

FAOSTAT Database

FAOSTAT is an online database maintained by the Food and Agriculture Organization of the United Nations (FAO). It provides access to comprehensive statistical information on food and agriculture from countries around the world.

In working directly with countries, FAO supports the development of national statistical strategies, the strengthening of their technical capacities, and the improvement of statistical systems. The database is organized by domain and contains data on a wide range of topics, including crop production, livestock, fisheries, forestry, land use, trade, GHG emissions, food balance sheets, the Food Insecurity Experience Scale, and public investments in agriculture.

FAOSTAT is an invaluable resource for researchers, policymakers, and others interested in food and agriculture. It offers a wealth of information on global trends, enabling users to track changes in production, consumption, and trade over time. The database is also used to inform policy decisions, such as those related to food security and sustainable agriculture. Overall, FAOSTAT is a powerful tool for anyone interested in understanding global food and agriculture trends.

Strengths

One of the main strengths of FAOSTAT is its comprehensiveness. The database includes data from more than 245 countries and territories, making it one of the most extensive sources of agricultural statistics available. Moreover, the data are updated regularly, ensuring that users have access to the most current information. Its user-friendly interface and extensive data coverage make it an essential resource for researchers, policymakers, and others seeking to make informed decisions about food and agriculture.

Limitations

The FAOSTAT database focuses mainly on information linked to agricultural commodity production, natural resources, and the role of women in agriculture. However, it does not cover in detail the entire food value chain, for example, transformation, packaging, and transport, or information linked to governance and macroeconomic indicators.

Living Standards Measurement Study: World Bank Survey Database

The Living Standards Measurement Study (LSMS) is a program initiated by the World Bank to support the collection of high-quality household survey data in developing countries. The LSMS program aims to provide policymakers, researchers, and development practitioners with reliable data to inform evidence-based decision-making and monitor progress toward poverty reduction and the SDGs.

The LSMS program was established in the early 1980s and has since supported more than 80 countries across various regions. It focuses on designing and implementing household surveys that capture a wide range of socioeconomic variables, including income, consumption, employment, education, health, and agricultural activities. The surveys employ rigorous methodologies to ensure data accuracy and comparability across countries and over time. The overarching goal of the LSMS is to foster and facilitate the development and adoption of new methods and standards in household data collection for evidence-based policymaking. An important component of the LSMS program is the Living Standards Measurement Study–Integrated Surveys on Agriculture (LSMS-ISA) initiative, a longitudinal survey with a strong focus on African agriculture.

Since 2008, the LSMS-ISA initiative has emerged as an exceptional model for (1) addressing national and international household survey data needs; (2) investing in methodological research with feedback loops into regular household survey operations; and (3) building the technical capacity of national statistics offices (NSOs) through on-the-job training, the introduction of innovative data collection technologies (including computer-assisted personal interviewing, GPS-based area measurement, and remote sensing and DNA fingerprinting–based crop variety identification), and involving the NSOs in an international program of validation of more accurate and cost-effective survey methods. The datasets from the LSMS-ISA generally allow for gender-disaggregated analysis, especially the LSMS+, which is designed specifically to produce data to facilitate such analysis.

To date, the LSMS-ISA initiative has engaged eight NSOs across Africa south of the Sahara in the design, implementation, analysis, and dissemination of national multitopic longitudinal household surveys that have a strong focus on agriculture and that are country-owned and integrated into national statistical systems. The financial and technical assistance, complemented by funding from national governments and numerous donor agencies at the country and global levels, has resulted in 33 surveys implemented, with more than 160,000 household interviews completed to date. The household survey data are made publicly available within 12 months of fieldwork. The LSMS program also supports policy research and analysis and methodological studies, with feedback engagement with policymakers.

The data from the LSMS-ISA and other LSMS-supported surveys continue to be important for monitoring progress toward some SDGs as well as other regional indicators. These data have informed policy discussions and program designs in various countries over the years.

In addition to the LSMS datasets, the World Bank maintains a global database of economic indicators and trends for all countries in the world. These data help meet many of the requirements outlined in Tables 11.1 and 11.2.

Strengths

The LSMS-ISA dataset provides valuable information needed for analyzing the socioeconomic and demographic indicators linked to small agricultural producers, a valuable input for food systems transformation analysis relating to nutrition, food availability, and poverty.

The LSMS datasets are freely available to the public, allowing researchers and policymakers to access and analyze the data for various purposes. These datasets have been widely utilized in academic research, policy formulation, and program evaluation. They have contributed to a deeper understanding of poverty dynamics, inequality, household behavior, and the impact of policies and interventions on living standards.

Limitations

Not all indicators needed for analysis of food systems transformation are included in the LSMS datasets due to the nature of these surveys, which collect data at the household level. Indicators on food transformation, transport, storage, and retail are not fully covered, except for employment; the rest of these indicators require specialized surveys at a level other than the household. Even though LSMS-supported surveys have been implemented in more than 80 countries, the LSMS-ISA surveys have limited country coverage.

The 50x2030 Initiative

The primary objectives of the 50x2030 Initiative to Close the Agricultural Data Gap are to increase evidence-based decision-making in agriculture by empowering 50 low- and lower-middle-income countries (L/LMICs), including about 30 in Africa, to build sustainable and strong national data systems that produce and use timely, high-quality agricultural and rural data through survey programs using sound and cost-effective survey-related methods and tools.

In many L/LMICs, limitations in the scope, quality, and frequency of agricultural data collection severely constrain effective planning, financing, and implementation of agricultural development policies. The gap in agricultural data in these contexts may lead to suboptimal policy design, which may result in failure to adequately address hunger and poverty. The 50x2030 Initiative addresses these problems with the goal of promoting evidence-informed decision-making, especially to achieve SDG 2 (zero hunger) in partner countries. Embedded in the initiative, through its emphasis on capacity building and country partner ownership, is a significant contribution to SDG Indicator 17.18, which aims to boost capacity-building support to developing countries in order to increase the availability of high-quality, timely, and reliable data.

To close the agricultural data gap, the 50x2030 Initiative supports a flexible survey system that facilitates (1) computing SDGs and regional indicators (for example, a few of the Comprehensive Africa Agriculture Development Programme [CAADP] indicators); (2) timely reporting of national statistics and production monitoring; and (3) providing high-quality, integrated data for analysis and informed policymaking. The system builds on the experience of FAO's Agricultural Integrated Survey Programme (AGRISurvey) and the World Bank's LSMS-ISA program. Just like those programs, the Initiative is designed to be an integral part of national statistical systems. At the core of the 50x2030 Initiative is a data production component that supports the design and implementation of national data collection activities, integrating economic, social, technical, and environmental themes linked to agricultural production and rural development indicators. This allows for analysis of the drivers of agricultural productivity and linkages between sociodemographic characteristics, agricultural management practices, and productivity, among other policy-relevant relationships. Among the economic aspects covered are agricultural costs of production, marketing and finance practices, and productivity and farm income. In the socioeconomic domain, the initiative collects data on education, living conditions of people engaged in farm activities, intensity of agricultural activities, off-farm activities, and household income.

The data production component is supported by a methods and tools development component and a data use component. The methods and tools development component is directed at ensuring that the initiative promotes and incorporates innovation in data collection and develops and utilizes cost-effective data collection methods. The data use component aims to ensure that the data collection efforts supported by the initiative are informed by policy needs and that the data are effectively used for decision-making.

The minimum set of data to be produced from the 50x2030-supported survey programs will include the following indicators of the SDG agenda: volume of production per labor unit, by class of farming/pastoral/forestry enterprise size; average income of small-scale food producers, by sex and indigenous status; average income of small-scale food producers, by sex and indigenous status; proportion of agricultural area under productive and sustainable agriculture; proportion of total agricultural population with ownership or secure rights over agricultural land, by sex;[2] and share of women among owners or rights-bearers of agricultural land, by type of tenure.

Strengths

The initiative helps countries to produce high-quality data on the agricultural sector by using cost-effective statistical methodologies. The statistical programs are not limited only to agricultural production and use of inputs but cover economic aspects, production methods, innovations, use of technologies, access to markets, finance and insurance schemes, agri-environmental indicators, food loss, processing, and use at the farm level. The data are connected in an integrated system using international concepts and definitions, thus limiting the risk of releasing conflicting data.

With sustainability in mind, the initiative is designed to support a long-term survey program, with data collection taking place annually and continuous capacity building. The survey is envisioned to be integrated into a partner country's national statistical program rather than being a stand-alone effort. And under the 50x2030 Initiative, special attention is given to providing access to and use of the data collected. Open access to anonymized microdata and related documentation, a key principle of the initiative, maximizes the use and value of the data.

Limitations

It should be noted that the 50x2030 Initiative does not maintain a database, the objective being to support the development of NSOs and improve their ability to generate and disseminate a regular flow of quality agricultural data. However, the proposed survey program does not span the entire food system outside of farms. The initiative supports the agricultural survey program; thus, information linked to governance and macroeconomic indicators is not included. Another limitation is the relatively small number of countries (up to 50) that can be financially supported to produce data.

The Global Strategy to Improve Agricultural and Rural Statistics

The Global Strategy to improve agricultural and rural statistics (GSARS) was designed as a blueprint for a coordinated and long-term initiative to address the relative decline in the agricultural statistical systems of many developing countries. The GSARS aims at providing a framework that will enable developing countries to produce more and better agricultural statistics through targeted training and technical assistance activities.

The implementation of Phase 1 of the Global Strategy (2012–2018) has had a significant positive impact on the agricultural statistical systems of many developing countries. It has also demonstrated its ability to respond to the needs of evolving international and regional agendas. The overarching objective of Phase 2 is to build stronger capacity in national agricultural statistical systems for accountability reporting and policymaking, building on the foundations established during Phase 1. In this context, four main components have been identified: the first is the Strategic Plan for Agricultural and Rural Statistics (SPARS), which focuses on the implementation of appropriate mechanisms for ensuring long-term national statistical development. The second component relates to formal training, and it aims to improve existing human resources and management policies, strengthen the technical capacity of statistical staff,

2 If the sampling universe is appropriate, the survey can produce the related SDG Indicator 1.4.2: proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure.

improve graduate programs on agricultural statistics, and facilitate access to scholarships. The third component is cost-effective methods. To support this component, the initiative provides technical assistance on cost-effective methodologies, most of which were developed during Phase 1. Finally, the fourth component relates to data analysis and dissemination. This component aims to increase countries' data analysis and dissemination capacities, enabling them to compute indicators relevant for accountability reporting and policymaking.

The GSARS targets 25 African countries in three economic communities—the Economic Community of West African States (ECOWAS), the Common Market for Eastern and Southern Africa (COMESA), and the Southern African Development Community (SADC)—that will directly benefit from certain technical assistance activities and also contribute to the implementation of various activities in the countries.

Strengths

The GSARS establishes the foundation for producing high-quality official agricultural statistics by training NSOs and ministries in new statistical methodologies.

Limitations

The GSARS focuses exclusively on capacity development in agricultural statistics, not on generating statistical datasets. The program limits its objectives to focused training on SPARS development; the indicators linked to agricultural production, productivity, profitability, and use of natural resources; and statistical data dissemination.

Africa Information Highway Database

The Africa Information Highway (AIH) was developed by the African Development Bank (AfDB) as part of the bank's statistical capacity-building program in Africa. AIH is a mega-network of live open data platforms (ODPs) electronically linking all African countries and 16 regional organizations. The overall objective is to significantly increase public access to both official and informal statistics across Africa, while at the same time supporting African countries in improving data quality, management, and dissemination. The AIH is a response to the decision of the African Union Summit of 2012, which called upon the AfDB, the African Union Commission (AUC), and the UN Economic Commission for Africa to help African countries develop more effective data management and dissemination systems to inform national development policies and strategies.

The AfDB launched the AIH that same year to support members under the AfDB's ongoing Statistical Capacity Building Program. The bank hosts the ODPs and makes funding and training available for improvement and maintenance. Since launching the AIH, the bank has expanded the system to include a variety of topic-specific portals—energy, climate change, infrastructure, and health, among others—creating a one-stop center for capturing and sharing development data on Africa. The expansion program has included a notable addition of SDG Data Hubs to facilitate monitoring the implementation of the 2030 Agenda for Sustainable Development across Africa. It also includes a new portal system to meet the bank's own data needs for monitoring the development impact of its interventions in African countries and ensuring that these are aligned with its "High 5s" transformation agenda for Africa for the period 2015–2025.

Strengths

The AIH aims to be a reference database for the African region, maintaining all necessary data for program development and monitoring and evaluation, and it covers all African countries.

Limitations

The main limitations are linked to the updating of data by countries, since these updates depend on a regular flow of data. The AIH focuses on macroeconomic data and analyses. Similar to the previously discussed databases and data initiatives, some important aspects needed for food systems analysis are not covered, for example, commodity transformation, transport, and retail.

CAADP-Related Databases

The Comprehensive Africa Agriculture Development Programme (CAADP) is a continentwide African Union framework for accelerating broad-based economic growth and progress toward poverty reduction and food and nutrition security through an agriculture-led growth strategy. Since its adoption by African heads of state and government in 2003, a key principle of CAADP has been to promote the use of evidence-based analysis and reliable data to guide decision-making and performance monitoring. This principle is reinforced by CAADP's emphasis on improving agricultural sector governance through benchmarking, dialogue, review, and mutual learning and accountability. The adoption of CAADP was followed by the development of a CAADP monitoring and evaluation framework in 2008 for assessing implementation progress in resource allocation and the achievement of desired CAADP goals and targets. The framework identified a set of key indicators to monitor implementation processes and track progress toward meeting commitments and targets.

In 2014, African leaders adopted the Malabo Declaration, which broadened the CAADP agenda by introducing seven commitment areas: upholding the CAADP principles and values; enhancing investment in agriculture; ending hunger by 2025; halving poverty by 2025; boosting intra-African agricultural trade; enhancing resilience to climate variability; and strengthening mutual accountability for actions and results by conducting a biennial review (BR) of progress made across the seven commitments. The adoption of the Malabo Declaration was followed by the development of a new CAADP Results Framework (RF) for 2015–2025—with a total of 38 input-, output-, and outcome-level indicators—for measuring progress in CAADP implementation, including progress toward meeting the Malabo commitments. The CAADP BR process that was launched in 2017 further expanded and introduced additional indicators aimed at monitoring all seven Malabo commitments using the Africa Agriculture Transformation Scorecard. The CAADP BR has a total of 59 indicators, about 24 of which are drawn from the CAADP RF.

Strengths

Broad coverage of indicators: The 59 BR CAADP indicators span all seven Malabo Declaration commitments and are quite broad in their coverage. The indicators cover multiple food system activities and components, including food security and nutrition, socioeconomic factors, and environmental outcomes. In addition, CAADP indicators have progressively been expanded to cover new areas deemed essential and thus include more food system activities and components. For example, following the first BR in 2017 and the third BR in 2021, new indicators were added that include food safety, plant and animal health, severity of food insecurity, cost of a healthy diet, proportion of the population that is overweight or obese, and total GHG emissions from agriculture.

Digital platform for data entry and management: The electronic BR (eBR) is an interactive web-based data platform developed by AUC in partnership with the Regional Strategic Analysis and Knowledge Support System (ReSAKSS), to facilitate the collection, analysis, access, management, and reporting of BR data at the country, regional, and continental levels. It was introduced during the 2019 BR in order to address data reporting challenges encountered during the first BR in 2017, when countries had to manually enter data into a country reporting template that was then submitted to regional economic communities (RECs). The introduction of the eBR has improved the efficiency of BR data entry by countries through its user-friendly interface, and it allows other data users at the RECs and AUC to instantaneously review, validate, and provide feedback on the data. The platform includes a cloud database for data storage and analysis and allows for the automated generation of BR scores.

The eBR has been a major factor contributing to the success of the BR by improving data quality and the timeliness of producing the scorecard and related results used in preparing the BR report. The eBR has helped to create a time-series database that can be used to analyze agriculture and food systems transformation. In addition, the eBR has improved the rate of compiling, reviewing, and processing data, as well as data documentation.

Strengthened BR country data systems: In light of the data challenges underscored in each successive BR report, countries and development and technical partners have made targeted efforts to strengthen country data systems. For example, with funding support from the Bill & Melinda Gates Foundation, ReSAKSS has supported efforts to strengthen BR data systems in 10 target countries (Benin, Botswana, Burkina Faso, Kenya, Malawi, Mozambique, Senegal, Togo, Uganda, and Zimbabwe). The efforts have helped to improve BR data quality (data accuracy, consistency, traceability, and validity), fill data gaps through setting up data clusters, and build capacity through capacity-strengthening activities.

CAADP mutual accountability platforms that foster improved data quality: Mutual accountability is a management approach that uses performance information at all stages of the development process to make better and more effective decisions and to steer development efforts toward clearly defined goals. Under CAADP, mutual accountability platforms and processes, such as the CAADP BR and agriculture joint sector reviews (JSRs), have helped to ensure effective delivery and tracking of shared commitments, increased accountability, and improved performance. To be effective, mutual accountability processes demand timely, high-quality data to inform their dialogue, review, and accountability activities.

In addition, country BR data validation meetings have provided platforms to review and improve data quality before the data are submitted to RECs. The BR validation workshops bring together a broad group of country stakeholders from different sectors, including nonstate actors, to review and validate BR data. Follow-up meetings to review BR performance through JSRs have facilitated discussions on the policy and programmatic adjustments that countries need to implement to meet the Malabo Declaration goals by 2025.

Limitations

Data quality issues and data gaps: Despite efforts to improve BR data quality and fill data gaps, data quality issues and data gaps remain, as noted in all three BR reports (2017, 2019, and 2021). The data still have internal inconsistencies; BR data values also sometimes vary too much from other data sources such as the World Bank's World Development Indicators (WDI), and the scorecard methodology has limitations such as assigning a zero score for different categories of indicator values, including missing observations and no change in the value of a parameter. Furthermore, several countries still report missing data in their BR reports. For example, out of 51 reporting countries in the 2021 BR, 29 countries reported missing 10 or more data parameters.

Limited data availability: There are still several data gaps in the BR, as some required data are not available because they are not collected, while some important data are not yet part of the process. For example, the BR does not currently include indicators on processing, storage, transportation, and marketing, all important food system activities. In addition, several types of BR data have not yet been introduced into the national statistical system of many countries. In some cases, even if the national statistical system were to collect the data parameters, the periodicity of the data availability would not match the needs of the BR, which occurs every two years. Also, some BR-related data previously provided by international organizations are no longer available or being published. These sources include the index of countries' capacity to generate and use agriculture statistical data and information (Agricultural Statistics Capacity Indicators) that was previously provided by the AfDB, and some parameters on the Trade Facilitation Index previously provided by the World Economic Forum and the Global Competitiveness Index.

Inadequate data capacity at regional and country levels: The BR process has revealed limited capacity at the country and regional levels to collect, analyze, and use BR data, as well as weak monitoring and evaluation capacity. Technical capacity is limited; BR experts with the critical monitoring and evaluation and analytical skills necessary to lead the review, analysis, and computation of indicators are in particularly short supply. In addition, monitoring and evaluation capacity is particularly limited at the REC level, where RECs are charged with controlling the quality of BR data submitted by countries in their regions.

World Development Indicators Database

WDI is the World Bank's primary database consisting of time-series development data that cover 1,400 indicators and 217 countries, with data for many indicators extending back more than 50 years. The data cover a broad number of thematic areas, including poverty and inequality, population dynamics, education, labor, health, gender, agriculture, climate change, energy, biodiversity, water, sanitation, economic growth, income, trade, markets, transport, technology, debt, aid dependency, and migration.

Strengths

WDI is one of the largest databases with internationally comparable data on development covering many countries, and it includes regional and global estimates, a long time series, and multiple relevant themes. It features an interactive, user-friendly online database that makes it easy to navigate, query, and analyze the data. Users can generate and visualize data using charts, tables, and maps and can download bulk data in various formats along with their metadata and sources. The database is regularly updated when new data become available, typically once a year using data from officially recognized national and international sources.

Limitations

Data availability remains a challenge, especially in poor countries and for data that rely on household surveys, which can impact the quality of data in WDI. This is because in poor and fragile countries household surveys may not occur at all or in a timely manner with the desired frequency, which can create uncertainty about the direction of change in indicators. In addition, data comparability across countries and time is limited due to differences in the timing of surveys, sampling frames, and the quality and training of enumerators.

National Statistics Office Databases

NSO databases are the first points of contact for anyone looking for national or disaggregated data in a country. They play a central role in 1) collecting, analyzing, and disseminating data; 2) serving as the custodian of a country's official statistics and maintaining a country's database of socioeconomic statistics; and 3) establishing data standards, protocols, and best practices for the production, analysis, and dissemination of statistical information. Many countries update their databases regularly, with some indicators being updated every year (for example, cost of living, gross domestic product [GDP], inflation) and others every five years or more (for example, malnutrition indicators, livestock inventories, and household asset inventories).

It is beyond the scope of this chapter to analyze all national statistical databases from a perspective of food systems data needs; however, using search facilities at the International Water Management Institute Library, several of the databases were analyzed for possible strengths and limitations (Table 11.3). For this purpose, national statistical databases of six African countries—Côte d'Ivoire, Egypt, Ghana, Malawi, Mozambique, and Rwanda—were selected to represent the key geographical regions in Africa (northern, western, eastern, and southern) as well as the key colonial heritages (Anglophone, Arabic, French, and Portuguese), as many of these databases were inherited from the pre-independence period. It is clear from the search conducted that these databases manage large amounts of data relevant for food systems, including indicators on population, economics, unemployment, education, health, agriculture, environment, and governance (Table 11.3).

Strengths

Compared to other databases in a country, NSO databases, which are government funded, are often the most comprehensive in terms of indicators covered. They are also highly regarded as sources of credible data because of their rigorous data collection and archiving methods.

Limitations

A common limitation of NSOs is that updating of data depends on national budgets, and updates are often given low priority especially when countries are faced with economic challenges, which are frequent in Africa. Thus, while the databases may cover many indicators, they are subject to copious gaps, archaic data-gathering methodologies, and poor data maintenance and accessibility.

Despite their broad coverage, NSO databases typically do not cover many food systems activities such as agro-processing, transportation, food loss, food waste, water use in agriculture, nutrient content of food, and the costs of a healthy diet.

Data Dashboards and Platforms

In recent years, data dashboards have become increasingly popular, given their ability to present large amounts of complex data using easy-to-digest formats that support timely, informed data-driven decisions. Dashboards often provide visual displays of data from different sources in one place using charts, tables, and graphs that enable data to be easily and quickly understood. Dashboards are dynamic and interactive, can show near-real-time data, and present comprehensive overviews of complex and large datasets. Countries and their development partners are using dashboards to monitor implementation progress and progress toward achieving key goals such as the CAADP Malabo Declaration goals or SDGs, and to assess the impact of policies on outcomes. Today, a plethora of dashboards relating to food and nutrition security, climate adaptation, and food systems exist at the national, regional, and global levels. A few examples of existing dashboards are discussed after Table 11.3.

Food Systems Dashboard: Several dashboards have been developed to inform and guide food systems or different elements of food systems. For example, in 2020, the Global Alliance for Improved Nutrition and Johns Hopkins University launched the Food Systems Dashboard, which assembles data from multiple sources to give users an overview of food system components (drivers, food supply chains, and food environments) across countries and regions. The Food Systems Dashboard helps users identify and prioritize ways to sustainably transform food systems (GAIN 2023).

TABLE 11.3—SELECTED DATA INITIATIVES AND DATABASES: COVERAGE AND LIMITATIONS FROM A FOOD SYSTEMS PERSPECTIVE

Data initiative / database	Selected indicators covered	Indicators not expressly covered
FAOSTAT	• Gross domestic product (GDP) and agriculture value added • Temperature change statistics • Food security indicators: food availability, access, utilization, and stability of food for different populations • Agricultural production and input statistics: water-related statistics, food loss and waste, and many more (Quality varies from country to country, as does frequency of updates for some indicators.)	• Agro-processing • Transportation • Financial inclusion • Food processing and packaging • Nutrition
50x30 Initiative	• National indicators needed for agricultural and development policies and food loss reduction • SDG 2: zero hunger – SDG 2.3.1: labor productivity growth in agriculture – SDG 2.3.2: smallholder income growth – SDG 2.4.1: land under sustainable management • SDG 5: gender equality and women's and girls' empowerment – SDG 5.a.1: (a) proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure • SDG 10: reduced inequality (partially, for agricultural population) – SDG 10.2: proportion of employed people living below the national poverty line, by sex, age, employment status, and rural/urban areas • SDG 17: partnerships for the goals (contribution) – SDG 17.18: proportion of countries with a national strategy for data development and dissemination	• Agro-processing • Nutrition • Transportation • Food security • Nutritious diet information • Food processing and packaging • Food distribution and retailing • Food consumption • Food waste
Living Standards Measurement Study (LSMS)	• Household living conditions • Access to clean water and sanitation • Education • Health and nutrition • Welfare dynamics, land ownership and rights, and ownership of other assets • Time use • Labor market • Energy sources used • Food security and agriculture (included in Living Standards Measurement Study–Integrated Surveys on Agriculture [LSMS-ISA])	• Agro-processing • Transportation • Food processing and packaging • Food distribution and retailing • Food waste and loss
Africa Information Highway	• Africa Infrastructure Database: energy, transport, water supply and sanitation, information and communication technology, and more • African Economic Outlook: economic, social, and political evolution indicators for all African economies • African Development Bank Operations Data Portal: consolidated information and data on approvals and disbursements of Bank Group operations on all regional member countries since the inception of the bank • Socioeconomic indicators: statistical data on economic and social situations and information on basic indicators, including demographics, health and nutrition, education and environment, national accounts, prices and money, government finance, external sector, debt, and financial flows • Minimum set of core agricultural production and consumption data	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food consumption • Food waste and loss
Côte d'Ivoire National Institute of Statistics	• Population: population size, population growth rate, urbanization, etc. • Economics: GDP, inflation, foreign direct investment flows, unemployment, etc. • Agriculture: agricultural production, food security, and nutrition • Education: enrollment rates, completion rates, and educational attainment • Health: health status, access to healthcare, and maternal and child health • Environment: air quality, water quality, deforestation, desertification, and soil quality • Governance: corruption, access to justice, and political participation	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss

continued

TABLE 11.3—SELECTED DATA INITIATIVES AND DATABASES: COVERAGE AND LIMITATIONS FROM A FOOD SYSTEMS PERSPECTIVE

Data initiative / database	Selected indicators covered	Indicators not expressly covered
Egypt Central Agency for Public Mobilization and Statistics	• Population: population size, population growth rate, urbanization, etc. • Economics: GDP, inflation, unemployment, etc. • Agriculture: agricultural production, food security, and nutrition • Education: enrollment rates, completion rates, and educational attainment • Health: health status, access to healthcare, maternal and child health, and injuries • Environment: air quality, water quality, deforestation, desertification, and soil quality • Governance: corruption, access to justice, and political participation • SDGs 1–17	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss
Ghana Statistical Service	• Population: total population of Ghana, as well as population estimates by age, sex, region, and other demographic characteristics • Economics: GDP, inflation, unemployment, trade, etc. • Agriculture: agricultural production, prices, and other agricultural indicators • Education: enrollment, completion rates, and educational attainment • Health: health status, access to healthcare, and maternal and child health • Environment: environmental indicators such as air quality, water quality, and deforestation • SDGs 1–17	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss
Malawi National Statistical Office	• Demography and other social indicators: population size, growth rate, distribution, fertility, mortality, HIV/AIDS, and other social indicators • Economic indicators: GDP, inflation, unemployment, and other economic indicators • Agricultural indicators: agricultural production, prices, and other agricultural indicators • Education indicators: enrollment, completion rates, and other education indicators • Health indicators: health status, access to healthcare, and other health indicators • Environmental indicators: air quality, water quality, and other environmental indicators • A variety of datasets, including census data, survey data, and administrative data • Data for tracking all SDGs (SDGs 1–17)	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss
Mozambique National Institute of Statistics	• Population: population size, population growth rate, urbanization, etc. • Economics: GDP, inflation, unemployment, etc. • Agriculture: agricultural production, food security, and nutrition • Education: enrollment rates, completion rates, and educational attainment • Health: health status, access to healthcare, and maternal and child health • Environment: air quality, water quality, and deforestation • Governance: corruption, access to justice, and political participation • SDGs 1–17	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss
Rwanda National Institute of Statistics	• Population: population size, population growth rate, urbanization, etc. • Economics: GDP, inflation, unemployment, etc. • Agriculture: agricultural production, food security, and nutrition • Education: enrollment rates, completion rates, and educational attainment • Health: health status, access to healthcare, and maternal and child health • Environment: air quality, water quality, and deforestation • Governance: corruption, access to justice, and political participation • SDGs 1–17	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss
International Debt Statistics	• Official development assistance • Foreign direct investment • Other private flows: debt flows • Financial development • Financial access: financial inclusion	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss • Nutrition

continued

TABLE 11.3—SELECTED DATA INITIATIVES AND DATABASES: COVERAGE AND LIMITATIONS FROM A FOOD SYSTEMS PERSPECTIVE		
Data initiative / database	**Selected indicators covered**	**Indicators not expressly covered**
Africa Development Indicators	More than 1,000 indicators, for 54 African countries, in the following areas: • Population • Economics • Agriculture: agricultural production, food security, nutrition, water use, land use, irrigation, livestock production, crop production, and forestry • Education • Health • Environment: air quality, water quality, soil quality, deforestation, desertification, climate change, renewable energy, and waste management • Governance: corruption, access to justice, political participation, human rights, social development, gender equality, and peace and security	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss • Nutrition
World Bank WDI Databases	• Population: population size, population growth rate, population density, age structure, sex ratio, and urbanization rate • Economics: GDP, GDP per capita, inflation rate, unemployment rate, trade, foreign direct investment, poverty headcount ratio, poverty gap ratio, labor and income inequality • Agriculture: agricultural production, food security, nutrition, water use, land use, irrigation, livestock production, crop production, and forestry • Education: enrollment rates, completion rates, educational attainment, literacy rate, school readiness, and quality of education • Health: health status, access to healthcare, maternal and child health, communicable diseases, noncommunicable diseases, injuries, HIV/AIDS, malaria, and tuberculosis • Environment: air quality, water quality, soil quality, deforestation, desertification, climate change, renewable energy, and waste management • Governance and social development : corruption, access to justice, political participation, human rights, social development, social protection gender equality, and peace and security	• Agro-processing • Transportation • Food and diet information • Food processing and packaging • Food distribution and retailing • Food waste and loss
CAADP- Related Databases	• Evidence-based policies, institutions, and platforms in agriculture • Investment finance in agriculture • Agriculture inputs and technology • Agricultural productivity and agricultural growth • Postharvest loss • Social protection • Food security and nutrition • Poverty, inequality, and employment • Partnerships in agriculture • Youth in agriculture • Women's participation in agriculture • Intra-African trade in agriculture, markets, and intra-African trade policies and institutions • Food safety and plant and animal health • Resilience to climate shocks, environment, and investment in resilience building • Capacity to generate, analyze, and use data • Peer review and mutual accountability mechanisms	• Agro-processing • Food processing packaging • Food storage • Transportation • Food distribution and retailing • Food marketing • Food waste and loss

Source: Authors' compilation, drawing on International Water Management Institute Library.

Global Food and Nutrition Security Dashboard: In 2022, the Global Alliance for Food Security launched the Global Food and Nutrition Security Dashboard to help guide timely and data-driven policy and financial responses to an unfolding global food security crisis. The dashboard consolidates the latest global and country-level data on food crisis severity, global food security financing, and research and analysis to strengthen crisis response and resilience.

Agricultural Market Information System: In 2011, following the global food price hikes in 2007–2008 and 2010–2011, G20 ministers of agriculture launched the Agricultural Market Information System to provide agricultural market information such as global food supplies of wheat, maize, rice, and soybeans and guide policy responses to food crises. The system includes a markets database that provides an overview of crop production and utilization and a policy database that assembles information on trade and domestic policies that are likely to impact the prices, trade, and production of the four crops tracked across 28 countries.

Strengths

Dashboards help to present complex and large amounts of data and information in an intuitive, clear, and easy-to-digest format. They also provide near-real-time data and analytics and forecasting. Overall, they help to make data, including big data, more accessible and allow for data-driven and informed decision-making.

Limitations

The plethora of dashboards at the country, regional, and global levels do not all show linkages and complementarities with each other and thus leave decision-makers to obtain information from different dashboards that may not be well coordinated or are contradictory.

Key Food Systems Data Gaps and Challenges

As highlighted above, it is beyond the scope of this chapter to survey all the available databases from which a country or stakeholder can obtain data to feed into the food system indicators. There are, however, outstanding nationwide databases in many countries. Many of these are developed and managed by NSOs or international organizations such as the World Bank, FAO, UNICEF, the International Labour Organization, the International Monetary Fund, and others. The data needed to inform decision-making around the food system span many fields, including socioeconomic indicators, biophysical indicators, agricultural production, input supply, processing, packaging, retailing, transportation, economic indicators, consumption, and outcomes of production.

In other countries, the data managed by NSOs may appear to offer good coverage, but the frequency of updates is low. For example, annual data on fish production and food consumption are needed to understand food system outcomes, but countries sometimes update their databases only every five years. This also applies to data on nutrition outcomes such as stunting, obesity, overweight, and others. Data collection methods also differ from one data initiative to another, which makes it difficult to rely on one database when another database has data gaps (Devarajan 2011). In general, most of the indicators of importance to food systems are not disaggregated by gender or age. For example, it would be useful to understand nutritional patterns as well as costs of food consumed by men, women, and youth, but no such disaggregation exists in nationally representative surveys. The NSOs of Malawi and Mozambique, for example, do not collect such data, and even where some disaggregation is available, the data are usually only updated at long intervals.

As highlighted in Devarajan (2011), the quality of data across many indicators, especially in national databases, is poor, and sometimes different data sources present different values for the same indicators. The poor quality of the data reflects low investment in data systems as well as in technical and institutional capacities across the data value chain, and undermines the ability to achieve food systems transformation through evidence-based decision-making. In the case of African countries, the key food systems areas with the most data challenges include food processing and packaging, food retailing, distribution, and transportation, as well as food waste and loss, and diet quality and nutrient content. The paucity of complete databases with this information can undermine efforts to fully and sustainably transform African food systems. It is important, therefore, that countries make deliberate efforts to invest in strengthening statistical capacities and databases at least for the key components of their food systems, including transportation, retailing, nutrition information, food processing, agro-processing, and food loss and waste across all stages of the food value chain.

Conclusion and Recommendations

This chapter sought to highlight data challenges and opportunities for food systems transformation in Africa. It is clear that food systems are complex, and each food system comprises actors, policies, institutions, and players that constantly interact in the course of carrying out their activities across the food system. A food system also comprises levers and drivers of change, as well as activities across all nodes of the food value chain (from food production to consumption and disposal). These levers and drivers of change influence food system activities to generate food system outcomes, which in turn also influence the food system. Thus, transforming food systems toward desired outcomes requires timely and quality data to guide decision-making by food system actors across all food system activities, components, sectors, policies, drivers, transformation pathways, and outcomes. In particular, data are needed to inform the adaptation of food system activities by food system actors; inform shared food system goals and performance indicators; bridge food system knowledge gaps; and support the evidence-based design, coherence, coordination, implementation, and reassessment of food system policies, as well as guide dialogue, learning, monitoring, and performance assessments of food systems and their transformation.

This chapter's close examination of food systems and food systems transformation shows an enormous demand for a broad range of data. A review of selected data initiatives and databases shows that while efforts are underway to improve data availability and accessibility, especially through the provision of open access and digital dashboards, data for several relevant indicators critical to informing food systems policy are simply not yet available. For example, across many of the data initiatives and databases reviewed, data on food storage, processing, packaging, distribution and transportation, retailing, and food loss and waste are largely unavailable. Gender- and sex-disaggregated data are also largely not available across existing data initiatives and databases. The quality of data across data initiatives and databases has been constrained by inadequate technical and institutional capacity to collect and analyze data; lack of rigorous methodologies; and institutional, political, and financial obstacles that limit data collection, analysis, and accessibility.

Furthermore, while the national databases that serve as the default sources of data for African governments' decision-making collect data on many indicators relevant to food systems transformation, often these databases are not well maintained, data are not well disseminated, and data for some of the key food system elements (such as food security and nutrition) are updated at longer than desired time intervals. The national databases for the selected countries considered in this chapter also do not cover food system components such as food processing, agro-processing, food loss and waste, transportation, and women's empowerment. While some of these types of data can be sourced from international databases, key databases such as FAOSTAT, WDI, and the AfDB's AIH are not without their own limitations. For example, apart from FAOSTAT, which covers agricultural statistics in more detail, the others cover indicators at an aggregate scale and in less detail. Even in the case of FAOSTAT, data on agro-processing, transportation, and food waste are not covered or not regularly updated.

To help ensure timely and high-quality data to guide decision-making for food systems transformation, we recommend the following:

1. **Track key food system indicators**: Using relevant available data, African governments should track indicators that help inform food systems, including the national food systems transformation pathways and the UNFSS action tracks, levers of change, and drivers of food systems, as well as the outcomes and activities of the food systems. Since no single data initiative or database at present can provide all the required data, there is a need for those leading the food systems transformation agenda in countries to raise awareness on the available sources of data on food systems.
2. **Develop common indicators for tracking:** Since any attempt to track every indicator related to food systems may be an impossible exercise, as part of the Africa Common Position on Food Systems, the AUC should consider leading an effort to develop common indicators for tracking and transforming food systems, which African countries report on periodically. These indicators should be chosen from each of the key components of the food system, for example, drivers, activities, and levers of change (Tables 11.1 and 11.2). Furthermore, indicators should be expressly assigned for each of the five action tracks identified by the UNFSS Scientific Group.
3. **Promote coordination among food system data users and suppliers:** Enhancing coordination among food system data actors is paramount to

assessing available and required data, connecting data suppliers and data users, allowing for uniform data standards and protocols, prioritizing what data can be collected, and improving overall data governance and coordination of national statistical systems. The national JSRs and SPARSs being established in some African countries provide platforms for better data prioritization and planning within the national statistical system. Moreover, mutual accountability platforms like the CAADP BR and JSRs have the potential to serve as platforms for overall food systems transformation dialogue, review, mutual learning and accountability, and performance monitoring.

Furthermore, linking data users such as decision-makers (demand) and data producers (supply) is crucial to ensure that data are used to transform food system outcomes, inform the adaptation behavior of food system actors, and guide food systems policy assessments. The local analytical networks being set up by ReSAKSS in several countries are helping to link data suppliers and users by connecting decision-makers in key government ministries to local data and analytical institutions, such as NSOs, universities, research organizations, and think tanks, as they support the data and analytical needs of policymakers.

4. **Invest in strengthening data capacities and tools:** As limited capacity has hampered data quality and availability, there is an urgent need for governments and development partners to invest in strengthening institutional and technical capacity for data collection, analysis, and use. Capacities need to be strengthened across the data value chain, from data prioritization, production, and curation to analysis, interpretation, and use as well as investing in state-of-the-art data methodologies and tools.

5. **Increase funding for data gathering and management:** Funding for data gathering and management, especially by governments, should be increased to ensure that there is a sustained effort to accumulate data on food system indicators over time. In particular, there is a need to invest in comprehensive primary data collection across food system activities, from production to consumption, as well as in collecting gender- and sex-disaggregated data.

6. **Embed food system data efforts in NSOs:** Because the NSOs serve as the custodians of a country's official statistics, it is essential to embed all data efforts around food systems within NSOs to enhance data coordination; promote uniform data standards, protocols, and best practices; and ensure the long-term sustainability of food system data efforts.

7. **Coordinate and harmonize data dashboards:** The emergence of data dashboards and platforms underscores the benefits of leveraging digital technologies to support decision-making in a timely manner using interactive and accessible formats. However, the plethora of dashboards and platforms has created an urgent need to coordinate and harmonize the dashboards to leverage synergies and complementarities among them. Data platforms should also leverage big data, including remote sensing data and artificial intelligence and machine learning, to improve food system data analysis and decision-making.

CHAPTER 12

Investing in Science, Technology, and Innovation for Sustainable, Productivity-Led Agricultural Growth[1]

Keith O. Fuglie

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The history of early human advances is the history of harvesting prosperity from agricultural innovation. In India, the later Vedic texts (c. 1100 BCE) make frequent reference to agricultural technology and practices (Tauger 2010). Jia Sixie, drawing on more than a thousand years of Chinese study in his *Qimin Yaoshu*, or *Essential Techniques for the Common People* (535 CE), asserted throughout his work the centrality of agricultural advances for the well-being of the people and the state. He proposed essential techniques to "save labor and increase yields." Giving practical advice for improving farm management, the Roman statesman Cato the Elder in *De Agricultura* (160 BE) emphasized how a prosperous agriculture system contributes to general welfare and stability: "It is from the farming class that the bravest men and the sturdiest soldiers come, their calling is most highly respected, their livelihood most assured..."

Continuing to increase agricultural productivity, especially in low-income countries, is necessary to ensure sufficient food for a growing population and to traverse the last mile toward eliminating extreme poverty, as illustrated by the following observations:

- ***Two-thirds of the global extreme poor who are working earn their livelihood in farming, and productivity growth in agriculture has a larger impact on poverty reduction than growth in any other sector.*** Rising agricultural productivity in China and other East Asian countries has contributed to impressive reductions in poverty, but productivity growth has been too low to have similar impacts in Africa and in South Asia, precisely where the largest remaining pockets of extreme poverty persist. The modest expansion of urban manufacturing and service sectors is unlikely to provide sufficient poverty-reducing economic growth over the medium term.
- ***Despite increases in world agricultural productivity over the past few decades, global undernourishment remains significant,*** afflicting 722 million people as of 2020 (FAO et al. 2022), and is on the rise, driven by conflict and worsening climatic change.
- ***Climate change will hit agriculture hard, particularly where large numbers of poor and vulnerable people live.*** Climate change models forecast warming of 1 to 2 degrees Celsius from the preindustrial level by 2050 (IPCC 2018). For every 1-degree increase, average global cereal yields are expected to decline by 3 percent to 10 percent (FAO et al. 2018). In addition, a deteriorating natural resource base reduces the resilience of the production system to climate variability and depresses future productivity.
- ***Agricultural productivity is lower and is growing more slowly in low-income countries, impeding their convergence with the advanced economies.*** Over four decades, crop yields in sub-Saharan Africa (SSA) have barely doubled, even as they tripled in South Asia and increased about sixfold in East Asia.

Hence, even after centuries of experimentation and progress, further advances in agricultural productivity remain critical to providing for basic human welfare, reducing extreme poverty, maintaining food security, and achieving social stability. Importantly, public and private investment in science, technology, and innovations to sustain agricultural productivity growth is also central to strategies addressing emerging environmental challenges and achieving a sustainable food future in the face of climate change (World Resources Institute 2019).

The Growing Importance of Increasing Total Factor Productivity

A deeper understanding of the drivers of agricultural productivity, and what is constraining it, remains critical. Globally, over the past five decades there has been a major shift in agriculture, from *resource-led* growth to *productivity-led* growth. Rather than increasing agricultural output by expanding the amount of land, water, and inputs used, most agricultural growth today comes from increasing total factor productivity (TFP), or the efficiency with which these inputs are combined to produce output, by using improved technology and practices. TFP is a more complete measure of technical and efficiency change in an economic sector. It represents how "knowledge capital," or the application of new ideas (embodied in new technologies and production practices), contributes to growth. TFP growth is especially important for agriculture and its sustainability, where the supply of land is either inherently limited or further expansion has an enormous environmental footprint, and use of labor and capital faces diminishing returns.

Evidence shows that globally, most gains in agricultural output are, in fact, driven by productivity increases, but the rates of productivity growth differ greatly across countries. The exercise reveals the need for continued research in measuring productivity and its drivers. Further, empirical assessments of agricultural productivity should (but rarely do) account for changes in the quality and quantity of natural resources, such as land, water, and biodiversity—as well as greenhouse gas emissions—that result from agricultural activity. Considering environmental factors in assessments of agricultural productivity is important because these resources have social value and have significant impacts on actual productivity that can be achieved in the future. While there is some evidence that agricultural TFP growth can in many cases conserve natural resources, more research is needed on this issue. Though beyond the scope of this chapter, sustainability is an important complementary policy objective to increasing productivity.

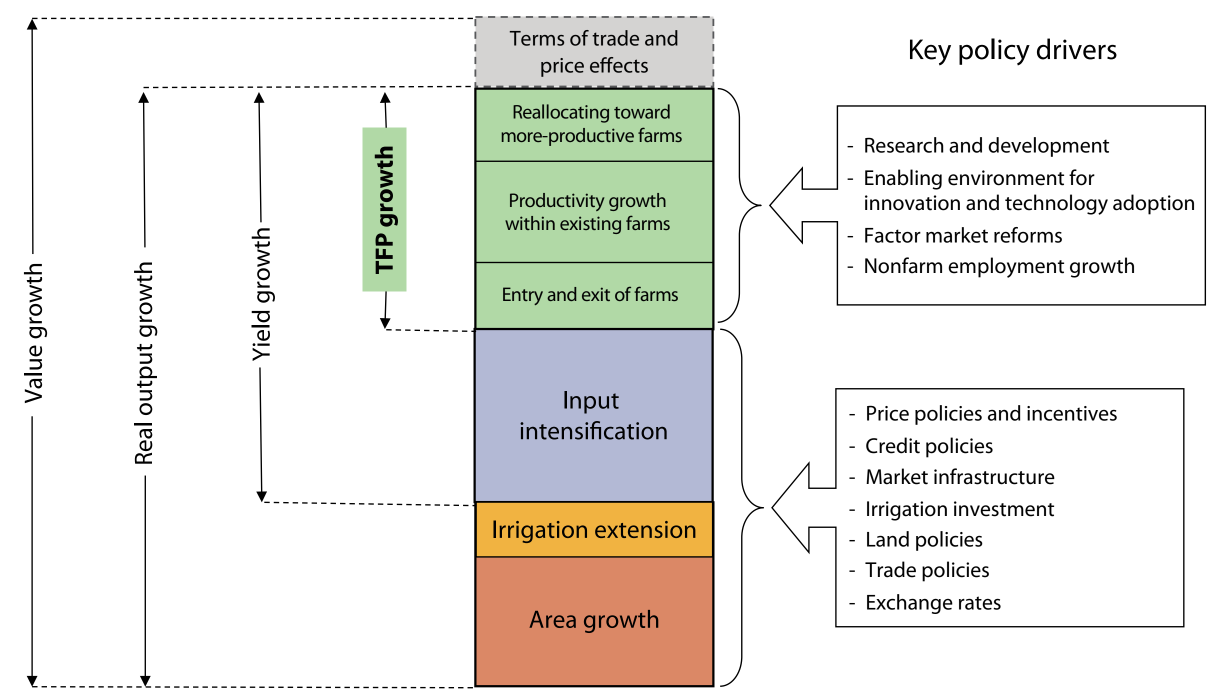
Transformations underway in market value chains in global food and agricultural products open up broader opportunities for boosting productivity. Improving farm productivity entails more than just raising yields or decreasing the use of inputs and costs. It also involves improving quality and moving into higher-value products, such as from generic staple crops to specialty crops and exportable food products. Moving toward higher-end products can provide an important growth opportunity for smallholder producers if they can reliably meet the more exacting standards of these markets.

Agricultural TFP is generally conceived as the overall efficiency with which inputs are used to produce products of the highest value (Cusolito and Maloney 2018). Broadly speaking, among the population of firms or farms, this can occur by (1) reallocating factors of production, such as moving land or inputs from lower- to higher-productivity farms, or even labor from agriculture to other activities; (2) increasing the productivity of existing farms through adoption of new technology, improved practices, and higher-value commodities; and/or (3) entry of more-productive farms and exit of less-productive ones. Correspondingly, there have been two broad schools of thought on where policies to raise productivity should focus: (1) removing barriers that prevent the rapid reallocation of factors of production across farms and sectors, or (2) increasing within-farm or potentially new-farm productivity through technological progress.

The Contribution of TFP to Agricultural Growth

The decomposition of agricultural growth is depicted graphically in Figure 12.1. The size of the stacked bars indicates the contribution of various factors to the growth in total value of output. Note that changes in the real *value* of agricultural output are due to changes in the *volume* of supply (labeled “real output growth”) and changes in the agricultural terms of trade (or the price

FIGURE 12.1—DECOMPOSING AGRICULTURAL GROWTH



Source: Fuglie et al. (2019).
Note: TFP = total factor productivity.

of agricultural commodities relative to the overall GDP price level). During commodity price booms, agricultural GDP may rise even if the volume of production remains unchanged. Conversely, it may decline during price busts due to these terms-of-trade effects.

The top box depicts terms-of-trade effects. Because the focus of this chapter is on the long-term performance of the agricultural sector and not short-term cyclical movements in prices or terms of trade, the analysis focuses on the components that contribute to real output growth—increases in the total volume of commodities produced.

The bottom component (orange box) captures the contribution of land expansion (extensification) to growth. The middle component (blue box) captures growth due to input intensification on existing land (for example, the use of more capital, labor, and fertilizer per hectare). The upper component (green boxes) represents growth in TFP, where TFP reflects the average efficiency with which all inputs are transformed into outputs.

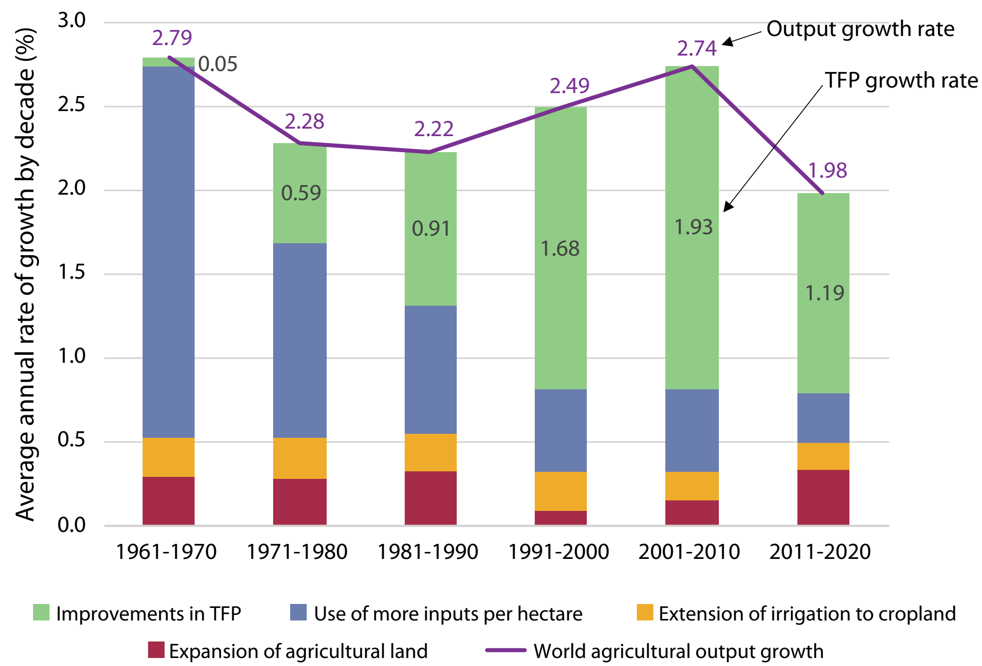
TFP growth (green boxes) is the sum of all the productivity changes taking place on individual farms. It, in turn, can be decomposed in a standard fashion into three effects: (1) reallocating factors of production: this could be reallocating land or inputs from lower- to higher-productivity farms, or even labor from agriculture to other activities; (2) increasing productivity among existing farms due to technical and managerial improvements; and (3) entry of more-productive farms and exit of less-productive farms.

The decomposition conveys a critical message: without expansion of the area of land devoted to agriculture, all increases in agricultural output will be due to more intense use of inputs and growth in TFP. Both can be affected by changes in commodity or input prices. For example, higher crop prices or real wages will induce more intensive use of existing farmland and investment in land improvement.

In the short term, the ability to raise yields through intensification is inherently limited by diminishing returns. To sustain growth over the longer run, improvements in TFP are necessary. This requires advances in technologies that expand the yield frontier as well as farm-level adoption of innovations that raise the value of output and save resources. Thus, it is through investment in research and development (R&D) that incremental improvements in productivity can be sustained over the long term. Policies that provide a constructive "enabling environment" can stimulate investment in innovation and adoption. Improved market integration and trade liberalization can raise TFP by enabling farmers to specialize in commodities in which they have a comparative advantage.

Figure 12.2 presents an empirical decomposition of global agricultural output growth into contributions from land (including augmentation of land quality through irrigation), input intensification, and TFP, using data from the United States Department of Agriculture Economic Research Service. Consistent with Figure 12.1, the height of each column gives the average annual

FIGURE 12.2—INCREASES IN TOTAL FACTOR PRODUCTIVITY AS A SOURCE OF GLOBAL AGRICULTURAL GROWTH



Source: USDA-ERS (2023).
Note: TFP = total factor productivity.

growth rate of agricultural output by decade since 1961, with the last column covering 2011–2020. Over the entire 1961–2020 period, total inputs (including land and irrigation) grew only about half as fast as output, implying that improvement in TFP accounted for the other half of new output. Moreover, the rate of input growth declined over time, while the contribution of TFP to output growth steadily increased. From 2011 to 2020, TFP accounted for two-thirds of the growth in global agricultural production. From a global point of view, TFP is the primary driver of output growth.

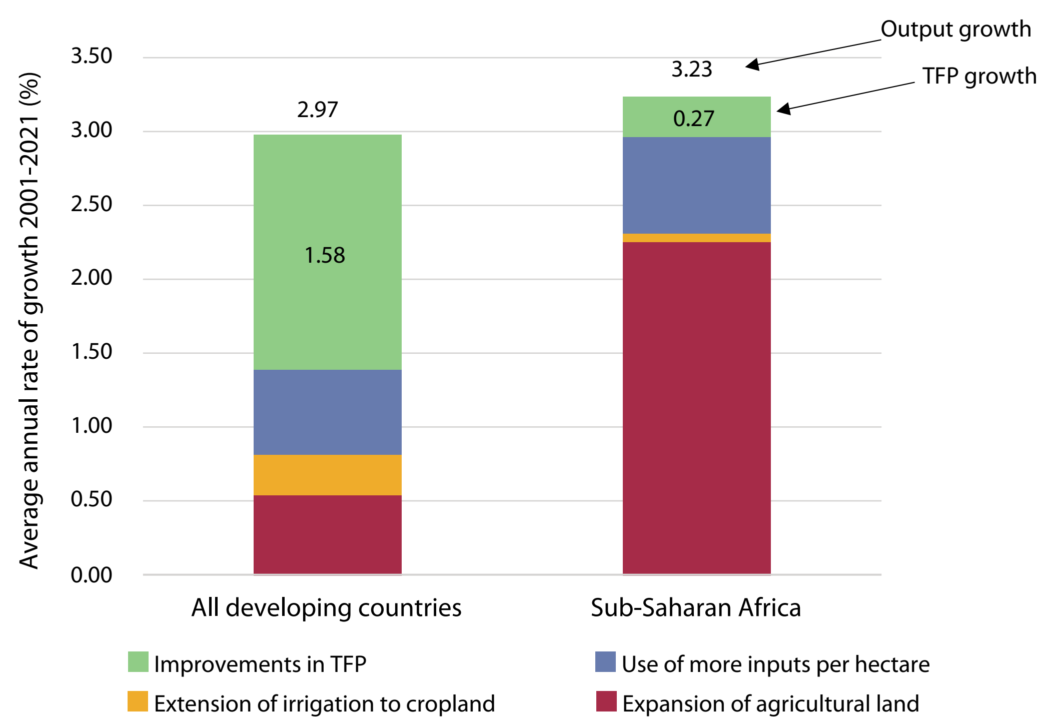
Sources of Agricultural Growth in Sub-Saharan Africa

Although SSA has achieved the highest rates of agricultural growth in the world since 2001, this growth has depended mostly on expansion of cropped area rather than productivity growth (Figure 12.3). Over 2001–2021, developing countries were able to maintain annual agricultural growth of just under 3 percent, but the primary source of growth was TFP rather than expansion of land area or intensification of the use of inputs per hectare. SSA was also able to achieve agricultural growth of 3.23 percent per year, but this was mostly due to expansion of the area under cultivation. Policy reforms and an improved enabling environment for agriculture have increased the incentives for farmers to expand land and production (Fuglie and Rada 2013), but without strong R&D systems to provide a steady stream of improved technologies, Africa has lagged in the transition to productivity-led growth.

Table 12.1 shows the growth in agricultural output and TFP for 51 African countries over the period from 2001 to 2021. Over this period, the countries that achieved the greatest increase in gross agricultural output were Angola, Democratic Republic of the Congo, Ethiopia, Malawi, Mali, Niger, Senegal, and Zambia. Each of these countries achieved an average annual output growth rate of at least 5 percent per year. What distinguished these countries from the others was that in addition to expanding the amount of land, labor, and other inputs in agriculture, they augmented this resource-led growth with higher productivity. The Democratic Republic of the Congo, Malawi, Niger, Senegal, and Zambia all achieved TFP growth of at least 2 percent per year over this period.

Note that several countries experienced declining agricultural TFP over these years. Botswana, Equatorial Guinea, Gambia, Libya, and Rwanda all saw TFP declines of more than 2 percent per year. One factor that may be contributing to declining TFP is degradation of natural resources. Worsening climate conditions, soil nutrient mining, and outbreaks of new pests and diseases are examples of factors that reflect resource degradation.

FIGURE 12.3—SOURCES OF AGRICULTURAL GROWTH: ALL DEVELOPING COUNTRIES VERSUS SUB-SAHARAN AFRICA, 2001-2021



Source: Jayne et al. (2021), updated with data from USDA-ERS (2023).
Note: TFP = total factor productivity.

TABLE 12.1—AGRICULTURAL OUTPUT AND TOTAL FACTOR PRODUCTIVITY GROWTH IN AFRICAN COUNTRIES, 2001-2021

Country/region	Agricultural output index (2001=100)							Agricultural TFP Index (2001=100)						
	2001	2005	2010	2015	2020	2021	Growth (%/yr)	2001	2005	2010	2015	2020	2021	Growth (%/yr)
Algeria	100	136	173	227	255	237	4.83	100	129	129	142	152	141	1.83
Angola	100	143	231	257	287	292	5.27	100	120	159	151	146	160	1.71
Benin	100	109	128	156	205	213	3.99	100	106	103	111	104	103	0.19
Botswana	100	101	123	103	98	104	0.10	100	82	76	61	48	50	-3.16
Burkina Faso	100	127	153	188	229	218	4.20	100	101	86	93	86	80	-0.88
Burundi	100	97	116	113	153	143	1.78	100	92	96	78	80	78	-1.79
Cabo Verde	100	96	95	103	83	84	-0.59	100	94	89	86	75	75	-1.16
Cameroon	100	128	172	210	212	218	4.27	100	111	127	137	125	128	1.62
Central African Rep.	100	104	118	124	138	140	1.83	100	99	109	119	130	126	1.66
Chad	100	117	169	186	230	234	4.84	100	101	97	90	97	99	-0.30
Comoros	100	102	112	113	122	122	1.10	100	103	110	110	101	101	0.15
Congo	100	119	143	172	175	182	3.06	100	123	138	145	131	118	1.01
Côte d'Ivoire	100	106	111	154	185	185	3.52	100	99	92	97	86	85	-0.50
Dem. Rep. Congo	100	100	165	201	232	241	5.54	100	91	108	133	149	150	2.69
Egypt	100	120	133	150	159	158	2.01	100	109	113	119	129	128	1.00
Equatorial Guinea	100	106	119	132	132	131	1.58	100	70	65	60	54	64	-2.23
Eritrea	100	121	115	120	126	127	1.41	100	107	100	94	92	89	-0.28
Eswatini	100	119	124	131	134	137	1.34	100	118	120	124	121	125	0.77
Ethiopia	100	134	192	236	280	270	5.09	100	120	131	121	114	112	-0.10
Gabon	100	103	118	135	140	142	2.03	100	98	108	106	102	98	0.14
Gambia	100	91	126	92	63	63	-1.94	100	71	80	64	44	41	-3.38
Ghana	100	123	155	186	220	221	4.01	100	110	122	136	131	134	1.54
Guinea	100	119	145	176	221	227	4.09	100	108	107	108	109	112	0.15
Guinea-Bissau	100	111	139	147	170	175	2.82	100	105	112	104	98	98	-0.26
Kenya	100	123	148	154	178	171	2.42	100	113	115	95	91	88	-1.36
Lesotho	100	86	89	87	83	88	0.23	100	107	97	97	93	80	-0.48
Liberia	100	105	111	118	130	129	1.37	100	96	86	78	69	70	-1.90
Libya	100	109	123	117	121	123	0.71	100	69	44	46	49	50	-3.64
Madagascar	100	118	139	131	135	137	1.47	100	105	117	103	96	98	-0.27
Malawi	100	84	152	215	285	299	6.75	100	77	115	139	142	138	3.27
Mali	100	121	157	198	260	258	5.27	100	95	88	78	77	72	-1.28
Mauritania	100	112	123	143	151	159	2.31	100	114	118	137	132	141	1.44
Mauritius	100	91	92	87	73	74	-0.99	100	89	92	85	85	83	-0.41

continued

TABLE 12.1—AGRICULTURAL OUTPUT AND TOTAL FACTOR PRODUCTIVITY GROWTH IN AFRICAN COUNTRIES, 2001-2021

Country/region	Agricultural output index (2001=100)							Agricultural TFP Index (2001=100)						
	2001	2005	2010	2015	2020	2021	Growth (%/yr)	2001	2005	2010	2015	2020	2021	Growth (%/yr)
Morocco	100	119	159	185	169	198	3.02	100	105	124	132	108	126	0.96
Mozambique	100	113	164	149	203	210	3.70	100	95	108	96	101	105	0.34
Namibia	100	98	103	103	107	109	0.39	100	97	104	93	99	103	-0.13
Niger	100	123	182	216	276	243	5.12	100	110	122	147	168	145	2.56
Nigeria	100	123	129	146	158	161	2.28	100	103	97	94	89	94	-0.62
Rwanda	100	120	141	135	167	174	2.11	100	103	85	62	67	69	-3.01
Sao Tome & Principe	100	97	94	82	94	94	-0.28	100	91	82	68	74	72	-1.22
Senegal	100	107	148	170	277	272	5.96	100	103	119	131	154	155	2.85
Sierra Leone	100	191	300	286	274	385	4.13	100	139	157	130	127	187	0.48
Somalia	100	108	108	103	102	99	-0.12	100	107	108	106	105	102	0.15
South Africa	100	115	130	146	161	165	2.41	100	112	124	126	139	141	1.51
Sudan, former	100	116	114	135	165	166	2.56	100	100	102	101	101	100	-0.30
Tanzania	100	128	170	230	249	250	4.72	100	91	99	100	87	87	-0.21
Togo	100	100	126	135	155	156	2.56	100	100	103	94	93	94	-0.54
Tunisia	100	139	146	198	213	181	2.70	100	129	127	164	177	144	1.56
Uganda	100	108	95	105	130	126	0.61	100	95	80	74	75	74	-2.03
Zambia	100	124	200	203	264	279	5.42	100	110	130	124	144	152	2.11
Zimbabwe	100	85	95	92	101	117	0.89	100	73	84	93	103	119	1.29

Source: USDA-ERS (2023).
Note: TFP = total factor productivity.

Renewing the Focus on Innovation

This discussion moves the second potential driver of TFP—the invention, adaptation, and dissemination of new technologies to existing firms—to center stage. Sustaining growth in agricultural productivity depends on farmers adopting a steady stream of new farm practices and technologies that enable them to raise yields, manage inputs more efficiently, adopt new crops and production systems, improve the quality of their products, and conserve natural resources. Moreover, these new technologies must be well adapted to local environmental and social conditions and be renewed as environmental conditions change (due to co-evolution of pests and diseases, degradation of water and land resources, and climate change, for example). These factors— productivity losses in the face of environmental changes and constraints to direct technology transfer between regions—point to a pressing need to strengthen *national* agricultural R&D and innovation systems. Such localized R&D capacity is essential for adapting technologies in specific areas and for specific needs.

The evidence is strong that investments in agricultural R&D pay off. Across developing countries, social rates of return to agricultural R&D have averaged more than 40 percent per year, implying that the economywide benefits of R&D greatly exceed its costs (Alston et al. 2000; Fuglie 2018). Moreover, high returns to agricultural R&D have been achieved in all developing regions (Table 12.2). But because of significant "knowledge spillovers" from R&D (the profitable use of new technologies by persons other than the inventor), the private sector underinvests in technology development. Thus, there is an essential role for the

TABLE 12.2—RETURNS TO AGRICULTURAL RESEARCH ACROSS REGIONS AND COMMODITIES

Geographic or commodity area	Median internal rate of return (%)
Developed countries	46.0
Developing countries	43.0
Asia-Pacific	49.5
Latin America and Caribbean	42.9
West Asia and North Africa	36.0
Sub-Saharan Africa	34.3
CGIAR and other international agricultural research	40.0
All agriculture	44.0
Field crops	43.6
Tree crops	33.3
Livestock	53.0
Natural resource management	16.5
Forestry	13.6

Source: Alston et al. (2000).

government in national agricultural R&D systems—both to directly fund public agricultural R&D and to create conditions to attract more private investment into agricultural R&D.

One important way in which investments in agricultural R&D contribute to productivity growth is through the development and diffusion of improved crop varieties and livestock breeds. Many African countries have made progress in extending improved varieties of food crops to farmers, especially through collaboration with CGIAR centers. These varieties often have improved resistance to pests and diseases and/or better tolerance to drought than traditional farmer varieties. Some have also been bred to respond better to high levels of fertilizers. However, by 2020, only about one-third of the area in major food staples in SSA was sown using modern varieties (Table 12.3). Improved varieties of wheat and maize have had relatively high rates of adoption in African countries, but adoption rates remain very low for some major staple crops, such as sorghum, millet, sweet potato, and beans. Among African countries, Morocco, South Africa, Tunisia, Zambia, and Zimbabwe have at least 70 percent of total food crop area sown with modern varieties. But farmers in many countries continue to lack access to improved varieties and good-quality seed. Moreover, rates of variety turnover (replacing one improved variety with a newer generation of improved variety) are very low. Many farmers growing improved varieties may be using a variety that is decades old (Walker and Alwang 2013).

Sustained and effective productivity improvement involves a steady supply of new technologies, but it also requires that farmers be willing and able to adopt them. Imperfect information about new technologies, a lack of markets for insurance and capital, high market transaction costs, and policy biases against agriculture can inhibit the adoption and diffusion of new technologies among farmers. Policymakers need to give careful attention to the broader enabling environment for technology generation and uptake, working on both the supply and demand sides, in order to drive productivity growth.

Beyond the farm, there are significant opportunities for innovations to raise productivity along the entire agrifood value chain. Prefarm value chains include the manufacture, supply, and distribution of fertilizers, quality seed and breeding stock, veterinary pharmaceuticals, and farm machinery and tools. These farm inputs often embody new technologies that raise farm productivity. Government policy has an important role to play in regulating these products to assure proper labeling and adherence to quality and safety standards. Postfarm value chains include the processing, storage, and distribution of agricultural commodities and food products. Global agrifood value chains are undergoing major structural changes and have been an important source of economic and employment growth in many countries (Barrett et al. 2022). However, unlike agricultural technologies that need to be adapted to local agroecological conditions, new technologies and practices in food manufacturing, storage and transportation logistics, and marketing can often be directly imported from other countries. Foreign direct investment (FDI) has proven to be a major driver of technology transfer in food systems transformation in developing countries. Countries can gain access to these technologies by enacting policies that facilitate FDI in their agrifood value chains (Reardon et al. 2003; Reardon, Henson, and Berdegué 2007). Another role of policy is to enable smallholder farmers to participate in higher-value market chains, often through cooperatives or contracting arrangements with agro-processing firms (Fuglie et al. 2019).

TABLE 12.3—PERCENTAGE OF FOOD CROP AREA PLANTED WITH MODERN VARIETIES IN AFRICAN COUNTRIES, 2016-2020

Country	All crops	Wheat	Rice	Maize	Sorghum	Millet	Barley	Cassava	Potato	Sweet potato	Ground nut	Cow pea	Beans
Algeria	59	95	—	—	—	—	10	—	—	—	—	—	—
Angola	10	—	—	7	17	—	—	32	—	—	—	—	—
Benin	40	—	70	54	—	—	—	66	—	—	—	—	—
Botswana	12	—	—	—	33	—	—	—	—	—	70	—	—
Burkina Faso	16	—	69	49	3	3	—	—	—	—	25	9	—
Burundi	12	—	—	—	—	—	—	28	100	28	—	—	9
Cameroon	40	—	52	89	25	—	—	36	—	—	—	71	—
Central African Rep.	1	—	72	—	—	—	—	—	—	—	—	—	—
Chad	14	—	—	70	29	—	—	15	—	—	—	—	—
Côte d'Ivoire	37	—	49	56	—	—	—	4	—	—	—	—	—
Dem. Rep. Congo	36	—	54	31	—	—	—	49	100	—	—	44	15
Egypt	47	100	50	—	45	—	70	—	—	—	—	—	—
Ethiopia	53	94	—	91	9	1	40	—	23	53	0	—	67
Gabon	4	—	—	—	—	—	—	16	—	—	—	—	—
Gambia	10	—	56	—	—	—	—	—	—	—	—	—	—
Ghana	41	—	58	88	—	—	—	36	—	—	—	81	—
Guinea	13	—	15	31	—	—	—	20	—	—	—	—	—
Kenya	53	99	90	93	39	—	—	44	29	—	47	—	—
Madagascar	24	—	35	26	—	—	—	—	80	—	—	—	—
Malawi	59	—	—	89	10	7	—	14	1	—	58	10	49
Mali	29	—	25	19	33	31	—	—	—	—	20	53	—
Morocco	70	99	—	—	—	—	35	—	—	—	—	—	—
Mozambique	33	—	—	54	5	11	—	19	—	9	75	11	14
Niger	14	—	—	—	15	11	—	—	—	—	12	17	—
Nigeria	38	99	50	47	20	25	—	66	—	—	19	39	—
Rwanda	31	—	69	100	—	—	—	2	36	0	—	—	46
Senegal	45	—	89	51	41	35	—	—	—	—	47	27	—
Sierra Leone	16	—	16	—	—	—	—	34	—	—	—	—	—
South Africa	75	99	—	98	78	—	—	—	65	—	75	—	—
Sudan, former	24	97	—	—	41	—	—	—	100	—	—	—	—
Tanzania	34	98	18	46	42	1	—	27	20	—	32	31	47
Togo	12	—	76	5	—	—	—	39	—	—	—	—	—
Tunisia	75	99	—	—	—	—	60	—	—	—	—	—	—
Uganda	33	—	83	72	—	—	—	35	74	9	56	16	31
Zambia	83	99	—	98	35	19	—	44	—	—	57	—	—
Zimbabwe	75	99	—	90	72	27	—	52	—	—	52	—	—

Source: Fuglie and Echeverria (2023).
Note: — = data not available.

The Changing Global Context of Agricultural Innovation

Policymakers need to consider national innovation systems in the context of 21st-century global developments. Important changes are underway in the nature of food and agricultural markets, in the global landscape for agricultural research and development, and in the emergence of new institutions and means for knowledge transmission:

- ***Freer international trade in food and agricultural products has created incentives for domestic production to be more closely aligned with comparative advantage.***
- ***The types of technologies needed on the farm are changing because of structural changes in agricultural and food marketing systems, including the rise of supermarkets and vertically coordinated market chains***—driven by consumer demand for product diversity, quality, and safety and by economies of scale in food processing and marketing. Food marketing and processing companies are becoming important players in creating and disseminating technologies to farmers in order to meet higher standards. This, in turn, opens new opportunities for public–private partnerships.
- ***Around the world, sources of advanced agricultural science and technology are becoming more diverse.*** Some countries, such as Brazil, China, and India, have expanded their capacity in agricultural sciences and are likely to become increasingly important sources of science and technology spillovers for global and developing-country agriculture.
- ***The emergence of an international private agricultural input supply sector as a provider and disseminator of new technologies offers developing countries the possibility of harnessing the private sector to increase international technology transfer and expand the overall national R&D effort.*** This requires developing effective relationships and networks with these sources, and enacting and enforcing regulations governing intellectual property rights, the movement of genetic material, and the health and safety of new products, as well as streamlined processes for registering and approving new technology.
- ***Rapidly expanding access to new digital information and communication technologies around the world offers new modalities for knowledge development and dissemination.*** While digital technologies substantially reduce the cost of information, their successful application to improve farm practices and promote technology adoption depends on the quality and local relevance of the messaging.

Agricultural policies, and the incentives they create, must be considered in the context of this evolving global environment.

Elements of a 21st-Century Agricultural R&D System

Agriculture has its own version of the innovation paradox (Cirera and Maloney 2017). While studies consistently find that investment in agricultural R&D leads to higher productivity growth, with social returns to public R&D averaging more than 40 percent, investment in agricultural R&D is *stagnant or falling* in regions where agricultural growth is most needed, notably in SSA (Table 12.4). Many of the poorest regions of the world, such as Africa and South Asia, have an increasingly acute *research spending gap*. Further, declining capacity, particularly in African

TABLE 12.4—PUBLIC AGRICULTURAL R&D INVESTMENT ACROSS REGIONS

Region	Public agricultural research intensity		
	ag R&D/ ag GDP		ag R&D/ cropland
	(%)	Trend	($/hectare)
Latin America and Caribbean	1.06	↑	$25
Brazil	1.65	↑	$31
East and South Asia	0.46	↑	$27
China	0.73	↑	$47
Southeast Asia	0.34	↓	$18
South Asia	0.3	↑	$17
Sub-Saharan Africa	0.38	↓	$9
Developing-country total public ag R&D	0.52	↑	$23
Developed-country total public ag R&D	3.25	↓	$52

Source: Fuglie et al. (2019).

Note: ag R&D = agricultural research and development; ag GDP = agricultural gross domestic product or value added.

agricultural universities, constrains long-term capacity development in human resources and knowledge creation in this region. But it is not only a question of adequate funding for public science institutions. The outcome also depends on how well those funds are used, and on aligning policies and incentives to crowd in private investment. Building an effective agricultural innovation system requires supportive policies that reward the performance of public scientists and advisory service providers, build human and knowledge capital, and encourage the private sector to invest in innovation and technology transfer to farmers.

Revitalizing Public Agricultural Research Institutes

Even with greater private R&D, strong public R&D institutions are still essential for achieving sustained agricultural productivity growth. Public institutions continue to provide many if not most of the new technologies for agriculture, especially in developing countries. While private research is focused on specific crops and on improving specific inputs such as hybrid seed, agrochemicals, machinery, and other inputs that can be sold to farmers, public research addresses a much broader range of scientific and technical issues, commodities, and resource constraints. Public capacity in agricultural science and technology is also needed to support government regulatory actions permitting the use of new technologies, establishing and enforcing sanitary and phytosanitary standards, and assuring safe food products. The fact that social returns to R&D tend to be much higher than private returns to R&D indicate the strong "public good" nature of research benefits. Moreover, the high social rates of return from agricultural R&D provide direct evidence of persistent societal underinvestment in this public good and imply that valuable opportunities for economic growth and poverty reduction are being missed.

Successful public research institutions foster a climate of innovation, where creativity and collaboration are encouraged, and performance is recognized and rewarded. International best practice suggests that several factors contribute to high-performing public research institutes:

- ***Institutional autonomy.*** Many public research institutes are located within ministries of agriculture. They are thus subject to governmentwide budgetary and human resource rules and regulations that are designed to assure hierarchical control of policies or programs but often interfere with the incentives necessary to encourage high performance in research programs. Granting greater autonomy within the context of a clear mission statement and well-designed incentives is necessary to encourage high performance in research programs.
- ***Performance incentives for scientists.*** As in any research institute, the attraction and motivation of staff is perhaps the central challenge for management. Hence, a modern human resource policy with performance rewards is critical. Some institutions provide bonuses and promotions to staff whose research has led to demonstrable outputs and impact. Plant breeders, for example, might be remunerated on the basis of area planted with varieties they develop. Another important type of incentive is the provision of opportunities for further education, training, and career advancement for staff who consistently perform at a high level. Institutes should avoid pressure to expand staff numbers if it means diluting resources for research and staff development (that is, if expenditure per scientist declines). In SSA, low staff retention, high absenteeism, and salary structures that do not reward performance or are not competitive with the private sector are depleting human resources at many public agricultural research institutes.
- ***Stable and diversified financing.*** Public agricultural research institutions have historically depended on general government revenues or aid programs for funding. A lack of diverse funding sources can leave them vulnerable to low and unstable funding. One potential source of supplementary funding for research is producer levies. Levies are assessments imposed on the value of commodity sales or exports. Revenues from levies may be channeled through producer organizations and used to fund a range of cooperative activities, including research, extension, and market promotion. Governments may give statutory authority to producer associations to impose mandatory levies on all their members when a majority of members are in favor. Levies are mostly used for commodities that are grown commercially and for export, and that are marketed through a limited number of outlets, such as processing mills or ports (which reduces the transaction cost of collecting the levy). Another potential source of research funding is fees for technology products and services.
- ***Programs aligned with client needs through public–private partnerships.*** One way to improve alignment with local farmer needs and to facilitate dissemination of agricultural innovations to farmers is through partnerships with producer groups and the private sector. Funding of public research

through levies imposed by producer associations, as described in the previous bullet point, ensures that producers have a direct stake (and say) in R&D program orientation. Joint R&D ventures, in which public institutes and private companies share in the development costs, also help ensure alignment of research with client needs.

- ***International R&D linkages.*** Although agricultural technologies need to be tailored to location-specific conditions, much of the pool of knowledge and genetic resources that scientists draw upon to make these adaptions is supplied by universities and research institutes in developed countries or through the affiliated research centers of the global CGIAR agricultural innovation network. Over the past few decades, for example, major advances have been made in the science of crop and animal breeding. Developing countries can gain rapid access to these scientific developments through research partnerships with foreign and international institutes. This is especially important for small countries whose own research institutes lack the scale to replicate these advances. Agricultural scientists in developing countries need to form networks and collaborative relationships with scientists from foreign and international centers through attendance at conferences, study leaves abroad, and collaborative research. Research budgets and human resource policies need to accommodate and encourage this.

Strengthening Agricultural Universities

An additional characteristic of a viable agricultural research system is the integral involvement of higher education in research. This is essential if developing countries are to remove the constraints to scientific knowledge and expertise that limit their capacity to move toward productivity-based agricultural growth. Graduate-level education in agricultural sciences is most effective when it occurs in association with a significant research program. Thus, universities play a fundamental role in agricultural research systems. Agricultural universities are home to some of the most highly skilled scientists, who have the essential task of training the researchers and technicians that staff research and development organizations in both the public and private sectors. However, there has been a serious decline in the quality of graduate training programs at many African agricultural universities, due primarily to declining public investment. This is crippling the ability of these institutions to train scientists and create sufficient agricultural research capacity in this region. Most of the reforms mentioned in the discussion of public research institutes also apply to research at agricultural universities.

Encouraging Private R&D in the Agrifood Value Chain

Governments need to consider both public and private research and technology transfer as they strengthen their overall innovation systems. Private R&D can help close the R&D funding gap and stimulate more rapid access to new technologies for farmers. In developed countries, private companies contribute about half of the total R&D spending targeting the needs of farmers, and in large emerging economies such as Brazil, China, and India, as much as 25 percent (Table 12.5). Governments can employ a variety of policy tools to encourage more private R&D in agriculture:

- ***Expand the market size for agricultural inputs by reducing restrictions on market participation, encouraging competition, and leveling the playing field.*** Countries can liberalize markets for seed, chemicals, and farm

TABLE 12.5—THE PRIVATE SECTOR'S ROLE IN AGRICULTURAL R&D

Country	Total ag R&D spending (million US$)	Private sector share of all ag R&D (%)
Developed countries:		
United States	9,643	50.1
Developing countries:		
Bangladesh	80	26.1
Brazil	2,719	14.4
China	5,730	25.3
India	1,140	24.8
South Africa	272	19.2
Sub-Saharan Africa:		
Kenya, Senegal, Tanzania, and Zambia	159	8.0

Source: Fuglie et al. (2019).
Note: Data from 2008–2013; — = data not available; ag R&D = agricultural research and development.

machinery to increase (foreign and domestic) participation and competition in these markets, including by eliminating monopolies held by state-owned enterprises. Reducing input subsidies that favor existing products and are not available for new products or that channel input sales through government tenders rather than markets could also provide more opportunity for private input suppliers. Eliminating government monopolies in agricultural input markets and permitting private companies to operate in these markets is a prerequisite for private investment in agricultural research and innovation. However, studies have shown that market liberalization alone may not lead to greater private research unless other conditions are in place, such as protection for intellectual property and clear regulatory pathways for licensing new technology (Pray et al. 2018). Reducing tariff and nontariff barriers to trade in seed, breeding stock, and other agricultural inputs can encourage research and technology transfer in countries with small domestic markets.

- ***Provide incentives to firms to invest more in R&D by removing onerous or duplicative regulations.*** The commercialization of new technologies for agriculture often involves lengthy and costly regulatory protocols that require substantial data to be collected and submitted to government regulators on a product's safety and performance. Streamlining and eliminating duplicative regulations can reduce these costs and thus make technology development more profitable for private firms. For instance, relaxing duplicative environmental, health, and efficacy testing for new technologies that have already passed these requirements in another country with similar growing conditions or moving toward regional harmonization of regulatory norms can promote technology transfer. Establishing regulatory protocols allowing the use of safe genetically modified crops could induce more research and technology transfer by seed and biotechnology companies.
- ***Strengthen intellectual property rights (IPRs) over new technology.*** IPRs enable firms to appropriate some of the gains from new technologies they develop, which is essential if companies are to earn a positive return on their R&D investments. While the evidence of the positive impact of IPRs on private R&D from middle-income countries is robust, results from low-income countries are mixed (Pray et al. 2018). Stronger IPRs alone may be insufficient if market size is small or regulatory regimes are too onerous.
- ***Support public institutes and universities.*** These centers provide complementary inputs for private sector research, supply advanced scientific personnel and resources, and expand the set of technological opportunities available for commercialization. These public investments are implicitly another form of subsidy that evidence suggests creates positive knowledge spillovers and stimulates more R&D by the private sector. However, public research may also crowd out private research if it duplicates activities that could profitably be undertaken by private firms.
- ***Support foreign direct investment in agrifood value chains***. Unlike those for agriculture, many of the technologies and innovations for food processing, supply chain logistics, and retailing are readily transferable across national boundaries. FDI has been an important supply-side driver of technology transfer in agrifood systems. Policies that facilitate FDI in agrifood value chains (such as trade and currency liberalization and protection for trademarks and intellectual property) can encourage technology transfer and productivity growth in this sector. Public investment in agricultural R&D also plays a major role: by raising productivity, agricultural R&D ensures greater supply of lower-cost raw agricultural commodities for processing. Governments also have a role in enabling smallholder farmers' participation in agrifood value chains through encouraging the formation of cooperatives and fair contractual arrangements with agrifood firms.

Table 12.6 gives a snapshot of the agricultural research and extension capacities of African countries using the most recent available data (2011–2016). Overall, more than 25,000 agricultural scientists and 100,000 agricultural extensionists were working at public institutes and universities on the African continent, and total spending on agricultural R&D amounted to more than $3 billion per year (in purchasing-power-equivalent dollars). However, these investments are relatively small given the size and extent of African agriculture. R&D spending on agriculture was only about 0.4 percent of the value of agricultural GDP, and only South Africa and a handful of small countries (Botswana, Cabo Verde, Mauritius, Namibia, and Zimbabwe) invested at least 1 percent of the value of their agricultural GDP in agricultural research.

Besides a relatively low level of investment, agricultural research and extension capacity is heavily skewed toward a few large countries. Egypt has by far the largest public agricultural R&D system in Africa, with more than 8,000 scientists employed in the system (nearly one in four of the total number of agricultural scientists in Africa). Egypt, Nigeria, and South Africa each spend more than $400 million per year on agricultural research, but most countries in Africa invest less than $50 million annually in agricultural R&D and hire fewer than 250 researchers, and most of these are at the bachelor's or master's degree level (Beintema and Stads 2017). Agricultural extension capacity is even more heavily skewed. Ethiopia alone accounts for 44 percent of total agricultural extension on the continent, with more than 45,000 extensionists serving more than 10 million farm households. Ethiopia's "agriculturally led industrialization" development strategy significantly increased government spending on agriculture, including on agricultural research and extension (Berhane et al. 2018). This helped to increase adoption of new technologies, boost the use of fertilizers, and accelerate growth in the agricultural sector, including in TFP. Moreover,

TABLE 12.6—AGRICULTURAL RESEARCH AND EXTENSION CAPACITIES IN AFRICAN COUNTRIES

TABLE 12.6—AGRICULTURAL RESEARCH AND EXTENSION CAPACITIES IN AFRICAN COUNTRIES

Country/region	Number of agricultural scientists (FTE)	Number of agricultural extensionists (FTE)	Agricultural research spending (million $)	Research spending as % of ag GDP (%)	Scientists per billion PPP$ of ag GDP (FTE/$billion)	Extensionists per billion PPP$ of ag GDP (FTE/$billion)
Algeria	593	835	92	0.21	13	19
Benin	202	517	30	0.60	40	102
Botswana	116	616	17	2.27	151	801
Burkina Faso	311	684	47	0.55	36	79
Burundi	134	—	11	0.39	49	—
Cabo Verde	25	—	3	1.17	87	—
Cameroon	297	2,389	55	0.38	21	167
Central African Rep.	123	—	5	0.40	102	—
Chad	89	3	6	0.05	7	0
Congo	79	—	6	0.26	33	—
Côte d'Ivoire	276	—	78	0.50	18	—
Dem. Rep. Congo	553	—	28	0.24	47	—
Egypt	8,420	7,421	528	0.44	70	62
Eritrea	117	—	3	0.30	122	—
Eswatini	26	87	7	0.70	27	90
Ethiopia	3,025	45,812	162	0.29	53	810
Gabon	65	—	2	0.10	40	—
Gambia	59	—	5	0.88	108	—
Ghana	599	1,244	179	0.91	30	63
Guinea	262	1,538	4	0.17	114	671
Guinea-Bissau	9	—	0	0.02	9	—
Kenya	1,156	5,488	222	0.48	25	119
Lesotho	33	7	3	0.94	110	23
Liberia	45	134	7	0.51	34	101
Madagascar	214	104	10	0.14	29	14
Malawi	158	3,054	28	0.53	30	572
Mali	296	1,129	58	0.44	23	86
Mauritania	102	381	19	0.49	27	101
Mauritius	142	133	37	4.82	183	172
Morocco	556	7	147	0.49	19	0
Mozambique	386	1,304	32	0.43	53	178
Namibia	100	—	39	3.09	79	—
Niger	200	847	22	0.32	29	124
Nigeria	2,975	7,000	434	0.22	15	35
Rwanda	149	1,244	27	0.44	24	199
Senegal	144	500	51	0.89	25	87
Sierra Leone	141	702	13	0.22	24	118
South Africa	811	2,210	417	2.78	54	147
Tanzania	785	10,891	69	0.17	20	273
Togo	110	16	9	0.20	25	4
Tunisia	542	854	63	0.64	55	87
Uganda	559	—	99	0.62	35	—
Zambia	246	908	27	0.51	46	171
Zimbabwe	242	6,159	42	1.39	81	2,064
All or average	**25,469**	**104,219**	**3,142**	**0.41**	**138**	**222**

Source: Agricultural research data are from 2011–2016, as reported by ASTI (2022); agricultural extension data are for 2012, as reported by Davis and Alex (2020).
Note: Research spending and agricultural GDP are in 2011 purchasing-power-parity dollars; — = data not available; ag GDP = agricultural gross domestic product; FTE = full-time equivalent.

higher agricultural productivity was a major contributing factor in the sharp reduction in poverty and malnutrition in the country (Jayne et al. 2021). Egypt, Kenya, Nigeria, Tanzania, and Zimbabwe also have sizable extension systems. However, many countries report few or no extensionists working in their national systems. As with agricultural research, Africa significantly underinvests in extension, forgoing opportunities to achieve higher growth in the sector.

Adequate research and extension services are critical components of agricultural innovation systems. They form the core of the enabling environment through which farmers gain access to new technologies to spur innovation and productivity. There are several additional elements of the enabling environment that can accelerate the adoption of agrifood innovations. These are taken up in the next section.

Facilitating Adoption of New Technologies by Farmers

In addition to low investment in high-payoff R&D, a second but related aspect of the agricultural innovation paradox is that farmers often do not adopt the technologies that are available. This "demand" side of the innovation dynamic is as central for policymakers to address as the supply of new technologies. It involves remedying numerous types of market distortions and failures. Clear identification of these constraints and appropriate design of policy remedies are essential for an innovation system to perform well. Key policy elements needed to strengthen the enabling environment for technology adoption include the following:

- ***Remove policy biases against agriculture.*** Policies in many developing countries have discriminated against agriculture, effectively taxing agriculture to provide subsidies to urban dwellers or nonagricultural sectors. Such policies lower returns to agricultural investment, discourage technology adoption, and lead to inefficient use of economic resources. For instance, reforms allowing agricultural prices to reflect market forces and permitting farmers to reap rewards from their efforts have led to large increases in productivity. Conversely, overvalued exchange rates that provide cheaper imports to consumers or trade policies that protect manufacturers impose implicit taxes on the agricultural sector. *It is essential to recognize that even the strongest innovation policies will fail if policy biases make it unprofitable for farmers to expand or experiment with new technologies.*
- ***Increase the capabilities of farmers.*** Boosting the human capital of farmers allows them to better evaluate technological opportunity and manage technology-related investments. However, both the average attainment levels and the quality of schooling are lower in rural areas than in urban areas (Filmer and Fox 2014). This is particularly the case for women, who form a major part of the agricultural workforce and often manage their own farms. Unsurprisingly, the returns to education increase when there are greater opportunities for new technological adoption.
- ***Increase the flow of information to smallholder farmers.*** The traditional argument for supporting agricultural extension services linked to research centers is that farmers are not aware of new technologies or of how to use them optimally. The success of extension and advisory services clearly depends on the quality of the knowledge being diffused. In addition, the performance of extension services can be greatly improved through institutional reforms that include embracing nongovernment actors; increasing accountability to farmers and local authorities; and improving the knowledge, networking, and coordination skills of agents. Finally, new information and communication technology (ICT), often combining voice, text, videos, and internet to interact with farmers, offers the potential to communicate tailored information at lower cost. ICT also opens the door to more sophisticated precision farming methods involving sensing data and satellite imagery to provide precise and real-time crop management advice that is more commonly applied on technologically advanced farms and plantations. Some of the world's newest industries have started to put money and tech talent into farming—the world's oldest industry. Digital soil maps, remote sensing, and GPS guidance are critical tools for modern farmers. "Big data" for precision agriculture can increase yields and efficiency. These high-tech tools mostly benefit big farms that can make large investments in technology. But there are also many innovative ways in which poorer and otherwise disadvantaged people use digital technologies, such as basic mobile phones. Greater efforts to close the digital divide in rural areas can have significant payoffs (World Bank 2016).

- ***Improve access to financial services.*** Formal banking institutions are hampered in servicing smallholder farmers, given the high transaction costs and lack of acceptable forms of collateral. Improving financial services, particularly by offering low-cost and reliable means for poor households to accrue savings, can help smallholder farmers stabilize their household expenditures and lessen their aversion to taking risks and adopting technology. Utilizing ICT to create new instruments such as digital finance and mobile money can dramatically lower the cost of financial transactions. These financial innovations offer new opportunities to extend financial services to better serve smallholder agriculture. Facilitating the establishment of credit histories, developing flexible collateral arrangements, and accounting for seasonality in repayment schedules are all ways to tailor financial services to smallholders' needs. Again, all are facilitated by ICT.
- ***Help farmers manage risk.*** Adopting an unfamiliar new technology fundamentally entails placing an informed bet that potentially poses risks to family income. Insurance institutions can help manage risk, but like financial services, they are hampered in servicing smallholder farmers because of market failures. Innovations such as weather index insurance significantly reduce transaction costs and avoid the pitfalls of moral hazard (where only the riskiest seek insurance) and adverse selection (where the insured take less care of their crops). But adoption of these products has suffered from insufficient targeting of payouts, lack of trust in the provider, and weak financial literacy among clients. Again, technological advances such as satellite-based remote sensing and improvements in agronomic crop models offer potential to improve insurance products and lower risks faced by farmers. Alternatives should be tested, such as developing more sophisticated indexes, providing subsidized policies as a form of social protection, and expanding the market for reinsurance among financial institutions. Importantly, agricultural R&D can be directed toward developing technologies that reduce risk, such as crop varieties that tolerate drought or resist pests and diseases.
- ***Enhance security of land tenure.*** Providing secure tenure to land creates the incentives needed for farmers to invest in land-improving practices, a key element for sustainable and productive land use. Secure tenure can often help farmers obtain better credit, provide an insurance substitute in the event of an income shock, and enhance the asset base of those, such as women, whose land rights are often neglected. Land policies need to be attuned to local conditions. Providing formal title is only one means of increasing tenure security; legal recognition of existing customary rights, with codification of internal rules and mechanisms for conflict resolution, can also greatly enhance occupants' security and lead to better economic efficiency and equity outcomes (Deininger 2003).
- ***Improve rural infrastructure.*** Remoteness from markets is often more a function of the quality of roads than actual distances traveled. The set of technologies that producers in remote locations can profitably adopt is often restricted because of high transport costs resulting from poor infrastructure, which drive up the prices paid for modern inputs and force down the prices received for farm commodities. For instance, in Ethiopia, farmers facing higher transportation and marketing costs were less likely to use modern crop varieties and applied less fertilizer (Minten, Koru, and Stifel 2013). The high costs of transporting inputs to fields and surplus grain back to markets made technology adoption significantly less profitable for these farmers. Investments that improve rural roads and related transport infrastructure can yield high returns.

Each of these policy elements represents a component of the enabling environment whose healthy functioning is an essential complement to investment in R&D. Eliminating distortions and resolving market failures that constrain technology adoption are essential parts of any productivity-enhancement program. However, agricultural policy faces the same dilemma as other policies: that simultaneously resolving multiple market failures is often challenging, given limited government resources and capabilities to diagnose problems and implement successful reforms. One way of reducing the dimensionality of the problem is to identify the most binding constraints in the local context and focus attention on these first. For instance, in many regions that rely on rainfed agriculture, the inability of farmers to adequately manage risk may be a more significant constraint to technology adoption than lack of access to financial services per se. In addition, drawing more heavily on the private sector where possible—for instance, in undertaking R&D—reduces the demand on the capabilities of the public sector.

Summing Up

Building an effective innovation system capable of generating and disseminating innovations for agriculture has been essential for countries wishing to accelerate and sustain productivity growth in this sector. And, given the unique features of agriculture—the diverse set of commodities produced, the prevalence and geographic dispersion of smallholder producers, and the local nature of technology—governments have a large role to play in this innovation system, both as investors in knowledge creation and as supporters of technology dissemination and utilization. This role requires a combination of targeted public investments as well as policy reforms that serve as incentives for public institutions and private companies to create knowledge relevant to the needs of users along the agrifood value chain.

One key responsibility for government is direct spending on agricultural R&D. While nearly all African countries now have public institutions dedicated to agricultural research, most governments continue to significantly underinvest in agricultural research. The high average return that has been earned from public spending on agricultural R&D reflects this underinvestment—significant opportunities for growth are being missed because public resources are being allocated to other areas offering lower returns. Moreover, because spillovers from agricultural R&D are so pervasive (and thus benefits are widely shared in an economy), the social return is much higher than the private return to R&D. Thus, especially for low-income countries, most agricultural research will need to be financed by the public sector. With appropriate incentive policies, the private sector can be expected to take on an increasing share of the technology generation effort for agriculture. But even in high-income countries, public spending still accounts for about half of the overall investment in agricultural R&D.

Countries in SSA in particular continue to invest relatively little in agricultural research, and this region continues to suffer from low levels of agricultural productivity and slow rates of productivity growth. Declining capacity in African agricultural universities is especially worrisome. Low-quality agricultural universities, particularly at the graduate level, where research capabilities are developed, are constraining long-term capacity development in human resources and knowledge creation in this region.

In addition to adequate funding, building an effective public research system requires a set of supportive policies that incentivizes scientists, directs activity to the needs of clients, and is connected to scientific developments in the rest of the world. Specific measures that have been found to improve the performance and impact of public research include the following:

- ***Institutional autonomy.*** Provide flexibility in human resource policies and funding strategies.
- ***Performance-based incentives.*** Reward staff performance and upgrade staff quality.
- ***Stable and diversified funding.*** Supplement robust public support with funding from nongovernment sources.
- ***Program alignment.*** Ensure that research responds to the needs and interests of farmers, agribusinesses, consumers, and government stakeholders.
- ***Linkages to international science networks.*** Promote international connections, which are especially important for small countries, to counter diseconomies of scale in research systems.

Worldwide, the private sector is playing an increasingly important role in developing and disseminating new technologies all along the agrifood value chain. Encouraging the private sector to invest in research and technology transfer in agrifood is another key component of a national innovation strategy. In a competitive marketplace, private innovation can be especially adroit in responding to rapidly changing consumer and market demands for new, more diverse, safer, and more nutritious foods. Specific measures governments can take to encourage private sector innovation include the following:

- ***Liberalize food and agricultural input markets.*** Allow private companies, foreign and domestic, to invest in and sell improved technologies to farmers and new food products to consumers, and ensure that these markets are competitive.
- ***Protect intellectual property.*** Enable private innovators to earn adequate returns to their sunk costs in research and product development.
- ***Reduce burdensome regulation.*** Focus science-based regulations on product safety and efficacy, harmonize regulatory protocols to avoid redundant product testing, and allow technology imports.

- ***Lower the cost of R&D.*** Use public institutes' and universities' R&D to expand the supply of R&D resources and knowledge.

In addition to the R&D investments necessary to generate innovations, farmers need a supportive enabling environment to access new technologies and successfully adopt them. Removing policy biases that lower returns to agricultural activities will encourage farmers to invest in new technologies and raise their productivity. Examples of policies that have discriminated against agriculture include government interventions that push commodity prices below market levels, limit trade, overvalue exchange rates, put high tariffs on imported agricultural inputs and export commodities, and offer protection for nonagricultural sectors. The high costs of marketing and transport services also impose large costs on the agricultural sector and limit incentives for technology adoption. Public investment in rural feeder roads and policies to assure competitively priced marketing services can significantly reduce marketing margins and raise returns to technology adoption.

Public support for extension and training can accelerate technology adoption and improve efficiency in crop selection, farm and marketing management, and resource allocation. But R&D institutions need to be capable of adapting technologies to local conditions and addressing farmers' practical needs. New opportunities and models have emerged that diversify the provision of agricultural advisory services beyond the public extension agent. But except for some specific high–value added market chains, farm advisory services, even if provided by the private sector, will likely require a public subsidy. Innovations in "e-extension" using ICT to deliver messages to farmers offer opportunities for advisory services to reach more clients at a significantly lower cost per farmer. But again, because of the public-good nature of information, even e-extension is unlikely to be adequately supplied if provision is strictly on a fee-for-service basis. Increased public investment in quality advisory services is likely to be necessary for rapid uptake of new technologies by smallholder farmers.

Improving financial services and offering farmers options to manage risk, such as offering reliable means for low-income households to accrue savings, can help smallholder farmers stabilize their household expenditures and lessen their aversion to risk taking. Utilizing ICT to create new instruments such as digital finance and mobile money can dramatically lower the cost of financial transactions. These innovations offer new opportunities to extend financial services that better serve smallholder agriculture. Securing land tenure rights for farmers, especially for women and other disadvantaged groups, can improve their access to formal credit. Tenure security also strengthens the incentive to invest in land improvement and conserve natural resources.

Finally, investing in people will improve the prospects for inclusive agricultural and economic growth. As agricultural productivity grows and the demand for nonfarm goods and services increases, more farm labor will exit agriculture and move to other sectors and urban areas. Improving the quality and availability of rural education and healthcare will facilitate this structural transformation. But significant gaps in access to quality schooling—between rural and urban populations and between boys and girls—persist in many countries and need to be closed.

While the list of policy priorities for the enabling environment may seem long, individual countries and communities can focus on addressing the most constraining factors first. Moreover, many countries already commit considerable resources to low-return activities, such as subsidizing private goods or favoring particular firms or industries. Shifting public resources to high-return investments in public goods such as well-designed R&D, extension, and infrastructure and removing impediments to competitive markets can be extremely effective in crowding in private investment and stimulating sustained growth in agricultural productivity.

The miracle of increasing agricultural productivity has nourished people and lifted people out of poverty to a degree that would have been unimaginable to our ancestors. However, adapting agriculture to new and possibly dramatically changing contexts requires a sustained process of experimentation and scientific inquiry. Continuing this trend will be vital in the push to end global poverty and create fulfilling livelihoods for all.

CHAPTER 13

Tracking Key CAADP Indicators and Implementation Processes

Julia Collins, Wondwosen Tefera, and Augustin Wambo Yamdjeu

Introduction

2023 marks two decades since the 2003 launch of the Comprehensive Africa Agriculture Development Programme (CAADP), a continentwide framework for agriculture-led development. The implementation of CAADP has coincided with a period of strong agricultural and economic growth across Africa. CAADP has been credited with galvanizing increased recognition by the international community of the key role agriculture plays in broader economic development on the continent (Benin et al. 2018). After the first decade of implementation, the CAADP agenda was deepened through the 2014 *Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods* (AUC 2014). Through the Malabo Declaration, African leaders recommitted to the principles and values of CAADP, including evidence-based planning, dialogue, and review, and reaffirmed the original CAADP targets of achieving 6 percent annual agricultural growth and 10 percent of public expenditures being directed to agriculture. The 2014 Declaration further expanded the CAADP commitments to include sharply reducing hunger and poverty, expanding intra-continental trade, building resilience to the adverse effects of climate change, and strengthening mutual accountability for CAADP-focused actions and results to advance agricultural transformation in Africa. The CAADP Biennial Review was designated as the operational tool to monitor the progress of African countries toward achieving these commitments.

Several of the Malabo Declaration targets, including doubling agricultural productivity, halving poverty, and tripling intra-African agricultural trade, have a timeline to achievement by 2025. In 2023, close to a decade after the Malabo Declaration, African leaders began the process of envisioning the next stage of CAADP under a new post-Malabo agenda. As a backdrop to these efforts, it is important to look back on what has been achieved during the first two decades of CAADP implementation.

The Regional Strategic Analysis and Knowledge Support System (ReSAKSS) was established in 2006 to support the successful implementation of CAADP by providing policy-relevant data and analysis to facilitate informed dialogue among stakeholders; monitoring progress toward achieving goals and targets; and strengthening mutual accountability processes at the continental, regional, and national levels.[1] Starting in 2007, at the behest of the African Union Commission (AUC), ReSAKSS led the development of the first monitoring and evaluation framework for assessing CAADP implementation progress and performance (Benin, Johnson, and Omilola 2010). Between 2008 and 2014, ReSAKSS used this framework to track CAADP implementation processes and the performance of AUC member-states in allocating 10 percent of national budgets to the agriculture sector and achieving 6 percent agricultural growth nationally. With the Malabo Declaration broadening the CAADP agenda by adding new commitment areas, AUC and the African Union Development Agency–New Partnership for Africa's Development (AUDA-NEPAD) developed a new CAADP Results Framework (RF) for 2015–2025 for measuring the progress of AUC member-states in CAADP implementation, including monitoring their progress toward meeting the Malabo commitments (AUC and NPCA 2015).

The CAADP RF is organized on three levels: outcomes (Level 1), outputs (Level 2), and inputs (Level 3.):

- Level 1 centers on the broader development outcomes and impacts to which agriculture contributes. These include wealth creation, food and nutrition security, enhanced economic opportunities, poverty alleviation, shared prosperity, and resilience and sustainability.
- Level 2 considers the outputs from interventions intended to transform the agriculture sector and to achieve inclusive growth. The outputs of interest include improved agricultural production and productivity, increased intra-African trade, more functional agrifood markets, expanded local agro-industry and value chain development that is inclusive of women and youth, more effective management of risks and increased resilience in agricultural livelihoods, and improved management of natural resources for sustainable agriculture.

1 ReSAKSS is facilitated by AKADEMIYA2063 and works closely with CAADP stakeholders across the continent, as well as with some of the international agricultural research centers of the CGIAR. The ReSAKSS activities discussed in this chapter were carried out in collaboration with the African Union Commission (AUC), the African Union Development Agency–New Partnership for Africa's Development (AUDA-NEPAD), regional economic communities, national governments, farmer organizations, members of the African and international research communities, and development partners.

- Level 3 focuses on the inputs and processes required to strengthen systemic capacity to deliver the CAADP results and to create an enabling environment in which agricultural transformation can take place across Africa. These inputs include effective and inclusive policy processes; effective and accountable institutions that regularly assess the quality of implementation of CAADP-related policies and commitments; strengthened capacity for evidence-based planning, implementation, and review; improved multisectoral coordination, partnerships, and mutual accountability in sectors related to agriculture; increased public and private investments in agriculture; and increased capacity to generate, analyze, and use data, information, knowledge, and innovations.

There are 38 indicators in the CAADP RF—14 for the outcomes of Level 1, 12 for the outputs of Level 2, and 12 for the inputs of Level 3 (Table 13.1).

ReSAKSS has tracked progress on CAADP indicators across the three levels of the RF for 2015–2025 through its flagship Annual Trends and Outlook Report (ATOR) and website (www.resakss.org). The CAADP RF also was designed to help track progress in implementing the seven commitments of the Malabo Declaration. With the launch of the CAADP Biennial Review (BR) process in 2015, additional indicators were formulated for monitoring each of the seven Malabo commitments using the Africa Agriculture Transformation Scorecard. Twenty-four of the BR indicators were drawn directly from the CAADP RF. However, by the third BR cycle of 2021, an additional 23 new indicators had been added, for a total of 47 BR indicators (Table 13.1).

The BR is the paramount continentwide mutual accountability process for Africa's agriculture sector. It enables AU member states to collectively review their individual and joint progress toward the goals and targets set under the seven Malabo commitments.

However, the CAADP RF is an important complement to the BR process, as its indicators provide additional context for the BR results and its coverage enables a range of analyses across the continent and over time. This chapter reviews progress on CAADP using the CAADP RF indicators. The RF data assembled by ReSAKSS are consistently available for a larger number of countries and for longer time periods than is the case for the BR data. The RF data allow for a broader set of aggregations across countries—such as by economic categories, regional economic communities, and stage of CAADP implementation—and deeper examinations of trends over time than does the BR data set.

TABLE 13.1—CAADP RESULTS FRAMEWORK AND CAADP BIENNIAL REVIEW AND AFRICA AGRICULTURE TRANSFORMATION SCORECARD, NUMBER OF INDICATORS BY LEVEL OR COMMITMENT

CAADP Results Framework	Number of indicators
Level 1: Agriculture's contribution to economic growth and inclusive development	14
Level 2: Outputs to contribute to agricultural transformation and inclusive growth	12
Level 3: Systemic capacity to deliver results for agricultural transformation	12
Total	**38**
CAADP Biennial Review and Africa Agriculture Transformation Scorecard	
Commitment 1: CAADP processes and values	3
Commitment 2: Investment finance in agriculture	6
Commitment 3: Ending hunger by 2025	21
Commitment 4: Halving poverty by 2025	8
Commitment 5: Boosting intra-African trade in agricultural commodities and services	3
Commitment 6: Enhancing resilience to climate variability	3
Commitment 7: Mutual accountability for results and actions	3
Total	**47**

Source: Authors based on AUC and NPCA (2015) and AUC (2014).

With 47 indicators, the CAADP BR indicators are broader in coverage than the RF indicators. However, there is considerable overlap between the two sets of indicators. ReSAKSS tracks progress on 18 CAADP RF indicators that also are found in the CAADP BR set of indicators (Table 13.2).

Six other indicators overlap between the CAADP RF and the CAADP BR. However, these indicators are not yet included in the ReSAKSS database because the data either are not available at all or are not available across all countries to allow for cross-country aggregation. These include indicators on postharvest loss, women's and children's dietary adequacy, resilience, sustainable land management, and capacity of statistical systems.

Data gaps in other areas covered under the CAADP RF, particularly on social protection and private sector investment, mean that currently only 27 of the 38 CAADP RF indicators can be tracked (Table 13.2). Although discussions that include the CAADP technical partners and the Biennial Review Technical Working Groups are underway to identify strategies to fill these data gaps, increasing the availability of the missing data is challenging. Resolute efforts by countries and their partners will be necessary to develop and fund comprehensive CAADP data collection processes.

Objectives of the Chapter

In keeping with the role of the ATOR as the official CAADP Monitoring and Evaluation report, this chapter reviews progress in CAADP implementation processes by examining changes in and the current status of the CAADP RF indicators. The assessment presented in this chapter will contribute to the design of the post-Malabo agenda for agriculture-led development in Africa by highlighting the successes and progress made under CAADP as well as the gaps and deficiencies that need to be addressed if future development efforts are to succeed.

The CAADP implementation process is led by AUC and AUDA-NEPAD working in collaboration with national governments, regional economic communities (RECs), non-state actors, and development and technical partners. The chapter aims to characterize trends over the entire CAADP period and identify both areas of strong performance and areas where greater attention is required to accelerate progress. The chapter discusses progress across various geographic and economic groupings of African countries, comparing trends during the first five years after the adoption of CAADP (2003–2008) with later subperiods (2008–2014 and 2014–2022). Specific attention is paid to the progress achieved under country and regional efforts to develop Malabo-compliant national agriculture investment plans (NAIPs) and to operationalize CAADP mutual accountability processes through agriculture joint sector reviews (JSR) and the CAADP BR.

TABLE 13.2—CAADP RESULTS FRAMEWORK INDICATORS

TABLE 13.2—CAADP RESULTS FRAMEWORK INDICATORS
LEVEL 1: Agriculture's contribution to economic growth and inclusive development
1. L1.1.1 Gross domestic product (GDP) per capita, constant 2015 US$
2. L1.1.2 Household final consumption expenditure per capita, constant 2015 US$
3. L1.2.1 Prevalence of undernourishment, % of population
4. L1.2.2a Prevalence of underweight (weight for age), % of children under five years of age
5. L1.2.2b Prevalence of stunting, (height for age), % of children under five years of age
6. L1.2.2c Prevalence of wasting, (weight for height), % of children under five years of age
7. L1.2.3 Cereal import dependency index
8. L1.3.1 Employment rate
9. L1.3.3 Poverty gap at US$2.15 a day (2017 PPP)
10. L1.3.4 Extreme poverty headcount ratio at US$2.15 a day (2017 PPP), % of population
LEVEL 2 Agricultural transformation and sustained inclusive agricultural growth
11. L2.1.1 Agriculture value added, constant 2015 US$ (million)
12. L2.1.2 Agriculture Production Index (2014 to 2016 = 100)
13. L2.1.3 Agriculture value added per agricultural worker, constant 2015 US$
14. L2.1.4 Agriculture value added per hectare of agricultural land, constant 2015 US$
15. L2.1.5 Yield for the five most important agricultural commodities
16. L2.2.1 Value of intra-African agricultural trade, constant 2015 US$ (million)
17. L2.4.2 Existence of food reserves, local purchases for relief programs, early warning systems, and school feeding programs
Level 3 Strengthening systemic capacity to deliver results
18. L3.1.1 Existence of National Agriculture and Food Security Investment Plan (NAFSIP) or National Agriculture Investment Plan (NAIP) developed through an inclusive and participatory process
19. L3.2.1 Existence of inclusive institutionalized mechanisms for mutual accountability and peer review
20. L3.3.1 Existence of and quality in the implementation of evidence-informed policies and corresponding human resources
21. L3.4.1 Existence of a functional multisectoral and multistakeholder coordination body
22. L3.4.2 Cumulative number of agriculture-related public-private partnerships successfully undertaken
23. L3.4.3 Cumulative value of investments in public-private partnerships
24. L3.5.1 Government agriculture expenditure, constant 2015 US$ (billion)
25. L3.5.2 Government agriculture expenditure, % of total government expenditure
26. L3.5.3 Government agriculture expenditure, % of agriculture value added
27. L3.6.2 Existence of operational country Strategic Analysis and Knowledge Support System (SAKSS)

Source: Authors, based on AUC and NPCA (2015).
Note: PPP = purchasing power parity. Shaded cells indicate that the Results Framework indicators are also Biennial Review indicators.

The next section discusses progress in CAADP implementation processes by examining progress on 27 of the 38 CAADP RF indicators for which cross-country data are available (Table 13.2). (Further details on all indicators are available in the data tables in Annexes 1–3 of this report.) The section describes general progress in the CAADP implementation process, while also highlighting the contributions of ReSAKSS, as a technical partner to AUC and AUDA-NEPAD, to the progress achieved.

Progress in CAADP Implementation Processes

Implementation Support

The *Country CAADP Implementation Guidelines under the Malabo Declaration*, developed by the AUC and AUDA-NEPAD (2016), outline four major stages of CAADP implementation at the country level:

- Domestication of the Malabo Declaration,
- Development of a Malabo-compliant NAIP,
- Implementation of the NAIP, and
- Assessment of NAIP implementation progress through an agriculture JSR.

For the first stage, a Malabo domestication event led by AUC, AUDA-NEPAD, and RECs is held to convene national CAADP constituencies to agree on a roadmap toward reviewing the current NAIP, if any, and developing a revised NAIP. Twenty-five African countries have held Malabo Domestication events to date, including nearly all southern African countries and most western African countries (Annex Table L3(a)). In other regions of Africa, the rollout of Malabo domestication events has been less consistent.

To be considered Malabo-compliant, a NAIP should have been assessed through an AU-led independent technical review as being aligned with the goals and targets of the Malabo Declaration and the recommendations from the review mission should have been integrated into the final NAIP document. A total of 36 African countries have developed and validated first-generation NAIPs—that is, either pre-Malabo Declaration NAIPs or NAIPs not assessed as aligned with the Malabo Declaration (Annex Table L3(a)). Three RECs have also developed first-generation Regional Agriculture Investment Plans. Malabo-compliant NAIPs—also referred to as second-generation NAIPs—as of September 2023, have been developed in 42 countries, including all western African countries and in most countries in the other regions of Africa. ReSAKSS provided analytical support for Malabo-compliant NAIP design in several countries. This included supporting national partners in 31 countries to develop Malabo Status Assessment and Profile reports, which summarize current progress on BR commitment areas, and in 25 countries to draft Malabo Goals and Milestones reports, which identify projected outcomes of alternative agricultural investments.

Progress on Malabo domestication and the development, assessment, and implementation of Malabo-compliant NAIPs has faced challenges at the country, REC, and continental levels. These often have been related to insufficient human capital, technical capacity, or financial resources or to inadequate coordination mechanisms (AUDA-NEPAD 2022, Collins et al. 2022). Finding ways to address these challenges will be vital to the success of the implementation of the post-Malabo agenda for agriculture-led development in Africa.

The CAADP and Malabo Declaration principle of mutual accountability has been operationalized through the twin processes of the BR and agriculture JSRs at national, regional, and continental levels. JSRs provide an inclusive, evidence-based platform for agricultural stakeholders to jointly review progress; hold each other accountable for actions, results, and commitments; and, based on gaps identified, agree on future implementation actions. Because JSRs are the bedrock for inclusive and comprehensive mutual accountability processes, AUC, AUDA-NEPAD, and technical partners, including ReSAKSS, have supported countries and RECs to embed their BR process into national and regional JSR processes. At the request of AUC and AUDA-NEPAD, ReSAKSS has helped to strengthen agriculture JSRs since 2014 by conducting assessments of JSR or JSR-like processes at country and regional levels, completing JSR assessments in 21 countries and in two RECs (Annex Table L3(a)). These JSR assessments evaluate the institutional and policy landscape and the quality of current agricultural review processes and identify areas that need additional strengthening to help countries and RECs develop regular, comprehensive, and inclusive JSR processes.

Biennial Review

AUC tracks the implementation of the Malabo Declaration through the BR process. So far, three BRs have been completed—in 2017 (AUC 2018), 2019 (AUC 2020), and 2021 (AUC 2021). Since mid-2022, AUC and AUDA-NEPAD, in collaboration with partners, including ReSAKSS, have been engaged in the latest CAADP BR reporting process. The fourth BR cycle started in August 2022 with a critical analysis of the last three BRs to identify what worked well in each and what needed to be improved in subsequent BRs (AUC 2023). The critical analysis included technical reviews of each BR by thematic area, including indicators and parameters; the scorecard methodology; data sources; technical guidelines; and the country reporting templates, including the electronic reporting system, the eBR. In preparation for the fourth BR, ReSAKSS contributed to the revision of BR technical guidelines, country reporting templates, and improvements to eBR.

The critical analysis done in the lead-up to the fourth BR brought into the BR process five new performance categories and 12 new indicators in four thematic areas (Table 13.3). The total number of BR performance categories increased to 29 and the number of BR indicators now is 59. In consequence, several new parameters will need to be collected on these new indicators for the fourth BR. As discussed in Chapter 2 of this ATOR, a total of 334 parameters were required to report on the indicators during the third BR of 2021. During the fourth BR cycle, the required number of parameters was further increased.

ReSAKSS has been actively participating in the fourth BR process. ReSAKSS experts took part in training on indicator profiles and BR data quality for all of the Malabo commitment themes and on the use of eBR at continental and REC levels. For their fourth BR preparations, ReSAKSS staff also provided in-depth technical support to 10 countries: Benin, Botswana, Burkina Faso, Kenya, Malawi, Mozambique, Senegal, Togo, Uganda, and Zimbabwe. ReSAKSS also supported regional and continental data validation for the fourth BR by reviewing the national BR data reports submitted by member states. Moreover, ReSAKSS has been actively participating in writeshops to draft the continental report for the fourth CAADP BR. In early 2024, AUC will release the fourth BR report together with the African Agriculture Transformation Scorecard.

In addition, drawing on the third BR report of 2021, AKADEMIYA2063 so far has published 17 BR briefs covering Africa as a whole, several RECs, and a dozen countries. These were prepared in collaboration with country and regional CAADP focal persons. The briefs highlight the performance of the continent, REC, or country as documented through the 2021 BR and discuss the policy actions that will be required for the continent, REC, or country in question to meet the Malabo Declaration commitments by 2025.

Progress on CAADP Indicators

This section discusses Africa's performance on 27 of the 38 CAADP RF indicators for which data are available, organized by the three RF levels. Data on the 27 indicators are presented in Annexes 1 to 3. Progress on the quantitative indicators is presented at the aggregate level for seven different groupings:

- Africa as a whole
- AU's five geographic regions—central, eastern, northern, southern, and western
- Five economic categories—low-income countries with less favorable agricultural conditions, low-income countries with more favorable agricultural

TABLE 13.3—NUMBER OF NEW PERFORMANCE CATEGORIES AND NEW INDICATORS, BY MALABO COMMITMENT

Malabo commitment	New performance categories, number	New indicators, number
Commitment 1: CAADP processes and values	-	-
Commitment 2: Investment finance in agriculture	-	-
Commitment 3: Ending hunger by 2025	1	5
Commitment 4: Halving poverty by 2025	-	-
Commitment 5: Boosting intra-African trade in agricultural commodities and services	1	4
Commitment 6: Enhancing resilience to climate variability	1	1
Commitment 7: Mutual accountability for results and actions	2	2
Total	**5**	**12**

Source: AUC (2023).

conditions, mineral-rich low-income countries, lower middle-income countries, and upper middle-income countries[2]

- Eight RECs—Community of Sahel-Saharan States (CEN-SAD), Common Market for Eastern and Southern Africa (COMESA), East African Community (EAC), Economic Community of Central African States (ECCAS), Economic Community of West African States (ECOWAS), Intergovernmental Authority on Development (IGAD), Southern African Development Community (SADC), and Arab Maghreb Union (UMA)
- By the period during which the country signed the CAADP compact—CC0, CC1, CC2, and CC3[3]
- By the level or stage of CAADP implementation reached by the country by the end of 2015—CL0, CL1, CL2, CL3, and CL4[4]
- By whether the country has formulated a first- or second-generation NAIPs—N00, N10, N01, and N11[5]

Annex 4 lists countries in the various geographic, economic, and REC categories; Annex 5 lists the countries in the different groupings for CAADP compact signing or level of implementation reached; and Annex 6 lists countries by NAIP formulation category. Complete information for all categories is provided in Annexes 1 to 3. The discussion here focuses on progress among different geographic groupings, economic categories, RECs, and NAIP categories. Progress is reported over different subperiods, with achievement in the early CAADP subperiod of 2003–2008 compared with achievements in the later subperiods of 2008–2014 and 2014–2022.[6] For all indicators, changes over periods are reported in terms of annual average percent change.

The discussion of trends and changes in CAADP indicators pertains to country categories or groupings as a whole and not to individual countries within the categories—for example, the measures reported relate, for example, to Africa as a whole, central Africa as a group, ECOWAS members as a group, and groups of countries categorized by their stage of NAIP formulation experience. Presenting the trends by different groups helps to determine how the implications for strengthening or maintaining desirable outcomes or for reversing undesirable outcomes under the CAADP process may differ across the continent, without inference of causality.

CAADP Results Framework Outcome (Level 1) Indicators: Agriculture's Contribution to Economic Growth and Inclusive Development

Wealth Creation

The launch of CAADP coincided with strong and widespread economic growth in Africa that began in the early 2000s. However, the rapid growth of the 2000s slowed during the 2010s. The COVID-19 crisis between 2020 and 2022 and the Russia-Ukraine war starting in 2022 both presented major challenges to maintaining positive economic progress. As shown in Figure 13.1, Africa's GDP per capita increased by an annual average of 3.2 percent during the 2003–2008 period,

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2 The five economic categories are exclusive, with countries first classified as low-income, lower middle-income, and higher middle-income. Low-income countries are then classified as having more or less favorable agricultural conditions. Then, countries with more favorable agricultural conditions are classified as mineral-rich or not. See Benin et al. (2010) for a description of the categorization methodology and the criteria used for classifying countries based on income, favorability of agricultural conditions, and mineral wealth.

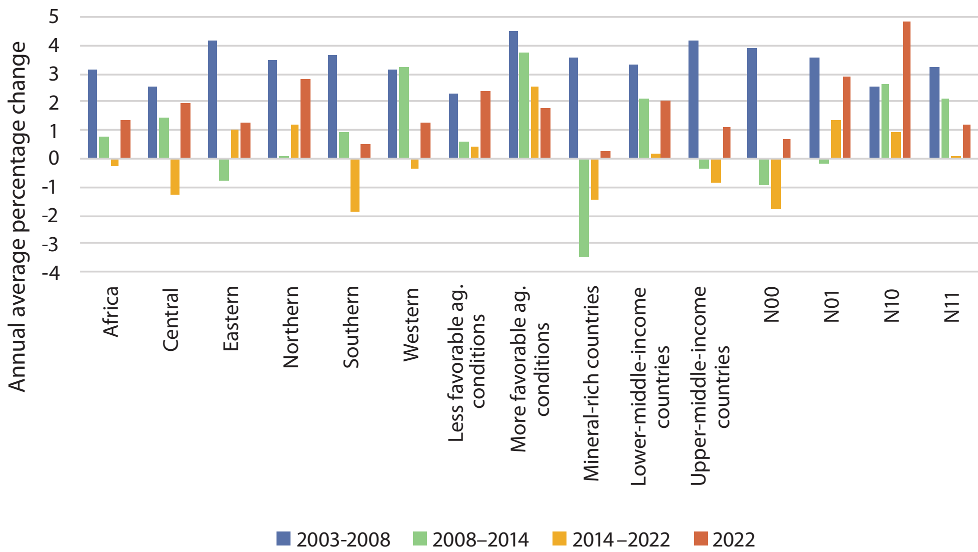
3 CC0 = group of countries that have not signed a CAADP compact; CC1 = group of countries that signed the compact in the period 2007 to 2009; CC2 = group of countries that signed the compact between 2010 and 2012; CC3 = group of countries that signed the compact between 2013 and 2015.

4 CL0 = group of countries that have not started the CAADP process or have not yet signed a compact; CL1 = group of countries that have signed a CAADP compact; CL2 = group of countries that have signed a compact and formulated a NAIP; CL3 = group of countries that have signed a compact, formulated a NAIP, and secured one external funding source; CL4 = group of countries that have signed a compact, formulated a NAIP, and secured more than one external funding source. Obtaining funding for NAIPs is an important step in CAADP implementation, as countries that have secured external funding are expected to be better able to implement NAIPs and other agricultural investments (Benin 2016).

5 N00 = group of countries that have neither a first-generation NAIP (NAIP1.0) nor a second-generation NAIP (NAIP2.0); N10 = group of countries that have NAIP1.0 but do not have NAIP2.0; N01 = group of countries that have NAIP2.0 but not NAIP1.0; N11 = group of countries that have both NAIP1.0 and NAIP2.0. A second-generation NAIP refers to a NAIP that takes into account the commitments of the 2014 Malabo Declaration. Thus, a NAIP for a country can be considered second-generation even if the country does not have a pre-Malabo Declaration, first-generation NAIP. Such countries are in country category N01.

6 Considering that CAADP was launched in 2003, renewed in 2008, and renewed again in 2014 with the Malabo Declaration, the years 2003, 2008, and 2014 represent important CAADP milestones. Therefore, the post-CAADP subperiods for reporting on progress use overlapping years to reflect that these milestones usually occurred in June in the middle of the year—that is, 2003 to 2008, 2008 to 2014, and 2014 to 2022.

FIGURE 13.1—GROSS DOMESTIC PRODUCT PER CAPITA, CONSTANT 2015 US DOLLARS, ANNUAL AVERAGE PERCENTAGE CHANGE, 2003–2022



Source: ReSAKSS based on World Bank (2023) and ILO (2023a)

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

but growth slowed to 0.7 percent on average during the 2008–2014 period. Per capita GDP growth turned negative during the next period, with average incomes declining by an average of 0.2 percent per year during 2014–2022, with a sizable contraction in economies at the onset of the COVID-19 pandemic in 2020 as well as slow growth or slight declines in years before the pandemic.

Incomes have begun to recover since the height of the pandemic, with GDP per capita increasing by 1.4 percent in 2021 and 2022. However, GDP per capita levels had not yet recovered in 2022 to their levels before the pandemic, being only moderately higher than their levels two decades prior—US$1,971 in 2022 on average compared with US$1,640 in 2003 (Annex Table L.1.1.1).[7]

The strongest growth in GDP per capita for most of the country groupings is seen during the period from 2003 to 2008, with decelerating or negative growth thereafter. However, several country groupings maintained positive growth throughout the CAADP period with no periods of economic contraction. These include northern Africa, lower income countries with less favorable agricultural conditions, lower income countries with more favorable agricultural conditions, and lower middle-income countries. In addition, countries that developed a first-generation NAIP (the N10 and N11 countries) avoided growth declines. In contrast, the largest declines in GDP per capita during the period from 2014 to 2022 were seen in the southern African countries (-1.8 percent) and countries with neither a first- nor a second-generation NAIP (N00 countries, -1.8 percent). Mineral-rich countries had negative per capita GDP growth both during the period from 2008 to 2014 (-3.4 percent) and from 2014 to 2022 (-1.4 percent).

The level of GDP per capita differs markedly between regions (Annex Table L.1.1.1). Average incomes in Central Africa in 2022 were less than half the continental average, at US$821, while in Northern Africa they were around twice the average at US$3,950. Western Africa was the geographic region with the largest growth in GDP per capita over the entire CAADP implementation period to date with a nearly 40 percent increase in GDP per capita between 2003 (US$1,345) and 2022 (US$1,868).

Household consumption expenditure measures household spending on goods and services. As with GDP per capita, annual household consumption expenditure per capita grew relatively rapidly for Africa as a whole between 2003 and 2008, increased more slowly between 2008 and 2014, and has fallen moderately since 2014 (Figure 13.2, Annex Table L1.1.2)., household spending dipped more noticeably in 2020, reflecting the adverse economic effects of the COVID-19 pandemic and remained close to the 2020 level for the next two years. Among the geographic regions, only eastern Africa and northern Africa showed positive growth during the period from 2014 to 2022—very moderate for eastern Africa and somewhat stronger for northern Africa (Annex Table L1.1.2). Northern Africa showed the strongest overall growth in per capita household spending over the entire CAADP period, increasing from US$1,679 in 2003 to US$2,665 in 2022. Increases were more muted in other regions, while southern Africa experienced an overall decrease in annual household consumption expenditure per capita between 2003 and 2022.

7 Unless otherwise stated, all monetary values reported have been converted into constant 2015 US dollar prices for intertemporal and cross-country or cross-category comparisons.

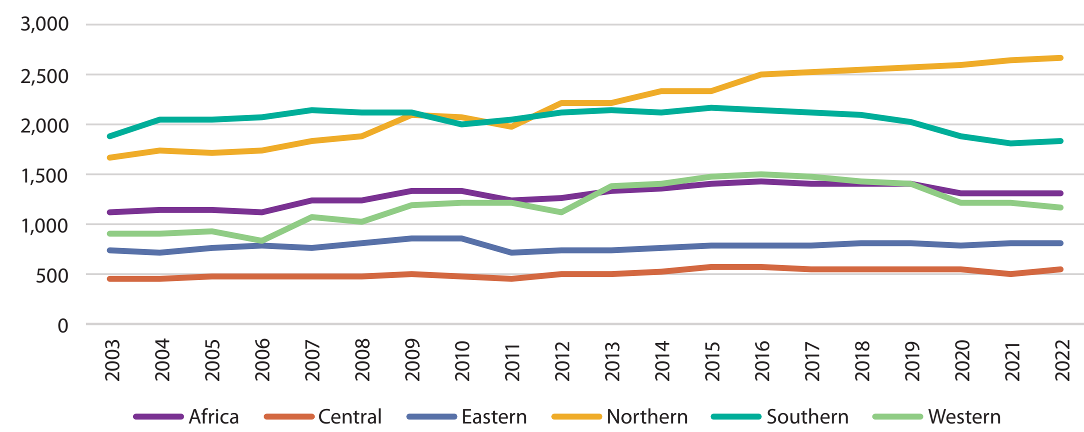
Food and Nutrition Security

Slowing economic growth and successive economic crises have had significant impacts on food and nutrition security in Africa. The prevalence of undernourishment, which measures the proportion of the population with caloric intake below the minimum dietary energy requirement, declined steadily through the early CAADP periods, but showed large annual increases of 3.8 percent between 2014 and 2021 (Figure 13.3, Annex Table L.1.2.1). The COVID-19 pandemic contributed to increases in 2020 and 2021, but undernourishment had already been rising since the mid-2010s in Africa as a continent and in most country groupings (Tefera, Collins, and Makombe 2021). In 2021, the last year with available data, the prevalence of undernourishment stood at 19.7 percent for Africa as a whole, only slightly lower than the prevalence at the 2003 launch of CAADP of 21.6 percent (Annex Table L.1.2.1).

Nearly all of the country groupings examined show similar patterns in undernourishment over time, with declining rates during the periods from 2003 to 2008 and from 2008 to 2014, but rising rates thereafter. Exceptions include upper middle-income countries—which showed increases during all three time periods—and western Africa and countries that developed a first-generation but not a second-generation NAIP (N10 countries)—these two country groups showed a rising prevalence of undernourishment already during the period from 2008 to 2014.[8] Increasing undernourishment in the period from 2014 to 2021 was widespread, affecting every country grouping examined. However, countries with neither a first- nor a second-generation NAIP (N00 countries) showed the highest annual increase in undernourishment during this period of 7.6 percent. As of 2021, by country group, the prevalence of

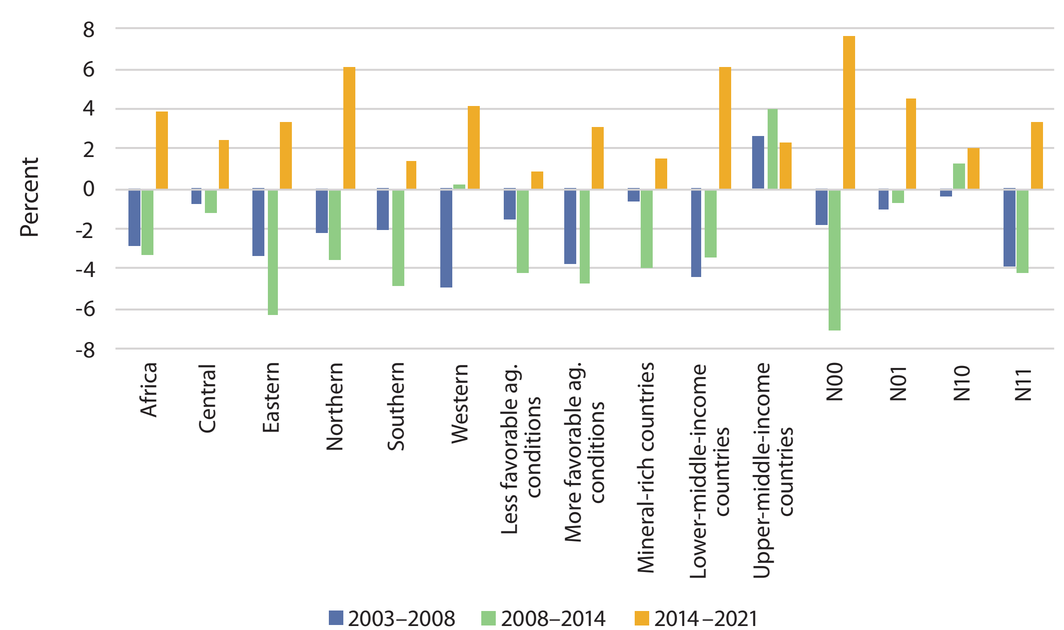
8 It should be noted that only eight African countries fall into the upper middle-income category (see Annex 4); country-specific factors may explain the rising hunger levels in this group. For example, in South Africa, declining food security during the early 2010s despite adequate food availability in the aggregate has been attributed to high food price inflation and high unemployment (Nenguda and Scholes 2022, Oxfam 2014).

FIGURE 13.2—ANNUAL HOUSEHOLD CONSUMPTION EXPENDITURE PER CAPITA, CONSTANT 2015 US DOLLARS, 2003–2022



Source: ReSAKSS based on World Bank (2023) and ILO (2023a).

FIGURE 13.3—PREVALENCE OF UNDERNOURISHMENT, ANNUAL AVERAGE PERCENTAGE CHANGE, 2003–2021



Source: ReSAKSS based on FAO (2023), World Bank (2023), and ILO (2023a).

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

undernourishment was highest in N10 countries at nearly 35 percent, followed by countries in central Africa at close to 30 percent. Despite the consistent rises in undernourishment in upper middle-income countries, this group still had among the lowest prevalences as of 2021 at 8.8 percent. By region, northern African countries had the lowest undernourishment rate of 6.4 percent.

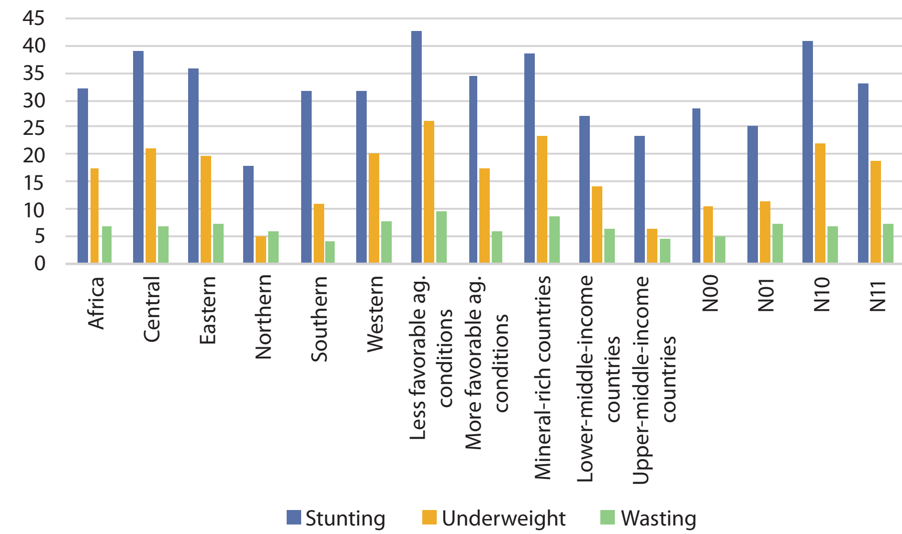
Figure 13.4 shows average prevalences during the period from 2014 to 2021 of three key measures of undernutrition in children under five years of age: stunting, or low height for age; underweight, or low weight for age; and wasting, or low weight for height.

- At the continental level, stunting, a measure of chronic child malnutrition, affected nearly a third of children under five (32 percent) in 2014–2021, with even higher rates in central Africa, low-income countries with less favorable agricultural conditions, and countries with only a first-generation NAIP (N10).
- The continental prevalence of child underweight was 17 percent during the same period, with similar patterns as stunting among country groups—the highest rates were found in central Africa, low-income countries with less favorable agricultural conditions, low-income mineral-rich countries, and N10 countries.
- For wasting, a measure of acute child malnutrition, the pattern differed slightly, with the highest rates in western Africa, low-income countries with less favorable agricultural conditions, low-income mineral-rich countries, and countries with only a second-generation NAIP. The continental average was 7 percent in the period between 2014 and 2021.

Upper middle-income countries had among the lowest rates for all three measures of child undernutrition. Northern Africa had the lowest rates for stunting and underweight, while southern Africa had relatively low rates for underweight and wasting.

Although child malnutrition remains worryingly high, its prevalence has decreased steadily throughout the CAADP period. At the continental level, each indicator showed annual average declines of between 1.0 and 2.5 percent during all three periods. Nearly all country groupings showed consistent reductions in child malnutrition as well. Exceptions to this general pattern were seen in the countries of northern Africa and in the N01 group—in both of which stunting

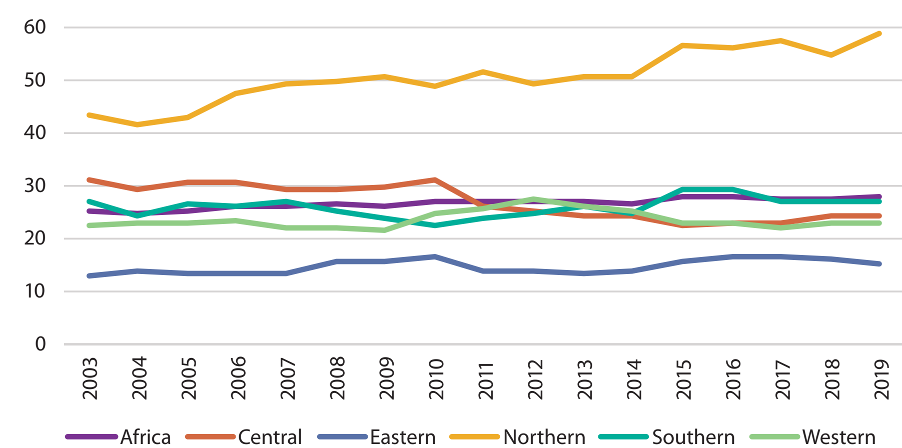
FIGURE 13.4—PREVALENCE OF UNDERWEIGHT, STUNTING, AND WASTING IN AFRICA, PERCENTAGE OF CHILDREN YOUNGER THAN FIVE YEARS, 2014–2021 AVERAGE



Source: ReSAKSS based on World Bank (2023) and ILO (2023a).

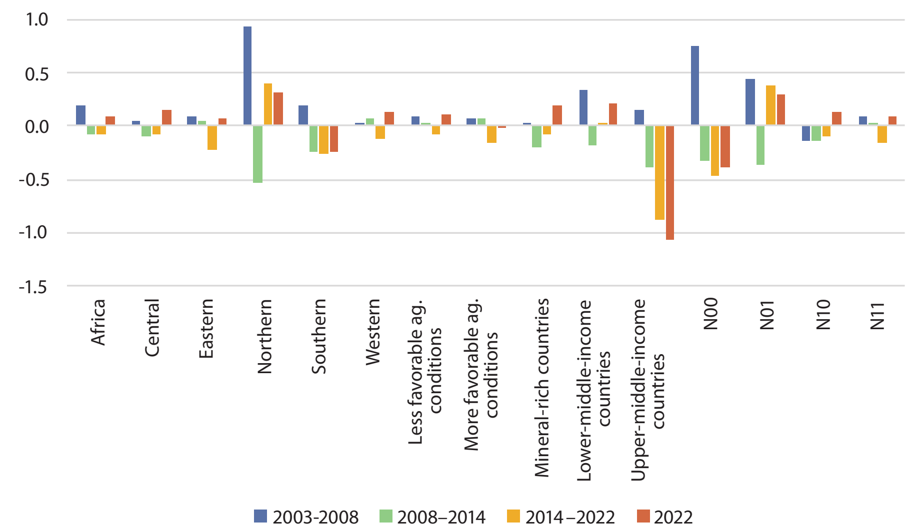
Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

FIGURE 13.5—CEREAL IMPORT DEPENDENCY RATIO, PERCENT OF TOTAL DOMESTIC CEREAL SUPPLY, 2003–2019



Source: ReSAKSS based on FAO (2023), World Bank (2023) and ILO (2023a).

FIGURE 13.6—EMPLOYMENT RATE, PERCENT OF LABOR FORCE AGED 15 TO 64 YEARS, ANNUAL AVERAGE PERCENTAGE CHANGE, 2003–2022



Source: ReSAKSS based on ILO (2023a).

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

rose during the 2003–2008 period and wasting rose during both the 2003–2008 and 2008–2014 periods.

The cereal import dependency ratio, calculated as the share of cereal imports in total domestic cereal supply, reflects the degree of a country's dependence on world markets for food supplies. While engaging in global trade is an important component of national food security strategies, a high degree of dependence on global markets also exposes countries to international trade and supply shocks. This risk was demonstrated by the inflationary impacts in many African countries of global cereal market disruptions related to the start of the Russia-Ukraine war in 2022. As shown in Figure 13.5, average cereal import dependency in Africa has increased slightly over the entire CAADP period, rising from 25 percent in 2003 to 28 percent in 2019. Central, southern, and western Africa had cereal import dependency ratios close to the continental average, while eastern Africa had the lowest ratio at under 20 percent throughout the CAADP period. Northern Africa has a markedly higher dependency on cereal imports than other regions, and also showed the fastest increase in the dependency ratio, rising from 43 percent in 2003 to 59 percent in 2019.

Employment

Africa's employment rate, measured either as a share of the labor force (Figure 13.6, Annex Table L1.3.1A) or as a share of the entire population aged 15 to 64 years (Annex Table L1.3.1B), rose during the period from 2003 to 2008 but declined slightly in subsequent periods. The decline in employment rates deepened in 2020, as the COVID-19 pandemic had severe repercussions on economic activity in general. These declines continued in 2021, due to continued impacts of the pandemic as well as continuing growth in the labor force (Collins et al. 2022, ILO 2022). As shown in Figure 13.6, this trend ended in 2022, during which a slight increase of 0.1 percent in the employment rate as a share of the labor force was registered for Africa as a whole. The increase in the employment rate was more sizable in northern Africa and in countries that formulated a second-generation but not a first-generation NAIP (N01). In contrast, the employment rate continued to fall in southern Africa, countries with neither a first- nor a second-generation NAIP (N00), and upper middle-income countries. The decline in the last group was especially large at over 1.0 percent.

Overall, 93 percent of Africa's labor force was employed in 2022, almost the same as the 2003 rate (Annex Table L1.3.1A). Employment rates are lowest in the set of country groups that experienced continued declines in their employment rate into 2022: southern Africa, upper middle-income countries, and N00 countries. For upper middle-income countries, the relatively low employment rate in 2022 reflects a decline of 7 percentage points from its 2003 level. Employment rates of 95 percent or more are found in western Africa and low-income countries with more favorable agricultural conditions.

It should be noted that Africa's generally high employment rate masks significant shares of underemployment and informal employment (Merotto, Weber, and Aterido 2018). The International Labour Organization reports that 85 percent of Africa's employment in 2022 was informal, with notably higher informality among women (88 percent) than men (82 percent). The share of self-employed workers is also high, at 69 percent of all employment in 2021, the last year with available data. The informality rate has increased slightly since 2010, but the self-employment rate declined between 2010 and 2019, before rising slightly in 2020 with the advent of the COVID-19 pandemic (ILO 2023b).

Poverty

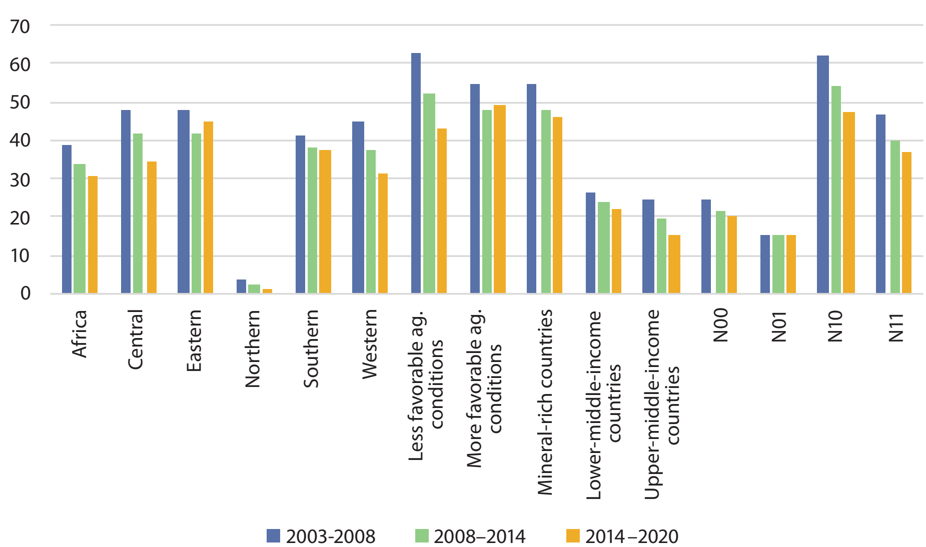
The extreme poverty headcount ratio, or the share of the population living on less than US$2.15 (2017 PPP) per day, showed a steady if moderate decline throughout the CAADP period for Africa as a whole and for most country groupings (Figure 13.7, Annex Table L1.3.4). However, a few country groupings—eastern Africa and low-income countries with more favorable agricultural conditions—showed an increased prevalence of poverty between 2014 and 2020 compared with the previous period between 2008 and 2014. At the continental level, the extreme poverty headcount rate declined from an average of 39 percent during the period from 2003 to 2008 period to 34 percent between 2008 and 2014 and further fell to 31 percent between 2014 and 2020, reaching 30 percent in 2020, the most recent year with available data. Country groups with the highest poverty prevalence levels in the 2014 to 2020 period included eastern Africa, low-income countries with more favorable agricultural conditions, mineral-rich low-income countries, and countries with a first-generation but not a second-generation NAIP. By far, the lowest extreme poverty headcount rate in the 2014 to 2020 period was in northern Africa.

At the continental level, the extreme poverty headcount rate declined by an annual average of 2.2 percent between 2003 and 2008 and by 2.3 percent between 2008 and 2014. Progress in poverty reduction decelerated between 2014 and 2020, with an annual average decline of 1.2 percent registered. Among geographic regions, several showed more robust reduction in extreme poverty levels in the most recent period, including northern Africa, with an annual average decline of 9.1 percent in the extreme poverty headcount, albeit from a low poverty rate to start with, and western and central Africa, both with declines of over 3 percent. However, eastern Africa's extreme poverty headcount rate increased by an annual average of 2.7 percent, representing a reversal of earlier progress.

Overall, progress in reducing extreme poverty has been steady but moderate at the continental level, with mixed progress among geographic regions and other country groupings. However, the general reduction in the extreme poverty headcount ratio has not been sufficient to reduce the total number of people living in extreme poverty in Africa, which continued to rise throughout the CAADP period (Collins et al. 2022). The likelihood of accelerating poverty reduction in the coming years is uncertain, as Africa continues to deal with repercussions of recent economic shocks and continued high inflation rates related to the Russia-Ukraine war and other factors.

The extreme poverty gap measures the severity of poverty and is calculated by the average distance between the incomes of the poor and the international extreme poverty line of US$2.15/day (2017 PPP). For Africa as a whole and for most country groupings, the extreme poverty gap declined steadily throughout the CAADP period, indicating that, in addition to a decline in the prevalence of extreme poverty (Figure 13.7), the average depth of extreme poverty has also decreased—the severity of destitution among the extreme poor has diminished. For Africa as a whole, the extreme poverty gap shrank by an annual average of 3.2 percent during the period from 2003 to 2008 and by 3.9 percent between 2008 and 2014 (Annex Table L.1.3.3). Progress in reducing the depth of extreme poverty decelerated between 2014 and 2020 (the last year with available data), with an annual average decrease in the extreme poverty gap of 1.3 percent. This reflects an uptick in the severity of poverty with the onset of the COVID-19 pandemic in 2020.

FIGURE 13.7—POVERTY HEADCOUNT RATIO, POVERTY LINE OF US$2.15 (2017 PPP) PER DAY, PERCENT OF POPULATION, 2003–2020



Source: ReSAKSS based on World Bank (2023) and ILO (2023a).

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

While the consistent progress in reducing the depth of extreme poverty before the pandemic offered hope, it is unclear how soon this progress will resume, given the severe food price inflation related to the Russia-Ukraine war and its expected continuing adverse impacts on the consumption levels of African households. Among country groupings, northern Africa shows the lowest extreme poverty gap—less than half a percent as of 2020—while the largest poverty gaps of over 20 percent are found in mineral-rich countries. Of the geographic regions, eastern Africa and southern Africa have the largest poverty gaps. The extreme poverty gap for Africa as a whole stood at 10.1 percent in 2020.

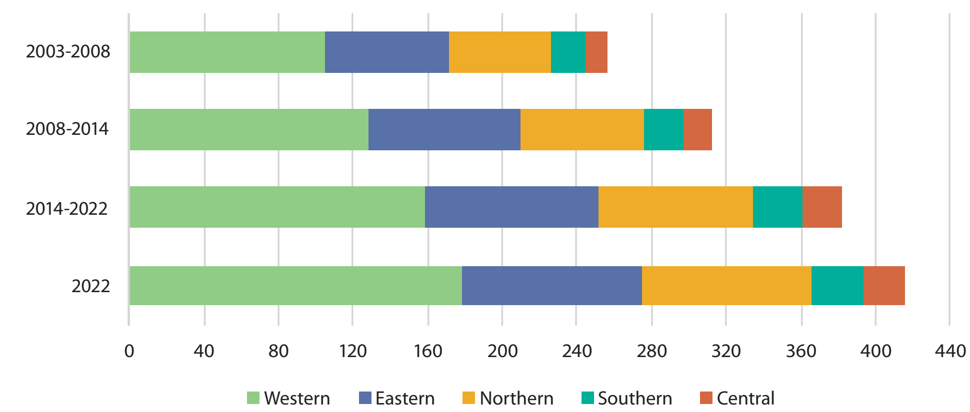
CAADP Results Framework Output (Level 2) Indicators: Agricultural Transformation and Sustained Inclusive Agricultural Growth

Agricultural Production and Productivity

For the economies in Africa, agriculture is an important sector—15 percent of the continent's GDP is produced from agriculture and the sector employs more than half of the working population (ReSAKSS 2023). Agriculture value added in Africa grew consistently over the past two decades, rising significantly from US$256 billion in the period from 2003 to 2008 to US$415 billion in 2022 (Figure 13.8). This represents a 65 percent increase during the CAADP period. Looking at performance at the regional level, western Africa dominates Africa's agricultural production. Moreover, the agriculture sector in western Africa consistently grew at a higher pace compared to other subregions between 2003 and 2022.

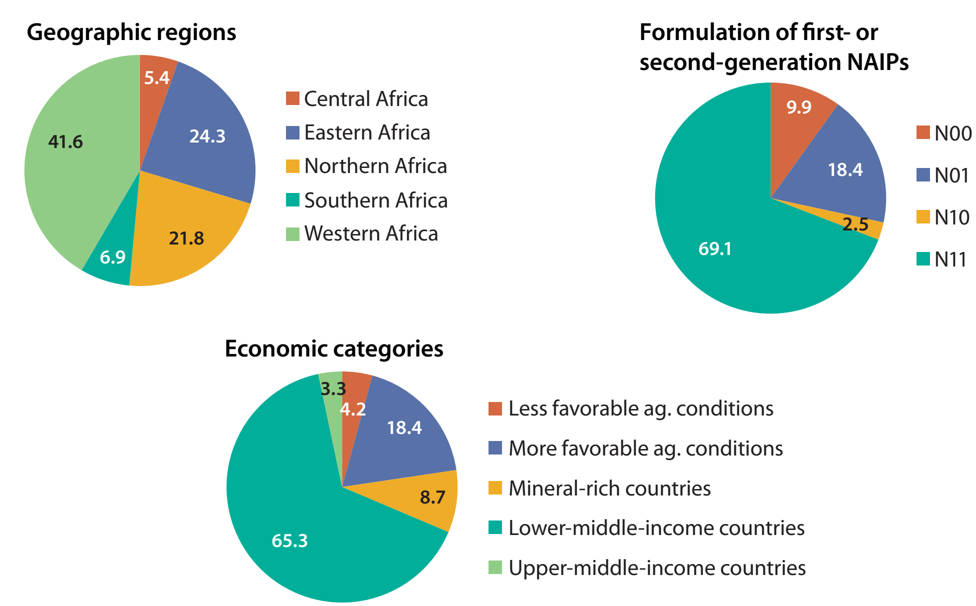
Forty-two percent of Africa's total agriculture value added for the period 2014 to 2022 was produced in western Africa followed by eastern Africa and northern Africa at 24 percent and 22 percent, respectively (Figure 13.9). Lower middle-income countries accounted for 65 percent of the continent's agricultural value addition over this period, while lower-income countries with more favorable agricultural conditions accounted for 18 percent. Considering country groups based on progress in formulating NAIPs, the countries that have formulated both first- and second-generation NAIPs (N11) account for 69 percent of all agricultural value addition. This breakdown of the source of agricultural production by value in Africa demonstrates that agriculture value addition is concentrated in a few subgroups of countries.

FIGURE 13.8—AFRICAN AGRICULTURE, AVERAGE ANNUAL VALUE ADDED, US$ BILLIONS (CONSTANT 2015 US$), BY TIME PERIOD AND GEOGRAPHIC REGION



Source: ReSAKSS based on World Bank (2023).

FIGURE 13.9—AGRICULTURE VALUE ADDED, AVERAGE PERCENTAGE SHARE OF AFRICA'S TOTAL AGRICULTURE VALUE ADDITION FOR PERIOD FROM 2014 TO 2022, BY COUNTRY GROUPING



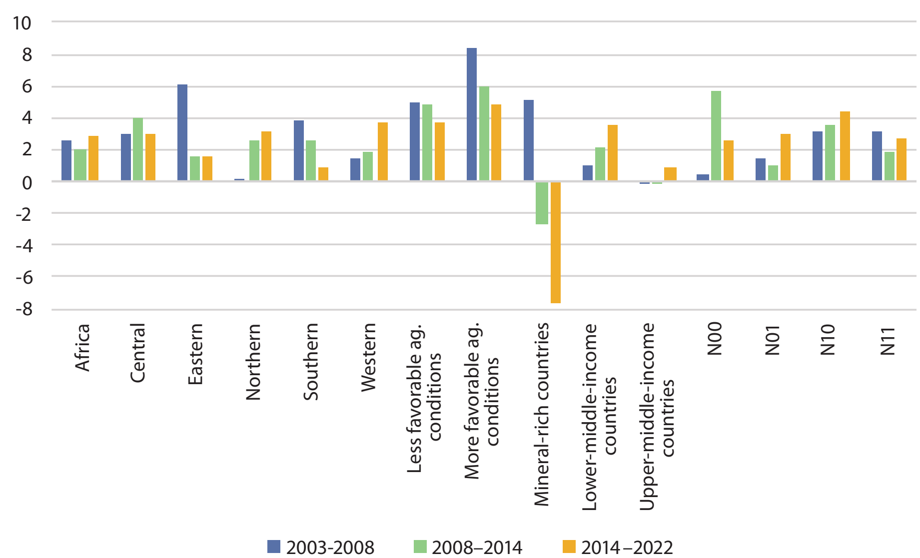
Source: ReSAKSS based on World Bank (2023).

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

For Africa as a whole, growth in agriculture value addition remained modest throughout the CAADP period (Figure 13.10). Continentwide, it grew by 2.6 percent on average during the period from 2003 to 2008. Average growth rates fell between 2008 and 2014 to 2.1 percent, before recovering, if still at a low rate, to 2.8 percent between 2014 and 2022. At the country subgroup level, the most consistent growth in agriculture value addition over the entire CAADP period was seen among lower-income countries with more favorable agriculture conditions.

Except for the growth in agriculture value addition between 2003 and 2008 for eastern Africa and for lower-income countries with more favorable agricultural conditions, the CAADP 6 percent agricultural sector annual growth target was not met by any country subgroups over any subperiod across the entire CAAD implementation period. Negative growth rates in agricultural value addition were seen in some subperiods both for mineral-rich countries and for upper middle-income countries (Figure 13.10).

FIGURE 13.10—AGRICULTURE VALUE ADDED, ANNUAL AVERAGE GROWTH, PERCENT, 2003–2022



Source: ReSAKSS based on World Bank (2023) and ILO (2023a).

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

Only Ethiopia and Rwanda were able to record annual growth in agricultural value addition higher than the CAADP target of 6 percent in both the 2008 to 2014 period and the 2014 to 2022 period (Figure 13.11). However, several countries met the target in one, but not both, periods—Algeria, Angola, Côte d'Ivoire, Equatorial Guinea, Gabon, Guinea, Kenya, Mali, Niger, Sao Tome and Principe, Senegal, Sierra Leone, and Tanzania.

Agricultural labor productivity measured by agriculture value added per worker grew for Africa as a whole from US$1,460 on average annually between 2003 and 2008 to US$1,605 between 2008 and 2014 and further to US$1,796 between 2014 and 2022. As shown in Annex Table L2.1.3 and Figure 13.12 (left panel), there is significant variation in agricultural labor productivity across the different country subgroups. Agricultural labor productivity over the entire CAADP period was highest at more than US$4,000 annually on average for the northern Africa region, upper middle-income countries, and the group of countries that have not yet formulated both NAIPs (N00). On the other hand, labor productivity was the lowest in central Africa and in the countries that had formulated the first-generation NAIP only (N10)—countries in these groups had average agricultural labor productivity levels of less than US$650 throughout the whole CAADP period.

As a measure of agricultural land productivity, agriculture value added per hectare of arable land for Africa as a whole was on average US$244 during the early CAADP period from 2003 to 2008 (Figure 13.12, right panel). Land productivity increased to US$294 in the 2008 to 2014 period and further to US$357 between 2014 and 2022. The northern and western regions of Africa, lower middle-income countries, the countries that joined the CAADP process early, and the groups of countries that have advanced in the CAADP implementation and formulated their second-generation NAIP recorded higher land productivity throughout the review period. Land productivity remained lowest in southern Africa and in upper middle-income countries (Annex Table L2.1.4).

For Africa as a whole, five commodities account for close to a third of total agricultural production—cassava, maize, yam, cattle meat, and milk. Combined, these commodities made up on average 29 percent of all agricultural value addition on the continent over the entire CAADP implementation period from 2003 to 2021. Except for milk, yields for the other major commodities were higher in the early CAADP period from 2003 to 2008 than later. While maize yield growth remained positive throughout the CAADP implementation period, for the other major agricultural commodities, yield growth was not consistent particularly during the period from 2008 to 2014 during which negative annual yield growth was recorded for cassava, yam, and cattle meat (Annex Tables L2.1.5A, L2.1.5B, L2.1.5C, L2.1.5D, L2.1.5E). For all five of the major commodities, average annual yields during the period from 2014 to 2022 were better than for the period from 2008 to 2014. However, for most of these commodities, lower yields were recorded in the period from 2014 to 2022 on average than during the 2003 to 2008 period.

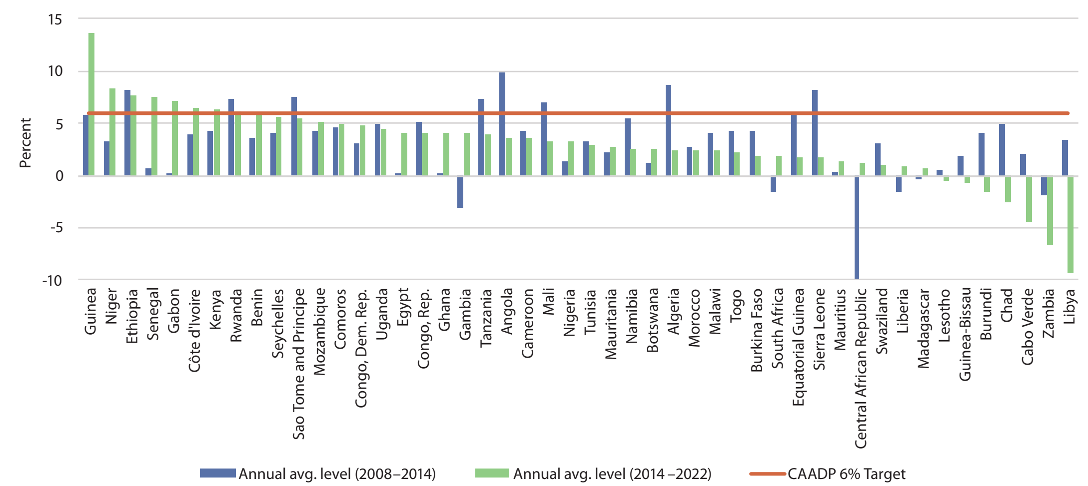
Intra-African Agricultural Trade

Intra-African agricultural trade rose steadily throughout the CAADP period. Between 2003 and 2022, the annual value of intra-African agricultural exports rose from US$5.7 billion to US$16.2 billion, an increase of over 180 percent in the last two decades. During the early CAADP period from 2003 to 2008, intra-African agricultural exports grew by 8 percent annually on average. The average annual growth in such exports between 2008 and 2014 was similar at 9 percent. However, this export growth trend slowed considerably between 2014 and 2022 with a growth rate of 3 percent, largely due to contractions in exports from Southern Africa (Annex Table L2.2.1A).

Notable variation was observed in the share of export trade among the different subgroups (Figure 13.13). Southern Africa dominates intra-African agricultural exports, making up a 44 percent share of all such exports, while central Africa is least involved in such trade, making up less than 1 percent. Likewise, lower middle-income countries and the group of countries that formulated both first- and second-generation NAIPs (N11) are the major players in intra-African agricultural export trade.

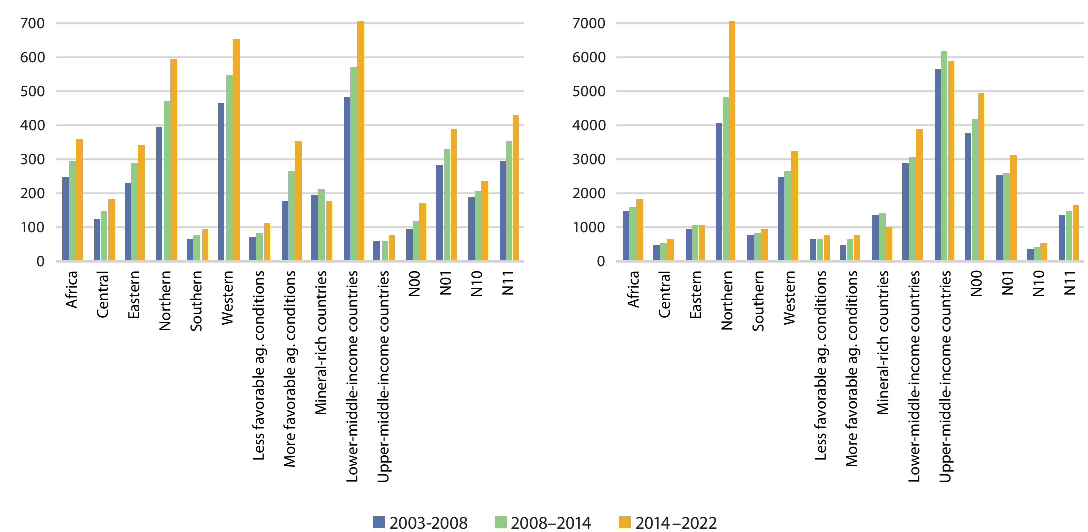
At the country level, South Africa is the largest exporter of agricultural goods within Africa, accounting for 24 percent of all such trade between 2014 and 2022, followed by Egypt (7 percent) and Uganda (6 percent). Another six countries each accounted for

FIGURE 13.11—NATIONAL AGRICULTURAL VALUE ADDED, ANNUAL AVERAGE GROWTH, PERCENT, BY TIME PERIOD



Source: ReSAKSS based on World Bank (2023) and ILO (2023a).

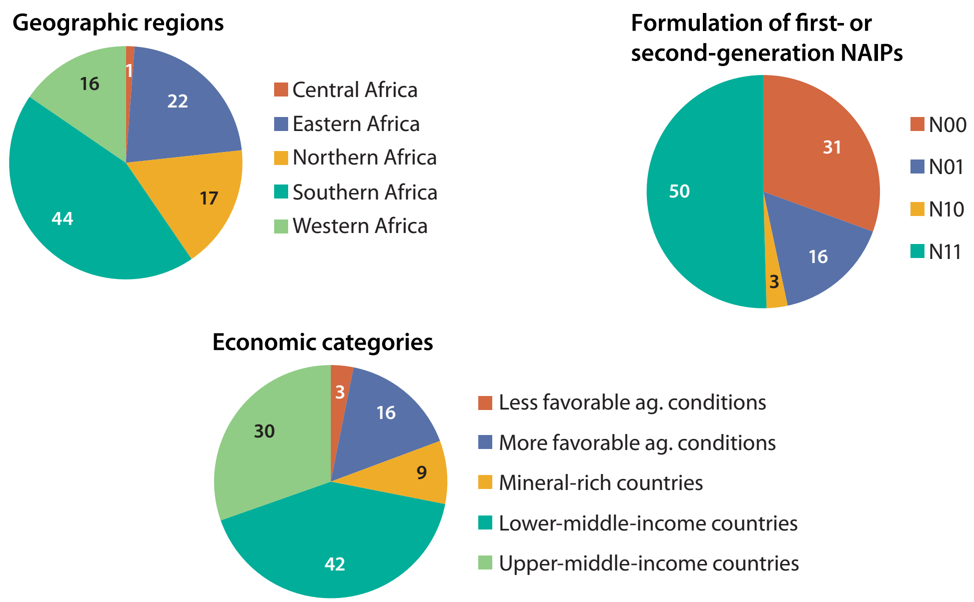
FIGURE 13.12—AGRICULTURAL LABOR (LEFT PANEL) AND AGRICULTURAL LAND (RIGHT PANEL) PRODUCTIVITY IN AFRICA, US$ (CONSTANT 2015 US$), BY TIME PERIOD



Source: ReSAKSS based on World Bank (2023) and FAO (2023).

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

FIGURE 13.13—INTRA-AFRICAN AGRICULTURAL EXPORTS, PERCENTAGE SHARE OF TOTAL INTRA-AFRICAN AGRICULTURAL EXPORTS FOR PERIOD FROM 2014 TO 2022, BY COUNTRY GROUPING



Source: ReSAKSS based on UNCTAD (2023) and World Bank (2023).

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

between 4 and 5 percent of all intra-African agricultural trade during the same period (ReSAKSS 2023).

Turning from exports to imports, intra-African imports grew from an annual average of US$8 billion recorded in the period from 2003 to 2008 to US$12 billion between 2008 and 2014 and further to US$15 billion in the period from 2014 to 2022. Growth in imports was the highest in the period from 2008 to 2014 with a 5.6 percent annual average growth rate, while it was between 3.1 and 3.3 percent annually on average in the other CAADP subperiods (Annex Table L2.2.1B). Similar growth trends in imports from elsewhere in Africa were observed among the different country subgroups. The largest intra-Africa exporters include countries in the southern Africa region, middle-income countries, and the countries that have formulated both generations of NAIP (N11). In contrast, imports from other African countries were lowest among countries in the central Africa region, lower-income countries with less favorable agricultural conditions, and the group of countries that have formulated only the first-generation NAIP (N10)—all of these categories of countries account for less than 10 percent of all intra-African imports. The top three countries accounting for the largest share of total intra-African agricultural imports are South Africa at 7.9 percent of all such imports, Zimbabwe at 6.4 percent, and Namibia at 5.2 percent. Despite the presence of notable increases in intra-African agricultural imports, imports from other countries in Africa make up a small share of all agricultural imports of African countries—less than a fifth come from other countries on the continent (FAO and AUC 2021).

The fifth commitment under the 2014 Malabo Declaration aims at tripling intra-African trade in agricultural commodities and services by the year 2025 (AUC 2014). Achieving this commitment by 2025 remains a challenge. Trends show that Africa was able to increase its intra-African trade only by just over 25 percent between 2014 and 2022. The third BR report shows that Africa is not on track to achieve the commitment of boosting intra-African trade three-fold by 2025 (AUC 2022).

CAADP Results Framework Input (Level 3) Indicators: Strengthening Systemic Capacity to Deliver Results

Capacities for Agriculture and Food-Security Policy Design and Implementation

Progress in the implementation of actions to strengthen systemic capacity for agriculture and food-security policy planning and implementation under CAADP is presented in Annex Table L3(b). As of September 2023:

- 42 countries had formulated new or revised second-generation NAIPs through inclusive and participatory processes;
- 28 had inclusive institutionalized mechanisms for mutual accountability and peer review—mainly JSRs;
- 36 were implementing evidence-based policies;
- 31 had functional multisectoral and multistakeholder coordination bodies—mainly agricultural sector working groups; and
- 22 had successfully undertaken agriculture-related public-private partnerships to boost specific agricultural value chains.

It should be noted that these figures are based on countries' self-reporting or the assessment of country experts. Determining the values for several of these measures required subjective judgments on the quality of capacities and processes, so they may be subject to change.

Government Expenditure on Agriculture

Agriculture is the mainstay of the majority of African economies, making notable contributions to employment and international trade. Hence, public spending on agriculture will expedite a wide range of benefits. In level terms, average annual government agriculture expenditure increased from US$13.3 billion on average between 2003 and 2008 to US$14.5 billion between 2008 and 20014 to US$17.1 billion in the period from 2014 to 2022. A breakdown of government agriculture expenditure by country subgroup shows notable variation in the level of such spending. Among countries classified by income, middle-income countries account for 60 percent of total public spending on agriculture in Africa between 2014 and 2022. For the same period, the share of government spending on agriculture was the highest in the group of countries that have formulated both generations of NAIP (N11) at 60 percent of all such spending.

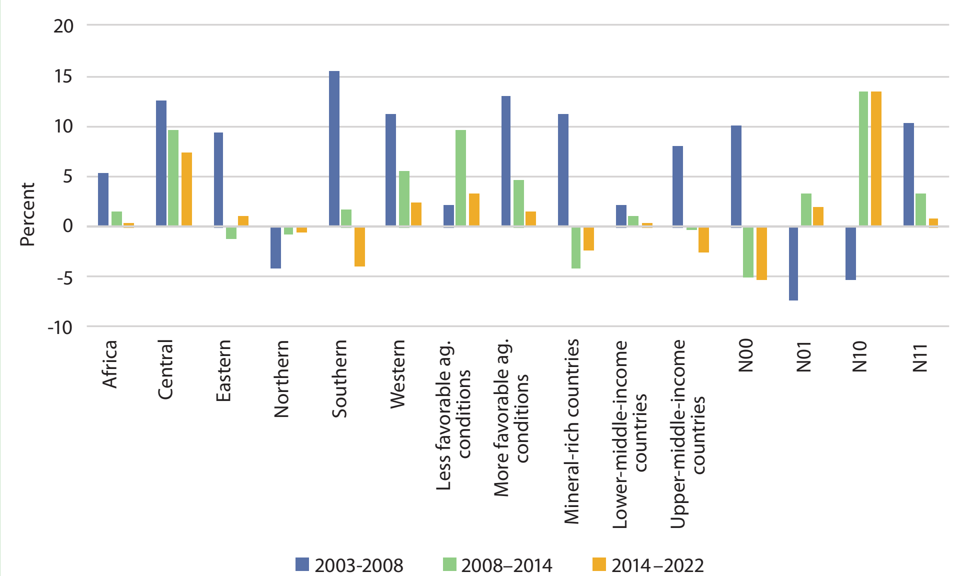
Growth in government agriculture expenditure in Africa was the highest in the early CAADP period but declined in subsequent subperiods. As a whole, the average annual growth rate in government agriculture spending was 5.3 percent between 2003 and 2008, but declined to 1.5 percent between 2008 and 2014 and fell further to a growth rate of just 0.3 percent between 2014 and 2022. As shown in Figure 13.14, a similar downward trend is observed for most of the country subgroups, particularly during the subperiod from 2014 to 2022.

The share of government agriculture expenditure in total government expenditure remained modest over the last two decades. For Africa as a whole, the share was 3.6 percent on average between 2003 and 2008, before declining to 2.6 percent for the 2008 to 2014 period. The share that agriculture expenditure made up of total government expenditure improved moderately between 2014 and 2022, reaching 2.8 percent.

Marked differences in the share that agriculture expenditure makes up of total government expenditure were seen among country subgroups during the review period (Annex Table L.3.5.2). The highest share was observed among the lower-income countries with less favorable agricultural conditions and the lower-income countries with more favorable agricultural conditions in all three subperiods. Among geographic regions, the eastern Africa region had on average the highest share of total government expenditure made up by agriculture expenditure.

Looking at agriculture expenditure as a share of total government expenditure at the country level, marked differences are seen across African countries. Very few countries consistently allocated a high share of their total public spending to agriculture (Figure 13.15). Only Ethiopia and Malawi consistently met the CAADP 10 percent budget target during the period from 2008 to 2022. The performance for other countries was much less consistent. Sierra Leone and Benin achieved the 10 percent budget target during the 2014 to 2022 period, devoting a much larger share of the national budget to agriculture than they did between 2008 and 2014. For the same period, Nigeria, Burkina Faso, Mali, and

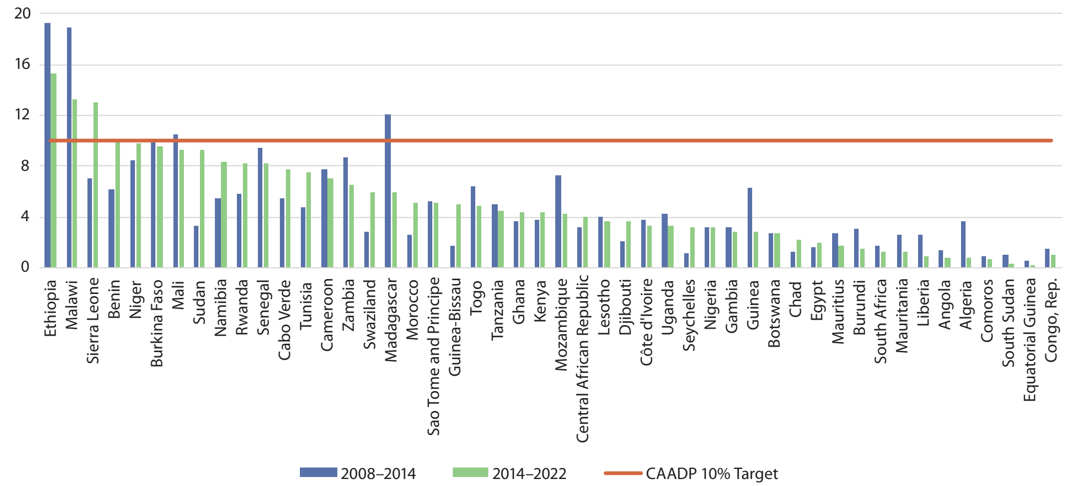
FIGURE 13.14—GOVERNMENT AGRICULTURE EXPENDITURE, AVERAGE ANNUAL PERCENTAGE CHANGE, 2003–2022



Source: ReSAKSS, based on IFPRI (2019), World Bank (2023), and national government sources.

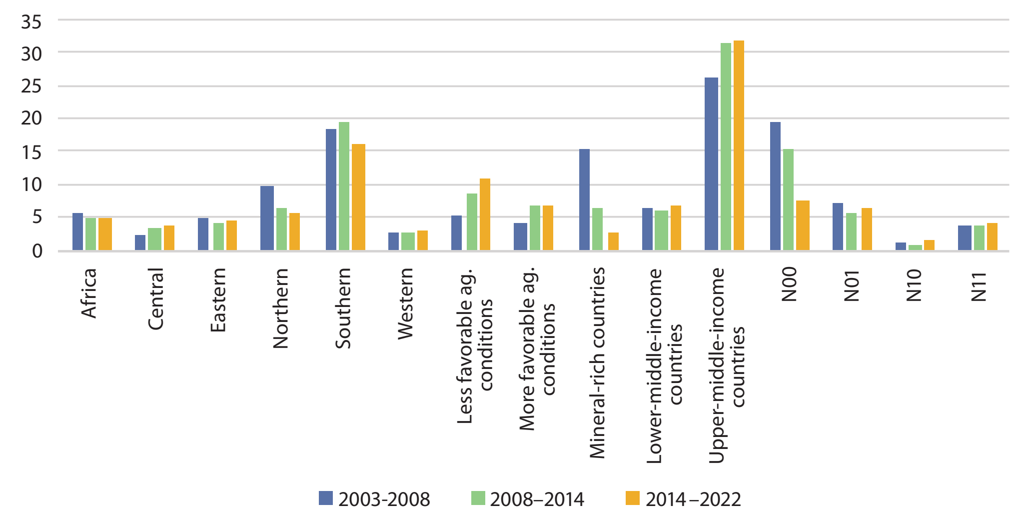
Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

FIGURE 13.15—SHARE OF GOVERNMENT AGRICULTURE EXPENDITURE IN TOTAL GOVERNMENT EXPENDITURE, PERCENT, 2008–2022, BY COUNTRY



Source: ReSAKSS, based on IFPRI (2019), World Bank (2023), and national government sources.

FIGURE 13.16—GOVERNMENT AGRICULTURE EXPENDITURE AS A SHARE OF AGRICULTURE VALUE ADDED, AVERAGE, PERCENT, 2003–2022



Source: ReSAKSS, based on IFPRI (2019), World Bank (2023), and national government sources.

Note: N00, N01, N10, and N11 categories refer to the presence or absence of first- and second-generation national agriculture investment plans (see footnote 5).

Sudan allocated more than 9 percent of their public spending to agriculture, close to the CAADP 10 percent budget target.

The share of government agriculture expenditure in agricultural GDP marginally declined for Africa as a whole from an average of 5.3 percent for the period from 2003 to 2008 to 4.8 percent between 2008 and 2014 to 4.6 percent between 2014 and 2022 (Figure 13.16). The performance for country subgroups was mixed—some groups showed an increasing trend, while the opposite was observed for a few others (Annex Table L.3.5.3). Over the review period, public spending on agriculture relative to the size of the country's agriculture sector was the highest for upper middle-income countries and the southern Africa region followed by the group of countries that are yet to embark on a NAIP (N00).

Conclusions

Africa has made major progress in agricultural development in several areas in the two decades since the launch of CAADP. Robust economic growth, particularly in the 2000s, produced rising average incomes and household consumption expenditures across the continent. Growth also led to moderate but steady decreases in the poverty rate as well as a consistent lessening of the severity of poverty. Food security and nutrition also improved, with undernourishment declining in the 2000s and early 2010s, and child malnutrition declining consistently throughout the CAADP period. However, progress on many of these indicators has either slowed or reversed in recent years. Since the mid-2010s, average annual growth in GDP per capita and household consumption for Africa as a whole has been negative, and the prevalence of undernourishment has increased. The COVID-19 pandemic and the impacts of the Russia-Ukraine war have exacerbated challenges that were already becoming apparent before these crises hit.

Africa's agriculture sector was an area of relative resilience during the COVID-19 crisis (Collins et al. 2022). Africa recorded notable growth in agriculture value addition over the last two decades. While growth in most years over this period has been positive, it has not met or surpassed the 6 percent CAADP agricultural growth target. Studies show that improved and sustainable growth in agriculture depends heavily on the sources of growth. Innovation—that is, total factor productivity growth—accounts for only 1 percent of agricultural sector growth in Africa, while innovation accounts for 3 percent of agricultural sector growth in countries in Asia and Latin America (Fuglie and Rada 2013). This suggests that Africa must realize its potential for improved agricultural production and productivity through locally adapted and appropriate policy changes, investments, and innovations (Baumüller et al. 2020).

Africa is a net food-importing continent. The major commodities imported include cereals, meat, dairy products, fats, oils, and sugar, mainly from the rest of the world rather than elsewhere in Africa (FAO and AUC 2021). The market in Africa for these imported agricultural goods is primarily urban (Baumüller et al. 2020). The growing size of the middle class in Africa and relatively high rates of urbanization will boost demand for value-added agricultural products. Expanded intra-African trade in higher-value food and agricultural products could be central to responding to this growing demand. At present, intra-African agricultural trade makes up less than one-fifth of total food and agricultural imports by African countries—the equivalent measures for Asian and European countries are more than 60 percent (AUC 2021). To increase the share of intra-African trade in all trade in food and agricultural products, Africa needs to engage in the production of value-added agricultural goods that will substitute for the commodities that it now imports from the rest of the world. In this regard, the African Continental Free Trade Area (AfCFTA) will play a key role in boosting intra-African agricultural trade.

For a majority of African countries, expenditure on agriculture is less than the CAADP target of earmarking 10 percent of total public spending to the sector. Such expenditures in the sector are necessary to tackle poverty and hunger and to improve agricultural productivity. Improving resource mobilization is one avenue to address shortages in public agricultural expenditures. Moreover, allocating the available resources more efficiently in a manner that improves the productivity of the sector needs to be given more priority. To this end, evidence-based intra-sectoral prioritization is critical in improving agricultural resource targeting.

Temporal patterns for many of the CAADP RF indicators show marked contrasts by geographic region, country economic characteristics, and the degree of progress countries have made in CAADP implementation. For example, northern African countries are notably different from the rest of the continent by having avoided declines in GDP per capita throughout the CAADP period. This group of countries also shows the lowest rates of poverty and undernourishment and the highest land and labor productivity growth rates. Among economic groupings, upper middle-income countries, while having the lowest rates of poverty and undernourishment overall, showed rising undernourishment throughout the CAADP period. This pattern may be related to low and declining employment rates in such countries. Upper middle-income countries and low-income mineral-rich countries also showed the lowest increases in agriculture value added throughout the CAADP period, including declines in some subperiods. Among the worst-performing countries are those with neither a first- nor a second-generation NAIP—these showed relatively large declines in GDP per capita since the mid-2010s, the highest increases in undernourishment, and low and declining employment rates.

Africa's progress over the last 20 years presents a picture of significant progress tempered by recent setbacks of concern. The post-Malabo agenda will need to build on the achievements of CAADP to date while finding new ways to address continuing challenges related to technical, institutional, and financial capacities. In particular, it will be essential for countries across Africa to maintain their commitments to enhance agricultural growth and productivity while increasing the level and efficiency of agricultural investments for a broader impact. The data challenges highlighted earlier also imply that focusing on mutual accountability in the post-Malabo period, including investments in filling data gaps, is imperative.

CHAPTER 14

Conclusion: Toward Resilient and Sustainable African Food Systems

John M. Ulimwengu, Ebenezer Miezah Kwofie, and Julia Collins

The 2023 ATOR aims to inform the design of the post-Malabo phase of the Comprehensive Africa Agriculture Development Programme (CAADP). The comprehensive discussions provided in this report offer a multifaceted blueprint to transform Africa's food systems in the post-Malabo era. From the in-depth analysis of the implementation challenges and successes of the Malabo Declaration to the exploration of cutting-edge approaches in bioeconomy and technology, this volume paves the way for a holistic and inclusive approach to food systems transformation in Africa. The findings underscore that while significant progress has been made in certain areas, such as the implementation of the CAADP/Malabo agenda, considerable challenges remain. These challenges are multidimensional, involving policy, institutional, and infrastructural barriers, and will need to be addressed with evidence-based, sustainable, and inclusive policies and practices.

Insights from the diverse chapters of this report provide a comprehensive view of the challenges and opportunities within post-Malabo African food systems. Every facet addressed here—whether it be policy, innovation, or sustainability—contributes to forming the picture of a continent ready for significant transformation.

From policy commitment to grounded action. Progress in the years following the Malabo Declaration reflects the diversity within African agriculture. The report underscores a continental dichotomy, with some countries showing commendable progress while others lag, tethered by institutional and policy constraints. A key conclusion is the need to move beyond the rhetoric of commitment to tangible action rooted in empirical evidence. The theoretical underpinnings of the Malabo agenda, while visionary, demand pragmatic execution grounded in solid data and responsive governance.

Food systems diagnostics: Malawi's microcosm. Malawi's journey embodies the complex interplay between national ambitions and the realities of implementation, which has been marked by environmental and economic hardships that challenge resilience. The lesson emerging from a diagnostic analysis of Malawi's food system is clear: policies must be backed by sustainable financial mechanisms and prioritized to generate the most significant multiplier effects on development. Malawi's experience suggests that the potential for synergy within policy execution is vast, but requires a harmonized approach to navigate trade-offs and amplify impacts.

Need to synchronize pledges. The responsiveness of African governments to their food systems transformation pledges is pivotal. The report identifies a continental imperative—the need for synchronized policy implementation that harmonizes country-specific contexts with collective goals. The World Health Organization's priority policies emerge as a guide, suggesting that innovative financial interventions like health taxes and subsidies could catalyze food systems transformation.

Nutrition-smart pathways. The call for nutrition-smart food systems is both urgent and compelling. Climate change, economic disparity, and public health crises present formidable barriers to adequate nutrition. Based on case studies of micronutrient adequacies in Senegal and Rwanda, the report suggests that African countries must overcome infrastructural, productivity, and policy challenges to foster food systems that prioritize health and environmental sustainability.

The imperative of food safety. Food safety is a critical yet often under-recognized facet of food systems. As Africa bears a disproportionate burden of foodborne diseases, a paradigm shift toward rigorous, risk-based food safety approaches from farm to table is essential. Such approaches hold promise to elevate food safety as a driver of agricultural and market development, public health, and food security.

Resilience and sustainability. The complex and interconnected nature of food systems demands holistic analysis and foresight. The report advocates for a nuanced understanding of trade-offs in policy strategies. Jointly assessing food system sustainability and resilience through the use of machine learning models and scenario planning can inform adaptive policy frameworks that navigate the trade-offs inherent in pursuing sustainable food systems.

Climate adaptation economics. Investing in climate adaptation is both an environmental and an economic imperative. The report's findings offer a strategic approach for aligning policies and investments to ensure increased food systems' resilience in the face of adverse climate-related events. This approach marks a shift from reactive to proactive, from short-term fixes to long-term, productivity-enhancing investments.

Gender-transformative change. Changing gender dynamics within food systems can open pathways for inclusive transformation. The report's discussion of gender shows that while there is no universal blueprint for increasing women's empowerment and inclusion, intentional, context-specific programming can yield significant dividends. Gender-transformative approaches go beyond merely increasing participation, aiming to reshape norms and systems for more equitable and productive engagement of women and men.

Bioeconomy as a vehicle for change. The African bioeconomy offers great potential as a model for innovation and progress. The report calls for a strategic, continentwide approach that unites policy actions, investments, and innovations. This vision requires a political climate conducive to change, where grassroots actors including farmers and small and medium enterprises are integral to policy development. A thriving bioeconomy could position Africa as a formidable player in global food systems.

Data for informed decision-making. Quality data are fundamental to good decision-making. The report highlights ongoing efforts to enhance data availability but stresses the urgent need to develop comprehensive datasets to inform food system activities and policies. Open-access and digital dashboards are steps forward, but significant data gaps remain, particularly for indicators critical to food systems policy.

Investment in science and technology. The report's final thematic chapter reaffirms the importance of science, technology, and innovation as foundations for sustainable, productivity-led agricultural growth. The role of governments as both investors and enablers is underscored, highlighting the need for public investments and policy incentives that drive the creation of knowledge and dissemination of technology.

The *African Food Systems Transformation and the Post-Malabo Agenda* report portrays a continent at the crossroads of potential and action. Drawing together the rich insights from individual chapters makes it clear that Africa's food systems are ripe for transformation. But achieving this transformation will require a cohesive effort to embrace data-driven policies, foster innovation for sustainable ecosystems, prioritize nutrition-smart and safe food practices, and invest in the resilience and adaptability of agricultural systems. The report echoes a continent-wide call to action for food systems transformation, for a future where sustainable agriculture provides the basis for economic prosperity and a healthy society. The transformative journey ahead is complex, but with collaboration and strategic foresight, it promises resilience and prosperity for all of Africa's people.

ANNEXES

Core CAADP Monitoring & Evaluation and Supplementary Indicators

Annexes:
Core CAADP Monitoring & Evaluation and Supplementary Indicators

This section presents data and trends across three levels of the CAADP Results Framework as well as supplementary data and trends.[1]

The data are presented at the aggregate level for the entire continent (Africa); the five geographic regions of the African Union (central, eastern, northern, southern, and western); eight regional economic communities (CEN-SAD, COMESA, EAC, ECCAS, ECOWAS, IGAD, SADC, and UMA); [2] five economic categories defined by agricultural production potential, nonagricultural sources of growth, and income level; nine CAADP groups representing either the period during which countries signed a CAADP compact or the level of CAADP implementation reached by countries by the end of 2015; and four levels of progress for countries in formulating national agriculture investment plans (NAIPs). Data for individual countries and regional groupings are available at www.resakss.org.

Technical Notes to Annex Tables

1. To control for year-to-year fluctuations, moving averages are used. Therefore, the values under the column "2003" are averages over the years 2002 to 2004 and the values under the column "2022" are averages over the years 2021 to 2022.
2. Annual average level and annual average change for 2014–2022 include data from 2014 up to either 2022 or the most recent prior year that is measured and available.
3. Annual average level is the simple average over the years shown, inclusive of the years shown.
4. Annual average change for all indicators is annual average percent change, from the beginning to the end years, shown by fitting an exponential growth function to the data points (that is, "LOGEST" function in Excel).
5. For indicators for which there are only a few measured data points over the years specified in the range (such as poverty, which is measured once every three to five years or so), a straight-line method was used to obtain missing values for the individual years between any two measured data points. Otherwise, estimated annual average change based on the measured values is used to obtain missing values either preceding or following the measured data point. In cases where the missing values could not be interpolated, the data are reported as missing and excluded from the calculations for that time period. Any weights used for these indicators are adjusted to account for the missing data in the series.

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1 Future Annual Trends and Outlook Reports (ATORs) will report on more of the CAADP Results Framework indicators as more data become available.

2 CEN-SAD is the Community of Sahel-Saharan States; COMESA is the Common Market for Eastern and Southern Africa; EAC is the East African Community; ECCAS is the Economic Community of Central African States; ECOWAS is the Economic Community of West African States; IGAD is the Intergovernmental Authority on Development; SADC is the Southern African Development Community; and UMA is the Union du Maghreb Arabe (Arab Maghreb Union).

6. Values for Africa, the regional aggregations (central, eastern, northern, southern, and western), economic aggregations (less favorable agriculture conditions, more favorable agriculture conditions, mineral-rich countries, lower middle-income countries, and upper middle-income countries), regional economic communities (CEN-SAD, COMESA, EAC, ECCAS, ECOWAS, IGAD, SADC, and UMA), CAADP groups (Compact 2007–2009, Compact 2010–2012, Compact 2013–2015, Compact not yet, Level 0, Level 1, Level 2, Level 3, and Level 4), and NAIP groups (NAIP00, NAIP10, NAIP01, and NAIP11) are calculated by weighted summation. The weights vary by indicator and are based on each country's proportion in the total value of the indicator used for the weighting measured at the respective aggregate level. Each country i's weight in region j (wij) is then multiplied by the country's data point (xi) and then summed for the relevant countries in the region to obtain the regional value (yj) according to: yj = Σi wijxi.

The trend data are organized as follows:

Annex 1
Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development

Annex 2
Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth

Annex 3
Level 3— Strengthening Systemic Capacity to Deliver Results

Annex 4
Country Categories by Geographic Regions, Economic Classification, and Regional Economic Communities

Annex 5
Distribution of Countries by Year of Signing CAADP Compact and Level of CAADP Implementation Reached by End of 2015

Annex 6
Distribution of Countries in Formulating First-Generation Investment Plan (NAIP1.0) and Second-Generation Investment Plan (NAIP2.0) Reached by September of 2023

Annex 7
Supplementary Data Tables

ANNEX 1a: *Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.1.1*

TABLE L1.1.1—GDP PER CAPITA (constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014–2022)	Annual avg. change (%) (2014–2022)	2022
Africa	1,530.1	1.4	1,640.2	1,770.6	3.2	1,949.7	0.7	1,983.9	–0.2	1,970.6
Central	712.9	–0.5	731.9	787.7	2.6	858.2	1.5	850.5	–1.3	820.5
Eastern	781.3	1.8	840.0	920.3	4.1	1,018.9	–0.8	1,070.3	1.0	1,099.3
Northern	2,750.7	2.4	3,016.7	3,296.8	3.5	3,609.6	0.1	3,801.8	1.2	3,950.3
Southern	2,535.2	1.1	2,667.2	2,891.3	3.6	3,161.9	0.9	3,038.2	–1.8	2,858.0
Western	1,208.4	1.7	1,344.7	1,455.3	3.1	1,741.3	3.2	1,876.3	–0.3	1,868.2
Less favorable agriculture conditions	443.1	1.6	483.9	518.4	2.3	558.6	0.6	580.7	0.4	586.9
More favorable agriculture conditions	411.1	1.7	442.4	489.5	4.4	608.2	3.8	762.3	2.5	820.6
Mineral-rich countries	932.0	1.5	994.5	1,074.3	3.6	1,102.8	–3.4	979.2	–1.4	926.8
Lower middle-income countries	1,815.5	1.9	1,982.8	2,144.9	3.3	2,487.4	2.1	2,661.1	0.1	2,684.4
Upper middle-income countries	5,256.7	1.7	5,699.2	6,332.7	4.1	6,687.2	–0.3	6,405.6	–0.8	6,242.9
CEN-SAD	1,654.1	1.9	1,803.5	1,953.4	3.2	2,167.9	0.6	2,227.3	0.3	2,254.6
COMESA	1,294.0	1.3	1,349.8	1,450.2	3.1	1,544.2	–0.7	1,591.0	1.3	1,672.5
EAC	596.9	–0.4	603.4	663.3	4.6	800.9	1.2	912.6	2.9	1,040.2
ECCAS	853.3	0.6	909.5	1,025.7	5.0	1,181.0	1.5	1,138.1	–2.2	1,062.6
ECOWAS	1,208.4	1.7	1,344.7	1,455.3	3.1	1,741.3	3.2	1,876.3	–0.3	1,868.2
IGAD	852.4	1.9	914.9	1,003.3	4.3	1,094.8	–1.7	1,116.8	0.9	1,144.7
SADC	1,617.0	0.6	1,669.2	1,793.3	3.2	1,944.8	0.9	1,894.7	–1.6	1,799.0
UMA	3,081.8	2.3	3,414.8	3,763.2	3.3	3,957.5	–0.3	3,955.9	–0.2	3,905.7
CAADP Compact 2007–09 (CC1)	951.2	1.9	1,081.6	1,190.8	3.8	1,469.6	3.6	1,609.5	–0.2	1,609.9
CAADP Compact 2010–12 (CC2)	701.4	–0.1	701.8	743.7	2.6	846.2	2.6	989.2	1.6	1,042.3
CAADP Compact 2013–15 (CC3)	1,610.7	2.1	1,741.8	1,892.1	3.5	1,992.1	–0.7	1,775.1	–3.1	1,584.0
CAADP Compact not yet (CC0)	3,218.3	2.1	3,505.2	3,815.1	3.3	4,026.9	–0.8	3,996.7	0.5	4,063.9
CAADP Level 0 (CL0)	3,218.3	2.1	3,505.2	3,815.1	3.3	4,026.9	–0.8	3,996.7	0.5	4,063.9
CAADP Level 1 (CL1)	1,713.1	2.1	1,850.8	2,020.8	3.8	2,132.6	–0.8	1,861.1	–3.5	1,636.4
CAADP Level 2 (CL2)	591.9	–1.4	580.3	610.3	1.9	662.9	2.1	757.0	1.1	784.1
CAADP Level 3 (CL3)	535.5	1.7	573.7	608.1	2.8	710.0	2.5	775.9	0.6	787.9
CAADP Level 4 (CL4)	958.3	1.5	1,057.4	1,155.2	3.6	1,404.1	3.5	1,577.4	0.4	1,607.1
NAIP00 (N00)	3,609.3	1.9	3,963.4	4,368.6	3.9	4,654.8	–0.9	4,196.0	–1.8	3,952.6
NAIP01 (N01)	2,373.5	2.1	2,553.9	2,781.3	3.6	3,025.6	–0.2	3,163.5	1.3	3,305.7
NAIP10 (N10)	443.7	–4.0	397.1	421.8	2.5	475.8	2.6	541.0	1.0	564.7
NAIP11 (N11)	988.9	1.6	1,075.8	1,160.1	3.2	1,348.7	2.1	1,448.8	0.1	1,454.2

Source: ReSAKSS based on World Bank (2023) and ILO (2023).
Note: GDP = gross domestic product. Aggregate value for a group is the sum of real GDP for countries in the group divided by total population of countries in the group.

ANNEX 1b: Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.1.2

TABLE L1.1.2—HOUSEHOLD CONSUMPTION EXPENDITURE PER CAPITA (constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014–2022)	Annual avg. change (%) (2014–2022)	2022
Africa	1,079.2	0.6	1,125.3	1,167.5	2.1	1,298.5	0.9	1,374.2	−0.9	1,313.4
Central	463.1	−0.8	458.8	473.9	1.4	498.6	1.0	552.0	−0.3	535.4
Eastern	771.3	−0.6	732.5	765.2	2.0	781.9	−2.1	797.8	0.7	815.7
Northern	1,711.1	0.2	1,725.5	1,765.3	2.3	2,116.6	3.0	2,528.7	1.6	2,656.2
Southern	1,870.0	0.5	1,944.4	2,055.5	2.1	2,097.0	0.3	2,021.9	−2.3	1,831.6
Western	736.0	3.3	898.9	952.3	3.0	1,227.8	4.0	1,368.3	−2.8	1,200.0
Less favorable agriculture conditions	358.7	0.8	384.1	390.9	1.6	428.2	2.2	493.7	1.1	504.1
More favorable agriculture conditions	391.1	1.4	412.7	433.6	2.3	468.4	0.2	522.3	2.4	571.6
Mineral-rich countries	730.5	−2.0	647.6	674.2	1.6	747.2	1.3	744.0	−3.1	652.7
Lower middle-income countries	1,147.0	1.6	1,250.3	1,305.9	2.6	1,616.0	3.7	1,852.0	−0.7	1,778.7
Upper middle-income countries	3,166.0	0.1	3,250.4	3,404.9	2.4	3,709.1	1.6	3,771.0	−1.1	3,540.0
CEN-SAD	1,100.9	1.3	1,177.3	1,230.5	2.8	1,502.0	3.0	1,661.5	−0.9	1,583.5
COMESA	1,150.9	−0.1	1,121.1	1,152.5	2.2	1,199.8	−1.8	1,240.8	1.2	1,299.4
EAC	472.7	−0.1	467.9	493.4	2.4	556.5	2.5	637.7	2.0	703.7
ECCAS	517.0	−0.9	512.9	522.2	1.3	597.2	2.3	686.9	−1.8	617.8
ECOWAS	736.0	3.3	898.9	952.3	3.0	1,227.8	4.0	1,368.3	−2.8	1,200.0
IGAD	1,003.2	−0.8	934.3	973.9	1.8	908.5	−5.4	869.8	0.9	897.3
SADC	1,123.3	−0.1	1,134.5	1,187.9	1.8	1,248.3	1.1	1,220.4	−2.1	1,115.3
UMA	1,624.2	−1.6	1,574.7	1,513.3	−0.1	1,700.4	2.4	1,993.3	0.0	1,920.7
CAADP Compact 2007–09 (CC1)	732.3	3.7	908.8	961.4	3.0	1,123.0	0.0	1,170.6	−2.5	1,040.6
CAADP Compact 2010–12 (CC2)	491.7	−0.5	488.9	518.0	2.5	577.3	2.0	685.7	1.5	713.6
CAADP Compact 2013–15 (CC3)	1,037.9	−1.2	970.0	974.7	0.9	1,121.4	2.5	1,185.5	−3.4	1,008.0
CAADP Compact not yet (CC0)	2,015.2	0.6	2,075.0	2,172.9	2.5	2,475.0	1.8	2,704.8	0.8	2,768.6
CAADP Level 0 (CL0)	2,015.2	0.6	2,075.0	2,172.9	2.5	2,475.0	1.8	2,704.8	0.8	2,768.6
CAADP Level 1 (CL1)	1,096.3	−1.8	999.2	1,002.0	1.0	1,169.3	2.7	1,226.1	−3.9	1,018.3
CAADP Level 2 (CL2)	452.5	−0.4	447.2	471.8	2.2	494.2	0.7	548.3	0.4	552.9
CAADP Level 3 (CL3)	390.3	1.0	412.1	434.2	2.4	501.4	2.5	529.5	−0.4	518.3
CAADP Level 4 (CL4)	719.2	2.9	854.4	905.0	2.9	1,060.7	0.8	1,146.0	−1.5	1,064.3
NAIP00 (N00)	2,148.1	0.1	2,202.5	2,275.6	1.2	2,382.7	0.4	2,368.3	−1.3	2,203.5
NAIP01 (N01)	1,550.8	0.5	1,573.5	1,633.3	3.0	1,971.7	2.9	2,298.3	1.5	2,408.6
NAIP10 (N10)	361.7	−2.7	327.0	347.0	1.9	363.6	0.3	394.4	0.4	400.2
NAIP11 (N11)	741.4	1.7	818.6	859.0	2.5	989.2	1.1	1,058.4	−1.6	979.3

Source: ReSAKSS based on World Bank (2023) and ILO (2023).

Note: Aggregate value for a group is the sum of household consumption expenditure for countries in the group divided by total population of countries in the group.

ANNEX 1c: *Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.2.1*

TABLE L1.2.1—PREVALENCE OF UNDERNOURISHMENT (% of population)

Region	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. level (2014-2021)	2021
Africa	21.6	20.0	–2.9	16.3	–3.3	17.5	3.8	19.7
Central	27.9	27.4	–0.8	25.0	–1.2	26.9	2.4	29.3
Eastern	35.9	32.6	–3.4	24.6	–6.3	23.8	3.3	26.1
Northern	6.0	5.9	–2.2	4.8	–3.5	5.4	6.0	6.4
Southern	25.5	24.2	–2.1	17.6	–4.8	19.2	1.3	20.5
Western	14.8	13.0	–4.9	11.6	0.2	12.5	4.1	14.7
Less favorable agriculture conditions	33.9	32.7	–1.6	27.1	–4.2	24.2	0.8	25.6
More favorable agriculture conditions	32.0	29.0	–3.7	21.4	–4.7	23.2	3.0	25.3
Mineral-rich countries	32.1	31.7	–0.6	28.3	–3.9	25.6	1.5	27.0
Lower middle-income countries	14.7	13.2	–4.4	10.3	–3.4	11.6	6.1	14.0
Upper middle-income countries	5.0	5.2	2.6	6.6	3.9	7.9	2.3	8.8
CEN-SAD	15.7	14.4	–3.4	12.5	–1.9	13.1	3.5	14.9
COMESA	27.1	25.7	–2.0	21.0	–4.1	21.8	3.3	23.8
EAC	28.8	27.0	–2.1	24.4	–1.3	27.5	2.4	29.2
ECCAS	33.4	31.6	–2.3	24.9	–3.8	25.4	2.8	28.0
ECOWAS	14.8	13.0	–4.9	11.6	0.2	12.5	4.1	14.7
IGAD	37.2	34.0	–3.0	24.2	–8.5	21.9	3.8	24.2
SADC	27.9	26.3	–2.2	22.0	–2.2	24.6	2.2	26.6
UMA	6.1	5.8	–2.0	4.4	–7.8	4.3	8.9	5.6
CAADP Compact 2007-09 (CC1)	20.7	18.3	–4.7	13.9	–4.3	13.9	5.8	16.9
CAADP Compact 2010-12 (CC2)	29.6	27.8	–2.3	24.0	–2.0	26.0	1.2	27.1
CAADP Compact 2013-15 (CC3)	35.7	32.6	–3.6	21.4	–8.6	21.3	4.3	24.1
CAADP Compact not yet (CC0)	8.6	8.7	–0.2	8.2	–1.8	9.0	4.5	10.3
CAADP Level 0 (CL0)	8.6	8.7	–0.2	8.2	–1.8	9.0	4.5	10.3
CAADP Level 1 (CL1)	39.4	36.7	–2.9	25.0	–8.8	24.0	4.2	27.2
CAADP Level 2 (CL2)	25.2	24.0	–2.0	22.7	0.4	24.9	2.2	26.9
CAADP Level 3 (CL3)	25.7	25.3	–0.2	21.2	–3.1	22.8	1.7	23.9
CAADP Level 4 (CL4)	24.2	21.4	–4.7	16.3	–4.2	16.7	3.8	19.0
NAIP00 (N00)	19.9	19.0	–1.8	14.0	–7.0	14.9	7.6	18.5
NAIP01 (N01)	11.4	11.3	–1.1	10.2	–0.7	12.8	4.5	14.4
NAIP10 (N10)	28.8	28.6	–0.3	29.1	1.3	32.3	2.1	34.9
NAIP11 (N11)	24.3	21.9	–3.9	16.9	–4.3	17.3	3.3	19.3

Source: ReSAKSS based on FAO (2023), World Bank (2023), and ILO (2023).
Note: Data are only available from 2000 to 2021.

ANNEX 1d: *Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.2.2A*

TABLE L1.2.2A—PREVALENCE OF UNDERWEIGHT, WEIGHT FOR AGE (% of children under 5)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	23.7	−1.2	22.4	21.5	−1.5	19.4	−2.1	17.2	−2.0	16.0
Central	27.1	−1.0	25.9	25.0	−1.5	23.1	−1.3	21.1	−1.9	19.7
Eastern	27.7	−1.4	25.7	24.9	−1.5	22.4	−2.0	19.9	−1.7	18.5
Northern	8.7	−1.8	8.2	7.0	−4.5	6.2	−1.6	5.1	−4.7	4.2
Southern	18.1	−1.2	17.1	15.7	−3.2	13.6	−2.5	11.1	−4.2	9.5
Western	27.3	−1.7	25.5	24.8	−1.0	22.4	−2.4	20.2	−2.1	18.8
Less favorable agriculture conditions	31.8	−1.3	30.2	29.7	−1.3	27.4	−0.3	25.9	−1.8	24.7
More favorable agriculture conditions	29.2	−2.0	26.3	24.8	−2.5	21.4	−2.8	17.3	−3.4	15.3
Mineral-rich countries	25.4	−0.1	25.1	24.6	−0.8	23.9	−0.5	23.2	−0.5	22.8
Lower middle-income countries	19.9	−1.3	18.9	18.1	−1.3	16.2	−3.0	14.1	−2.4	12.9
Upper middle-income countries	9.1	−1.4	8.5	8.3	0.0	7.6	−3.1	6.4	−2.0	6.0
CEN-SAD	22.5	−1.0	21.7	21.3	−0.7	19.8	−1.7	18.4	−1.2	17.7
COMESA	24.2	−1.0	23.0	22.1	−1.6	20.2	−1.5	18.1	−1.5	17.2
EAC	23.6	−1.9	21.5	20.7	−1.6	18.4	−2.6	16.1	−2.2	14.7
ECCAS	27.2	−1.6	25.4	24.1	−2.4	21.8	−1.9	19.2	−2.8	17.4
ECOWAS	27.3	−1.7	25.5	24.8	−1.0	22.4	−2.4	20.2	−2.1	18.8
IGAD	28.4	−1.3	26.6	25.9	−1.3	23.6	−1.7	21.3	−1.3	20.5
SADC	23.1	−1.1	21.6	20.4	−2.3	18.1	−2.2	15.8	−2.6	14.0
UMA	8.2	−0.8	8.2	6.7	−6.2	5.5	−3.1	4.3	−5.9	3.3
CAADP Compact 2007–09 (CC1)	31.6	−1.9	29.0	27.8	−1.8	24.6	−2.6	21.5	−2.5	19.7
CAADP Compact 2010–12 (CC2)	22.7	−1.6	20.9	20.1	−1.4	17.9	−2.3	15.6	−2.2	14.3
CAADP Compact 2013–15 (CC3)	22.7	−1.6	20.9	20.1	−1.4	17.9	−2.3	15.6	−2.2	14.3
CAADP Compact not yet (CC0)	10.2	−0.8	10.0	9.3	−1.8	8.4	−1.4	7.6	−1.4	7.4
CAADP Level 0 (CL0)	10.2	−0.8	10.0	9.3	−1.8	8.4	−1.4	7.6	−1.4	7.4
CAADP Level 1 (CL1)	25.3	−0.2	25.3	24.6	−1.5	24.0	−0.7	22.9	−1.2	21.6
CAADP Level 2 (CL2)	25.5	−0.9	24.3	23.5	−1.5	21.9	−1.2	20.1	−1.7	18.9
CAADP Level 3 (CL3)	25.6	−1.6	23.8	22.9	−1.8	20.7	−1.4	18.3	−2.4	17.2
CAADP Level 4 (CL4)	27.8	−2.0	25.3	24.3	−1.6	21.2	−3.0	18.2	−2.6	16.4
NAIP00 (N00)	15.7	−0.5	15.5	14.3	−2.9	12.4	−3.0	10.5	−3.2	9.4
NAIP01 (N01)	15.1	−0.4	15.1	14.2	−2.5	13.1	−1.4	11.4	−2.4	10.3
NAIP10 (N10)	28.9	−1.0	27.3	26.3	−1.6	24.1	−1.6	21.9	−1.7	20.5
NAIP11 (N11)	26.2	−1.6	24.3	23.5	−1.4	21.1	−2.2	18.8	−2.1	17.5

Source: ReSAKSS based on World Bank (2023) and ILO (2023).

Note: For regions or groups, level is weighted average, where weight is country's share in population under 5 years for the region or group.

ANNEX 1e: Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.2.2B

TABLE L1.2.2B—PREVALENCE OF STUNTING, HEIGHT FOR AGE (% of children under 5)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	41.2	−1.1	39.5	38.4	−1.1	35.4	−1.9	32.2	−1.4	30.6
Central	45.1	−1.0	44.0	43.4	−0.7	41.3	−0.8	39.2	−1.0	37.9
Eastern	47.7	−1.3	45.0	43.6	−1.4	39.9	−1.9	35.7	−1.6	33.8
Northern	25.3	−2.9	23.2	22.6	2.3	20.9	−3.4	18.0	−2.6	16.3
Southern	42.7	−1.0	41.0	38.9	−2.2	35.8	−1.9	31.4	−2.2	29.0
Western	39.7	−0.9	38.2	37.3	−1.2	34.1	−2.0	31.6	−1.2	30.2
Less favorable agriculture conditions	43.7	0.0	43.2	43.6	−0.1	42.7	−0.4	42.5	−0.2	41.8
More favorable agriculture conditions	50.8	−1.7	47.3	44.9	−1.9	40.5	−2.3	34.4	−2.4	31.5
Mineral-rich countries	44.0	−0.8	42.9	42.3	−0.6	40.3	−0.7	38.4	−0.8	37.3
Lower middle-income countries	35.6	−1.2	34.1	33.2	−0.8	30.1	−2.7	27.2	−1.5	25.8
Upper middle-income countries	28.4	−0.9	27.2	26.4	−1.4	25.2	−0.5	23.4	−1.4	22.4
CEN-SAD	36.6	−1.0	35.3	34.9	−0.3	32.5	−1.9	30.5	−0.9	29.5
COMESA	44.1	−1.3	42.0	41.1	−0.5	38.3	−1.8	34.8	−1.2	33.4
EAC	45.4	−1.3	43.1	42.2	−1.2	39.1	−1.8	35.4	−1.5	33.9
ECCAS	46.5	−1.3	44.7	43.3	−1.5	40.7	−1.3	37.6	−1.5	35.6
ECOWAS	39.7	−0.9	38.2	37.3	−1.2	34.1	−2.0	31.6	−1.2	30.2
IGAD	47.0	−1.3	44.3	43.0	−1.3	39.3	−1.7	35.5	−1.5	33.8
SADC	45.7	−1.1	43.9	42.2	−1.6	39.2	−1.7	35.4	−1.6	33.4
UMA	22.9	−1.3	21.4	19.4	−2.9	16.9	−2.4	14.3	−3.6	12.6
CAADP Compact 2007–09 (CC1)	46.8	−1.2	44.2	42.6	−1.7	38.4	−2.2	34.8	−1.6	32.5
CAADP Compact 2010–12 (CC2)	43.3	−1.3	41.2	40.1	−1.1	37.0	−1.8	33.1	−1.5	31.7
CAADP Compact 2013–15 (CC3)	43.3	−1.3	41.2	40.1	−1.1	37.0	−1.8	33.1	−1.5	31.7
CAADP Compact not yet (CC0)	26.7	−1.7	25.4	25.3	1.8	24.5	−1.9	23.2	−0.5	22.9
CAADP Level 0 (CL0)	26.7	−1.7	25.4	25.3	1.8	24.5	−1.9	23.2	−0.5	22.9
CAADP Level 1 (CL1)	43.4	−1.2	41.7	40.1	−1.9	37.6	−1.5	34.2	−1.9	31.9
CAADP Level 2 (CL2)	43.3	−1.0	42.2	41.7	−0.7	39.6	−0.7	37.9	−0.8	36.8
CAADP Level 3 (CL3)	44.6	−1.1	41.9	40.9	−1.2	37.7	−1.4	34.1	−1.8	32.1
CAADP Level 4 (CL4)	45.3	−1.3	42.8	41.2	−1.6	37.0	−2.5	32.9	−1.7	30.9
NAIP00 (N00)	32.4	−0.1	32.2	30.6	−1.9	29.4	−1.1	28.2	−0.9	27.6
NAIP01 (N01)	32.5	−2.2	30.6	30.3	1.4	28.5	−2.6	25.1	−1.8	23.3
NAIP10 (N10)	47.2	−1.1	45.9	45.2	−0.6	43.1	−0.8	40.9	−0.8	39.6
NAIP11 (N11)	43.9	−1.2	41.6	40.3	−1.4	36.7	−2.1	33.0	−1.6	31.2

Source: ReSAKSS based on World Bank (2022) and ILO (2022).
Note: Data only available up to 2021. For regions or groups, level is weighted average, where weight is country's share in population under 5 years for the region or group.

ANNEX 1f: Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.2.2C

TABLE L1.2.2C—PREVALENCE OF WASTING, WEIGHT FOR HEIGHT (% of children under 5)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	9.6	–1.3	9.1	8.8	–1.1	7.9	–2.0	6.9	–2.5	6.5
Central	11.3	–0.4	10.4	10.0	–2.2	8.5	–2.6	7.0	–3.5	6.1
Eastern	9.5	–1.1	9.0	8.9	–1.2	8.2	–1.6	7.5	–1.8	7.3
Northern	5.6	–1.2	5.6	5.6	3.3	6.1	1.7	6.0	–2.9	6.2
Southern	6.2	–1.7	5.7	5.6	–1.2	4.9	–1.1	4.2	–2.0	3.8
Western	12.4	–2.5	11.3	10.8	–1.7	9.4	–3.2	7.8	–2.9	7.3
Less favorable agriculture conditions	14.9	–2.7	13.6	12.6	–3.3	11.3	–1.2	9.6	–4.1	8.5
More favorable agriculture conditions	9.0	–2.0	8.3	8.0	–2.5	7.0	–2.2	5.9	–3.1	5.6
Mineral-rich countries	11.8	0.0	11.1	10.7	–1.6	9.8	–1.5	8.7	–1.8	8.2
Lower middle-income countries	9.0	–1.6	8.4	8.3	0.2	7.5	–2.5	6.6	–2.3	6.3
Upper middle-income countries	4.6	0.1	4.6	4.7	2.5	4.7	–1.7	4.4	–0.5	4.4
CEN-SAD	10.8	–1.6	10.2	9.9	–0.6	9.2	–2.0	8.2	–2.2	7.9
COMESA	9.2	–0.6	8.8	8.7	–0.8	8.1	–1.2	7.4	–2.1	7.2
EAC	8.4	–1.4	7.4	7.2	–1.3	6.2	–2.9	5.0	–3.9	4.5
ECCAS	10.5	–0.7	9.7	9.2	–2.0	7.9	–2.6	6.6	–3.1	5.8
ECOWAS	12.4	–2.5	11.3	10.8	–1.7	9.4	–3.2	7.8	–2.9	7.3
IGAD	10.1	–0.7	9.7	9.7	–0.7	9.2	–1.5	8.7	–1.0	8.7
SADC	8.2	–1.0	7.6	7.2	–2.2	6.1	–1.9	5.0	–3.6	4.4
UMA	5.4	–1.4	5.5	4.8	–2.5	4.4	–0.6	4.0	–3.2	3.8
CAADP Compact 2007–09 (CC1)	12.1	–2.3	11.0	10.6	–2.0	9.3	–2.8	7.8	–3.1	7.1
CAADP Compact 2010–12 (CC2)	8.8	–1.5	7.9	7.6	–1.3	6.7	–2.6	5.5	–2.9	5.2
CAADP Compact 2013–15 (CC3)	8.8	–1.5	7.9	7.6	–1.3	6.7	–2.6	5.5	–2.9	5.2
CAADP Compact not yet (CC0)	6.3	–0.7	6.3	6.2	2.0	6.3	–0.2	5.9	–2.7	5.9
CAADP Level 0 (CL0)	6.3	–0.7	6.3	6.2	2.0	6.3	–0.2	5.9	–2.7	5.9
CAADP Level 1 (CL1)	10.4	0.1	10.7	10.5	–1.0	10.1	–0.3	9.9	–0.3	9.6
CAADP Level 2 (CL2)	11.3	–0.4	10.3	9.8	–2.6	8.3	–2.7	6.7	–3.6	5.9
CAADP Level 3 (CL3)	9.5	–2.2	8.8	8.4	–2.3	7.7	0.0	7.0	–2.9	6.7
CAADP Level 4 (CL4)	10.5	–2.2	9.4	9.1	–1.3	8.0	–3.4	6.6	–2.9	6.1
NAIP00 (N00)	7.4	–0.5	7.4	6.8	–1.0	6.0	–3.2	5.0	–2.1	4.6
NAIP01 (N01)	7.1	–0.2	7.4	7.5	1.4	7.7	0.7	7.5	–2.4	7.5
NAIP10 (N10)	12.5	–0.2	11.2	10.5	–2.6	8.6	–3.3	6.7	–4.4	5.7
NAIP11 (N11)	10.2	–1.9	9.4	9.1	–1.4	8.2	–2.2	7.1	–2.3	6.8

Source: ReSAKSS based on World Bank (2023) and ILO (2023).

Note: Data only available up to 2021. For regions or groups, level is weighted average, where weight is country's share in population under 5 years for the region or group.

ANNEX 1g: Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.2.3

TABLE L1.2.3—CEREAL IMPORT DEPENDENCY RATIO (%)

Region	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014–2019)	Annual avg. change (%) (2014–2019)	2019
Africa	25.1	25.5	1.2	26.7	0.3	27.4	0.4	27.5
Central	30.7	30.0	−0.7	27.0	−4.2	23.5	0.9	24.4
Eastern	13.2	13.7	2.6	14.6	−3.4	15.5	1.6	15.5
Northern	43.7	45.6	3.8	50.1	0.2	55.6	2.0	56.7
Southern	24.9	25.9	−0.4	24.2	1.0	27.3	0.4	27.0
Western	22.6	22.5	−0.7	24.6	3.3	23.1	−1.5	22.9
Less favorable agriculture conditions	10.3	10.8	0.8	10.6	1.4	12.9	3.9	13.7
More favorable agriculture conditions	13.4	13.4	−1.3	12.4	0.2	13.9	−1.1	13.3
Mineral-rich countries	23.2	19.9	−7.4	15.6	2.5	17.8	6.3	20.6
Lower middle-income countries	33.7	34.6	2.1	38.6	0.9	38.8	0.4	39.1
Upper middle-income countries	16.9	19.1	3.2	19.6	5.8	27.1	−0.4	24.5
CEN-SAD	25.8	26.8	2.6	30.6	1.9	31.8	0.5	32.0
COMESA	20.3	20.9	3.4	23.5	−1.4	25.5	2.6	26.6
EAC	13.6	16.3	6.2	18.8	−1.9	19.2	1.6	19.6
ECCAS	37.6	37.8	−0.2	33.3	−4.9	27.4	0.2	27.9
ECOWAS	22.6	22.5	−0.7	24.6	3.3	23.1	−1.5	22.9
IGAD	13.4	13.6	3.6	15.5	−4.5	16.5	2.0	16.5
SADC	21.0	21.8	−0.6	20.1	0.2	21.1	0.3	21.1
UMA	58.0	58.7	2.2	59.7	−0.1	66.2	1.5	66.5
CAADP Compact 2007–09 (CC1)	17.0	16.5	−1.1	18.4	2.9	18.1	−1.0	17.9
CAADP Compact 2010–12 (CC2)	22.3	22.9	0.3	22.6	−1.5	22.3	0.4	22.4
CAADP Compact 2013–15 (CC3)	22.3	22.9	0.3	22.6	−1.5	22.3	0.4	22.4
CAADP Compact not yet (CC0)	35.6	37.6	3.8	40.3	0.4	46.5	1.9	46.7
CAADP Level 0 (CL0)	35.6	37.6	3.8	40.3	0.4	46.5	1.9	46.7
CAADP Level 1 (CL1)	35.8	37.0	1.3	39.4	0.4	37.4	0.7	38.9
CAADP Level 2 (CL2)	32.2	30.9	−0.8	27.0	−5.1	23.9	1.2	24.8
CAADP Level 3 (CL3)	15.1	14.7	−5.5	9.2	−4.3	10.7	13.9	14.1
CAADP Level 4 (CL4)	19.2	19.3	0.4	21.9	1.9	21.6	−2.0	20.6
NAIP00 (N00)	39.7	41.0	1.1	39.7	−0.5	40.9	−0.8	38.9
NAIP01 (N01)	32.0	33.9	4.9	38.4	1.1	44.2	2.8	45.7
NAIP10 (N10)	28.7	29.1	1.2	24.9	−8.7	19.6	1.9	20.8
NAIP11 (N11)	20.0	20.1	−0.2	21.4	1.2	21.5	−0.3	21.5

Source: ReSAKSS based on FAO (2023), World Bank (2023), and ILO (2023).

Note: Data are only available from 2000 to 2019. For regions or groups, level is weighted average, where weight is country's share in total population for the region or group.

ANNEX 1h: Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.3.1A

TABLE L1.3.1A—EMPLOYMENT RATE (% of labor force, 15-64 years)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	92.7	0.0	93.0	93.5	0.2	93.6	−0.1	93.2	−0.1	92.9
Central	95.5	0.0	95.8	96.0	0.0	95.5	−0.1	95.2	−0.1	94.9
Eastern	94.7	0.0	94.9	95.2	0.1	95.3	0.0	94.9	−0.2	94.2
Northern	85.5	0.1	86.3	88.2	0.9	88.9	−0.5	89.1	0.4	90.1
Southern	88.2	0.1	88.4	88.7	0.2	88.1	−0.2	86.8	−0.3	85.6
Western	96.0	0.0	96.0	96.0	0.0	96.2	0.1	95.9	−0.1	95.5
Less favorable agriculture conditions	95.5	−0.1	95.2	95.2	0.1	95.7	0.0	95.7	−0.1	95.4
More favorable agriculture conditions	96.5	0.0	96.7	97.0	0.1	97.2	0.1	96.8	−0.2	96.3
Mineral-rich countries	93.2	0.0	93.1	93.1	0.0	92.5	−0.2	92.1	−0.1	91.7
Lower middle-income countries	91.9	0.1	92.4	93.2	0.3	93.3	−0.2	93.0	0.0	93.0
Upper middle-income countries	80.0	0.1	80.4	80.7	0.2	79.3	−0.4	76.3	−0.9	73.0
CEN-SAD	93.6	0.0	93.6	93.7	0.1	93.7	−0.1	93.5	0.0	93.4
COMESA	93.6	0.0	93.7	94.0	0.2	93.8	−0.1	94.0	0.2	95.0
EAC	96.2	0.0	96.2	96.3	0.0	96.0	0.0	95.7	−0.2	95.1
ECCAS	95.1	0.0	95.3	95.5	0.0	94.6	−0.2	93.9	−0.1	93.5
ECOWAS	96.0	0.0	96.0	96.0	0.0	96.2	0.1	95.9	−0.1	95.5
IGAD	94.4	0.0	94.7	95.0	0.1	95.0	0.0	94.1	−0.3	93.3
SADC	92.1	0.1	92.4	92.6	0.1	92.3	−0.1	91.8	−0.1	91.0
UMA	81.0	0.4	83.5	86.6	1.2	88.9	0.0	88.3	−0.2	87.6
CAADP Compact 2007–09 (CC1)	96.0	0.0	96.2	96.4	0.1	96.7	0.0	96.0	−0.2	95.4
CAADP Compact 2010–12 (CC2)	96.1	0.0	96.0	95.9	0.0	95.8	0.0	95.9	−0.1	95.4
CAADP Compact 2013–15 (CC3)	92.0	0.1	92.6	93.2	0.2	92.6	−0.2	91.7	−0.2	91.1
CAADP Compact not yet (CC0)	83.9	0.1	84.5	85.9	0.7	86.1	−0.4	85.2	0.0	84.7
CAADP Level 0 (CL0)	83.9	0.1	84.5	85.9	0.7	86.1	−0.4	85.2	0.0	84.7
CAADP Level 1 (CL1)	91.7	0.1	92.2	92.5	0.1	91.8	−0.2	90.7	−0.2	90.1
CAADP Level 2 (CL2)	95.5	0.1	95.9	96.1	0.0	95.5	−0.1	95.2	−0.1	94.8
CAADP Level 3 (CL3)	96.1	0.0	95.9	96.2	0.2	96.9	0.1	97.0	−0.1	96.7
CAADP Level 4 (CL4)	96.0	0.0	96.1	96.2	0.0	96.4	0.0	95.9	−0.2	95.3
NAIP00 (N00)	81.0	0.3	82.6	84.5	0.7	84.6	−0.3	82.5	−0.5	80.6
NAIP01 (N01)	90.2	0.0	90.2	90.9	0.4	90.9	−0.4	91.4	0.4	92.4
NAIP10 (N10)	96.6	0.0	96.6	96.4	−0.1	95.5	−0.1	95.0	−0.1	94.6
NAIP11 (N11)	95.2	0.0	95.3	95.5	0.1	95.6	0.0	95.3	−0.2	94.7

Source: ReSAKSS based on ILO (2023).

Note: For regions or groups, level is weighted average, where weight is country's share in total labor force for the region or group.

ANNEX 1i: *Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.3.1B*

TABLE L1.3.1B—EMPLOYMENT RATE (% of population, 15+ years)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	59.8	–0.1	59.7	60.1	0.2	59.4	–0.5	58.2	–0.2	57.9
Central	70.5	–0.1	70.4	69.8	–0.6	66.0	–1.0	63.9	–0.2	63.6
Eastern	69.0	0.1	69.6	70.0	0.1	69.9	–0.1	68.8	–0.4	68.0
Northern	40.0	–0.6	39.3	40.9	1.6	41.8	–0.6	39.2	–0.9	38.3
Southern	60.2	–0.1	59.9	59.9	0.0	57.8	–0.6	57.0	–0.3	56.1
Western	61.8	–0.1	61.6	61.4	–0.1	59.9	–1.0	58.4	0.1	58.4
Less favorable agriculture conditions	64.1	–0.4	63.3	63.1	0.0	62.9	–0.4	60.5	–0.6	59.5
More favorable agriculture conditions	76.8	0.1	77.3	77.5	0.0	76.4	–0.3	74.6	–0.4	73.8
Mineral-rich countries	60.6	–0.1	60.4	59.9	–0.5	57.4	–0.8	55.8	–0.2	55.5
Lower middle-income countries	53.4	–0.2	53.1	53.9	0.6	53.7	–0.7	52.3	–0.1	52.2
Upper middle-income countries	47.6	–0.2	47.2	47.1	0.0	44.3	–0.9	43.0	–1.2	40.5
CEN-SAD	54.9	–0.3	54.3	54.7	0.3	54.2	–0.8	52.5	–0.2	52.3
COMESA	60.0	–0.1	59.8	60.4	0.4	60.4	–0.2	59.6	0.0	60.4
EAC	72.3	0.0	72.4	72.2	–0.2	70.4	–0.4	69.3	–0.1	69.6
ECCAS	69.9	–0.1	69.8	69.3	–0.4	66.0	–1.0	63.9	–0.3	63.4
ECOWAS	61.8	–0.1	61.6	61.4	–0.1	59.9	–1.0	58.4	0.1	58.4
IGAD	65.5	0.2	66.1	66.6	0.2	66.7	0.0	65.8	–0.4	65.1
SADC	67.3	0.0	67.4	67.3	–0.1	65.1	–0.6	64.2	–0.2	63.6
UMA	38.4	0.0	39.0	40.1	1.0	40.5	–0.3	38.8	–0.8	37.9
CAADP Compact 2007–09 (CC1)	65.6	0.1	66.0	66.2	0.1	65.5	–0.7	63.9	–0.1	63.7
CAADP Compact 2010–12 (CC2)	70.1	–0.1	69.9	69.5	–0.3	67.5	–0.5	66.3	–0.2	65.9
CAADP Compact 2013–15 (CC3)	63.9	–0.1	63.9	64.1	0.0	62.7	–0.5	61.2	–0.3	60.6
CAADP Compact not yet (CC0)	42.5	–0.5	41.8	43.0	1.1	43.0	–0.6	40.7	–1.0	39.3
CAADP Level 0 (CL0)	42.5	–0.5	41.8	43.0	1.1	43.0	–0.6	40.7	–1.0	39.3
CAADP Level 1 (CL1)	61.6	–0.1	61.4	61.5	0.0	60.8	–0.2	59.6	–0.3	59.1
CAADP Level 2 (CL2)	68.5	0.0	68.7	68.1	–0.6	63.9	–1.2	61.6	–0.2	61.2
CAADP Level 3 (CL3)	67.2	–0.1	67.0	67.2	0.2	67.1	–0.2	66.0	–0.2	65.5
CAADP Level 4 (CL4)	68.0	0.0	68.2	68.3	0.0	67.2	–0.6	65.8	–0.1	65.6
NAIP00 (N00)	45.7	–0.1	45.9	46.6	0.5	45.5	–0.6	44.6	–0.7	43.2
NAIP01 (N01)	47.8	–0.5	46.8	48.1	1.2	49.0	–0.4	46.9	–0.6	46.2
NAIP10 (N10)	69.4	0.0	69.5	68.6	–0.8	64.2	–1.1	62.6	–0.1	62.4
NAIP11 (N11)	66.2	0.0	66.3	66.4	0.0	65.3	–0.6	63.9	–0.2	63.6

Source: ReSAKSS based on ILO (2023).
Note: For regions or groups, level is weighted average, where weight is country's share in total population for the region or group.

ANNEX 1j: Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.3.3

TABLE L1.3.3—POVERTY GAP AT $2.15/ DAY (2017 PPP) (%)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2020)	Annual avg. change (%) (2014-2020)	2020
Africa	18.3	–2.9	16.0	14.9	–3.2	12.0	–3.9	10.4	–1.3	10.1
Central	23.3	–3.6	20.6	18.8	–3.6	15.3	–3.9	11.3	–6.3	9.5
Eastern	22.4	–2.6	18.9	17.7	–2.1	14.7	–3.7	16.0	3.4	16.5
Northern	0.9	–4.7	0.7	0.6	–6.2	0.3	–10.8	0.2	–3.9	0.2
Southern	19.6	–1.2	18.4	17.6	–3.3	15.8	–0.8	14.8	–1.1	14.4
Western	22.3	–3.9	19.1	17.3	–4.3	12.7	–6.2	8.8	–5.3	7.8
Less favorable agriculture conditions	34.2	–3.7	29.4	26.7	–4.5	19.0	–7.6	12.7	–2.8	12.0
More favorable agriculture conditions	27.5	–3.0	23.3	21.6	–2.4	17.8	–3.9	18.4	2.9	19.2
Mineral-rich countries	29.7	–3.0	26.1	25.1	–3.3	20.1	–4.7	18.4	6.1	23.1
Lower middle-income countries	11.2	–2.8	10.1	9.4	–3.7	7.6	–2.9	6.7	–1.8	6.4
Upper middle-income countries	11.4	–3.0	9.5	8.3	–8.9	6.1	0.7	4.3	–11.2	3.2
CEN-SAD	15.4	–3.5	13.4	12.3	–3.9	9.3	–5.5	6.9	–4.1	6.2
COMESA	14.8	–1.9	13.3	12.9	–0.9	11.5	–2.7	12.8	3.8	13.6
EAC	23.7	–1.6	21.2	19.6	–3.1	16.1	–3.1	13.6	–3.4	12.5
ECCAS	20.5	–2.8	18.3	16.8	–4.1	14.1	–2.4	11.5	–4.3	10.1
ECOWAS	22.3	–3.9	19.1	17.3	–4.3	12.7	–6.2	8.8	–5.3	7.8
IGAD	17.9	–3.9	14.2	13.1	–2.3	9.8	–6.0	10.7	4.7	11.3
SADC	23.2	–0.9	21.7	20.8	–2.4	18.9	–1.2	17.6	–1.2	17.1
UMA	1.8	–5.4	1.4	1.1	–9.3	0.6	–14.1	0.2		0.0
CAADP Compact 2007–09 (CC1)	22.5	–4.2	18.6	16.9	–4.3	12.3	–6.3	9.8	–2.3	9.1
CAADP Compact 2010–12 (CC2)	24.6	–2.2	22.0	20.7	–2.5	17.3	–3.3	14.4	–2.4	13.7
CAADP Compact 2013–15 (CC3)	24.6	–2.2	22.0	20.7	–2.5	17.3	–3.3	14.4	–2.4	13.7
CAADP Compact not yet (CC0)	4.2	–3.6	3.4	3.0	–8.7	2.1	–1.1	1.5	–8.8	1.2
CAADP Level 0 (CL0)	4.2	–3.6	3.4	3.0	–8.7	2.1	–1.1	1.5	–8.8	1.2
CAADP Level 1 (CL1)	21.2	0.5	21.5	20.9	–0.8	19.9	–1.6	20.1	1.4	20.7
CAADP Level 2 (CL2)	19.3	–4.9	16.1	14.3	–5.3	10.1	–6.9	6.2	–6.9	5.3
CAADP Level 3 (CL3)	30.7	–2.8	27.4	25.3	–3.5	19.4	–5.3	15.5	–0.2	16.0
CAADP Level 4 (CL4)	21.6	–3.5	18.3	16.9	–3.4	13.2	–4.6	11.2	–2.4	10.4
NAIP00 (N00)	11.0	–2.0	9.7	8.5	–8.3	7.2	3.3	6.6	–3.7	6.0
NAIP01 (N01)	6.2	0.9	6.4	6.4	1.0	6.7	0.5	7.5	3.7	8.3
NAIP10 (N10)	41.6	–3.9	35.6	31.6	–5.0	22.8	–6.9	13.9	–9.6	10.4
NAIP11 (N11)	22.8	–3.4	19.5	18.0	–3.5	13.9	–5.0	11.6	–1.6	11.1

Source: ReSAKSS based on World Bank (2023) and ILO (2023).

Note: Data only available up to 2020. For regions or groups, level is weighted average, where weight is country's share in total population for the region or group.

ANNEX 1k: *Level 1—Agriculture's Contribution to Economic Growth and Inclusive Development, Indicator 1.3.4*

TABLE L1.3.4—POVERTY HEADCOUNT RATIO AT $2.15/ DAY (2017 PPP, % of population)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2020)	Annual avg. change (%) (2014-2020)	2020
Africa	44.1	−1.8	40.6	38.6	−2.2	33.8	−2.3	30.7	−1.2	30.0
Central	55.5	−2.7	51.0	48.1	−2.4	41.6	−2.5	34.7	−3.7	31.4
Eastern	56.6	−1.9	50.4	48.1	−1.7	42.0	−2.5	44.6	2.7	46.0
Northern	4.6	−4.2	4.0	3.4	−4.8	2.1	−11.1	1.2	−9.2	0.9
Southern	43.9	−0.6	42.5	41.0	−2.1	38.4	−0.2	37.7	−0.1	37.7
Western	52.0	−2.3	47.6	44.7	−2.8	37.7	−3.3	31.1	−3.1	29.5
Less favorable agriculture conditions	72.6	−2.4	66.0	62.5	−2.5	52.1	−3.7	43.1	−1.6	42.1
More favorable agriculture conditions	65.2	−2.1	58.1	54.9	−1.8	47.7	−2.8	49.2	2.1	50.6
Mineral-rich countries	58.3	−0.8	56.6	54.5	−2.0	47.7	−2.5	46.3	4.4	54.3
Lower middle-income countries	29.2	−1.6	27.7	26.4	−2.3	23.6	−1.6	21.8	−1.3	21.3
Upper middle-income countries	31.6	−2.6	27.4	24.8	−6.5	19.4	−0.4	15.0	−7.3	12.4
CEN-SAD	36.7	−1.9	34.2	32.5	−2.4	27.9	−2.9	23.6	−2.8	22.3
COMESA	38.5	−1.4	35.7	34.7	−0.9	31.5	−2.0	32.2	1.8	33.3
EAC	56.4	−0.9	53.1	51.0	−1.6	45.9	−1.5	42.6	−1.4	41.1
ECCAS	47.4	−1.9	44.4	42.2	−2.5	38.1	−1.2	34.4	−2.2	32.3
ECOWAS	52.0	−2.3	47.6	44.7	−2.8	37.7	−3.3	31.1	−3.1	29.5
IGAD	50.4	−2.7	43.1	40.6	−2.1	33.6	−3.7	35.2	3.4	36.9
SADC	51.7	−0.5	49.9	48.4	−1.5	45.4	−0.7	44.1	−0.4	43.7
UMA	7.8	−5.1	6.0	4.9	−7.9	2.7	−14.7	0.7	−41.5	0.1
CAADP Compact 2007–09 (CC1)	55.2	−2.7	48.7	45.6	−3.0	37.6	−3.7	33.4	−1.0	32.5
CAADP Compact 2010–12 (CC2)	55.2	−1.1	52.3	50.2	−1.2	45.8	−1.8	42.2	−1.2	41.5
CAADP Compact 2013–15 (CC3)	55.2	−1.1	52.3	50.2	−1.2	45.8	−1.8	42.2	−1.2	41.5
CAADP Compact not yet (CC0)	13.1	−3.3	11.1	9.9	−6.2	7.2	−2.9	5.3	−7.8	4.3
CAADP Level 0 (CL0)	13.1	−3.3	11.1	9.9	−6.2	7.2	−2.9	5.3	−7.8	4.3
CAADP Level 1 (CL1)	46.8	0.4	47.5	46.9	−0.8	45.1	−0.9	46.3	1.2	47.4
CAADP Level 2 (CL2)	45.5	−3.4	40.7	37.4	−3.0	29.8	−4.1	23.7	−4.0	21.7
CAADP Level 3 (CL3)	67.2	−1.5	63.1	59.6	−2.2	51.2	−2.9	45.6	−0.3	46.4
CAADP Level 4 (CL4)	52.8	−2.2	47.6	45.0	−2.3	38.9	−2.7	35.7	−0.9	34.9
NAIP00 (N00)	29.5	−1.8	26.5	24.4	−5.7	21.4	1.8	20.1	−2.5	18.8
NAIP01 (N01)	15.6	−0.2	15.7	15.6	0.0	15.1	−0.7	15.1	0.1	15.0
NAIP10 (N10)	70.5	−2.0	65.2	61.8	−2.2	54.3	−2.5	47.1	−1.6	46.1
NAIP11 (N11)	54.5	−2.1	49.5	46.9	−2.3	40.2	−2.9	36.6	−0.7	36.2

Source: ReSAKSS based on World Bank (2023) and ILO (2023).

Note: Data only available up to 2020. For regions or groups, level is weighted average, where weight is country's share in total population for the region or group.

ANNEX 2a: *Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.1*

TABLE L2.1.1—AGRICULTURE VALUE ADDED (billion, constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	205.2	4.4	246.7	256.0	2.6	312.3	2.1	381.9	2.8	415.5
Central	13.5	–4.5	11.3	11.8	3.0	15.5	4.0	20.5	2.9	22.0
Eastern	55.0	1.9	58.1	66.0	6.1	81.5	1.6	92.8	1.6	95.7
Northern	43.3	7.6	54.3	54.9	0.2	65.5	2.5	83.3	3.1	91.3
Southern	16.5	1.2	17.0	17.8	3.8	21.2	2.6	26.5	0.9	27.5
Western	76.8	6.6	106.1	105.4	1.5	128.6	1.8	158.8	3.6	178.9
Less favorable agriculture conditions	7.2	3.5	8.2	9.3	4.9	11.6	4.8	16.1	3.7	18.1
More favorable agriculture conditions	26.6	–0.9	27.1	32.9	8.3	50.7	5.9	70.4	4.9	82.3
Mineral-rich countries	34.9	2.5	36.5	39.6	5.1	42.4	–2.7	33.3	–7.6	21.5
Lower middle-income countries	127.6	6.1	164.0	164.2	1.0	197.2	2.1	249.4	3.6	281.0
Upper middle-income countries	8.9	3.4	10.9	10.1	–0.2	10.4	–0.2	12.7	0.9	12.7
CEN-SAD	150.1	5.4	188.6	192.4	2.0	223.9	0.8	259.1	2.3	277.2
COMESA	92.9	2.1	98.2	106.1	3.8	124.1	0.9	140.9	2.1	149.4
EAC	28.2	–3.0	25.7	27.9	3.6	37.6	4.8	50.9	3.4	54.5
ECCAS	14.5	–4.1	12.5	13.1	2.9	17.1	4.3	23.0	3.3	25.1
ECOWAS	76.8	6.6	106.1	105.4	1.5	128.6	1.8	158.8	3.6	178.9
IGAD	45.5	2.7	48.1	54.9	6.5	66.7	0.8	71.7	1.0	72.7
SADC	30.0	–2.5	27.9	29.6	3.6	35.6	2.7	45.1	2.0	46.3
UMA	17.1	13.1	24.9	24.2	–2.1	29.5	5.4	40.9	2.0	42.2
CAADP Compact 2007–09 (CC1)	76.7	6.4	105.6	108.0	2.8	138.1	2.6	172.8	4.0	198.9
CAADP Compact 2010–12 (CC2)	40.8	–1.4	39.5	41.9	2.6	54.4	4.3	76.4	4.6	85.8
CAADP Compact 2013–15 (CC3)	37.5	3.6	40.4	43.9	4.6	45.9	–1.8	40.9	–5.7	30.4
CAADP Compact not yet (CC0)	50.1	6.6	61.3	62.2	0.9	73.9	2.0	91.8	2.8	100.5
CAADP Level 0 (CL0)	50.1	6.6	61.3	62.2	0.9	73.9	2.0	91.8	2.8	100.5
CAADP Level 1 (CL1)	34.7	3.5	37.2	40.7	4.9	41.8	–2.4	35.2	–7.2	24.0
CAADP Level 2 (CL2)	12.6	–4.4	10.5	10.7	1.7	13.8	3.9	19.5	4.9	22.1
CAADP Level 3 (CL3)	12.6	3.7	14.1	15.7	4.8	21.8	4.1	25.8	2.9	28.2
CAADP Level 4 (CL4)	95.2	4.8	123.7	126.8	2.5	161.0	2.9	209.5	4.3	240.7
NAIP00 (N00)	14.7	14.0	20.2	20.0	0.4	25.5	5.6	37.9	2.6	41.2
NAIP01 (N01)	42.4	3.5	48.4	50.1	1.4	58.4	1.0	69.2	3.0	76.6
NAIP10 (N10)	7.4	–9.4	4.8	5.0	3.1	7.0	3.6	9.3	4.4	10.3
NAIP11 (N11)	140.3	4.6	173.0	180.5	3.1	221.1	1.9	265.2	2.7	287.1

Source: ReSAKSS based on World Bank (2023) and FAO (2023).

Note: Aggregate value for a group is the sum of agriculture value added for countries in the group.

ANNEX 2b: Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.2

TABLE L2.1.2—AGRICULTURAL PRODUCTION INDEX (API) (2014-2016 = 100)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	61.7	3.0	70.2	76.7	3.1	88.7	3.1	106.1	2.2	112.6
Central	53.3	0.5	55.4	60.1	3.4	83.6	7.3	105.5	2.2	112.5
Eastern	59.4	3.2	68.1	74.5	3.3	89.0	4.0	106.7	2.7	116.7
Northern	63.7	2.6	72.4	79.5	3.2	92.6	2.4	102.9	1.0	105.8
Southern	66.5	2.0	69.8	74.7	2.8	93.8	3.7	108.7	3.0	118.7
Western	61.9	3.6	71.3	78.2	3.0	86.1	2.4	107.2	2.4	112.8
Less favorable agriculture conditions	54.1	3.3	61.7	67.8	4.3	87.7	3.8	112.7	4.4	124.4
More favorable agriculture conditions	55.9	3.3	64.3	69.9	3.1	87.4	4.7	108.0	3.0	118.7
Mineral-rich countries	52.6	1.3	56.5	60.4	2.5	85.5	7.6	107.8	3.0	117.7
Lower middle-income countries	63.3	2.9	71.7	79.1	3.3	88.8	2.4	105.1	1.8	109.7
Upper middle-income countries	73.6	2.6	81.3	84.5	1.7	95.7	2.0	103.6	1.3	109.4
CEN-SAD	63.1	3.5	72.8	79.9	3.2	89.0	2.2	105.8	2.0	111.2
COMESA	65.4	3.0	73.9	80.0	2.9	91.8	2.6	105.2	2.1	113.2
EAC	61.2	2.8	69.5	74.8	2.6	89.8	4.9	106.3	2.7	117.6
ECCAS	51.8	1.6	56.5	62.1	3.9	87.0	6.5	106.0	2.4	113.9
ECOWAS	61.9	3.6	71.3	78.2	3.0	86.1	2.4	107.2	2.4	112.8
IGAD	60.2	3.2	69.3	75.8	2.9	88.7	3.7	107.2	2.9	118.0
SADC	60.7	1.8	64.7	69.4	3.0	89.6	5.1	106.8	2.5	115.4
UMA	57.4	1.6	65.3	70.4	1.2	88.4	4.8	105.2	1.6	108.7
CAADP Compact 2007–09 (CC1)	60.3	3.9	70.9	77.5	3.0	86.4	2.7	106.4	2.2	111.6
CAADP Compact 2010–12 (CC2)	59.2	2.5	65.5	71.4	2.9	88.0	4.8	109.3	3.5	122.4
CAADP Compact 2013–15 (CC3)	59.2	2.5	65.5	71.4	2.9	88.0	4.8	109.3	3.5	122.4
CAADP Compact not yet (CC0)	64.8	2.4	72.9	79.8	3.2	92.9	2.3	103.1	1.0	106.3
CAADP Level 0 (CL0)	64.8	2.4	72.9	79.8	3.2	92.9	2.3	103.1	1.0	106.3
CAADP Level 1 (CL1)	71.0	1.3	72.4	77.7	2.5	92.5	2.7	106.7	2.4	113.3
CAADP Level 2 (CL2)	52.4	0.6	54.3	59.4	3.4	83.1	7.5	105.8	2.3	113.7
CAADP Level 3 (CL3)	66.9	2.4	74.1	78.8	1.9	91.9	3.1	109.4	3.5	122.0
CAADP Level 4 (CL4)	59.4	3.8	69.6	76.4	3.2	86.4	3.0	107.0	2.5	113.9
NAIP00 (N00)	55.6	0.6	60.4	66.7	3.3	87.7	5.2	105.1	1.8	110.2
NAIP01 (N01)	67.1	3.4	76.9	83.8	3.2	95.0	1.5	102.4	0.8	105.2
NAIP10 (N10)	53.2	–0.8	51.9	52.8	0.6	81.1	10.9	107.0	2.6	116.4
NAIP11 (N11)	61.1	3.4	70.0	76.5	3.1	87.1	3.2	107.2	2.6	114.7

Source: ReSAKSS based on FAO (2023) and World Bank (2023).

Note: Data only available up to 2021. For regions or groups, level is weighted average, where weight is country's share in total agriculture value added for the region or group.

ANNEX 2c: *Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.3*

TABLE L2.1.3—LABOR PRODUCTIVITY (agriculture value-added per agricultural worker, constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	1,410.8	1.4	1,513.4	1,460.4	−0.4	1,605.5	1.4	1,796.0	1.1	1,854.3
Central	645.3	−6.7	487.8	475.7	0.0	540.5	2.4	638.1	1.1	645.4
Eastern	944.7	−1.3	877.8	931.1	3.8	1,051.1	0.4	1,039.3	−1.0	983.2
Northern	4,008.3	3.4	4,263.4	4,039.0	−1.6	4,808.3	3.5	7,046.4	6.2	8,517.4
Southern	895.3	−1.9	789.8	780.1	1.1	835.2	0.9	920.6	−0.1	956.1
Western	2,125.4	4.4	2,760.1	2,490.5	−3.6	2,648.2	2.5	3,235.8	2.2	3,497.9
Less favorable agriculture conditions	615.4	0.7	635.9	649.3	−0.2	647.3	2.4	772.6	0.6	774.0
More favorable agriculture conditions	441.7	−3.5	402.2	458.7	6.1	642.9	4.0	772.5	2.9	856.8
Mineral-rich countries	1,365.6	−0.4	1,277.5	1,320.0	3.7	1,383.0	−1.4	1,020.6	−9.5	617.6
Lower middle-income countries	2,814.2	3.1	3,218.0	2,894.6	−3.9	3,039.7	2.4	3,877.5	3.2	4,319.4
Upper middle-income countries	5,167.3	1.3	5,641.0	5,659.5	2.7	6,151.1	−1.7	5,902.3	−0.9	5,758.4
CEN-SAD	2,616.2	2.9	2,999.0	2,776.6	−2.4	2,848.5	1.5	3,297.1	1.4	3,432.7
COMESA	1,207.0	−1.1	1,106.1	1,116.0	1.5	1,201.5	−0.1	1,206.9	0.2	1,206.2
EAC	699.8	−5.6	568.2	584.6	1.6	707.5	2.8	846.8	3.3	953.6
ECCAS	685.8	−6.5	513.1	511.1	0.4	606.3	3.7	764.6	1.3	805.2
ECOWAS	2,125.4	4.4	2,760.1	2,490.5	−3.6	2,648.2	2.5	3,235.8	2.2	3,497.9
IGAD	1,225.1	−0.7	1,124.4	1,180.9	3.8	1,302.0	−0.4	1,198.2	−1.8	1,102.1
SADC	658.7	−4.9	545.9	553.5	1.9	636.0	2.1	738.0	0.6	755.1
UMA	3,046.0	4.7	3,482.3	3,449.1	−0.8	4,538.6	6.8	6,831.6	3.1	7,372.7
CAADP Compact 2007–09 (CC1)	1,386.1	3.4	1,729.1	1,610.2	−1.2	1,829.3	1.9	2,126.2	2.3	2,324.0
CAADP Compact 2010–12 (CC2)	738.1	−3.8	646.8	650.6	0.2	741.8	2.7	909.5	2.7	969.8
CAADP Compact 2013–15 (CC3)	1,698.0	0.3	1,551.1	1,543.9	1.3	1,499.9	−1.1	1,242.2	−8.0	845.8
CAADP Compact not yet (CC0)	4,164.0	3.1	4,437.2	4,252.2	−0.7	5,093.7	2.9	7,080.4	5.5	8,407.1
CAADP Level 0 (CL0)	4,164.0	3.1	4,437.2	4,252.2	−0.7	5,093.7	2.9	7,080.4	5.5	8,407.1
CAADP Level 1 (CL1)	2,085.4	−0.2	1,845.2	1,814.3	0.7	1,679.5	−1.8	1,288.1	−9.9	792.4
CAADP Level 2 (CL2)	620.9	−6.8	464.5	455.3	0.6	543.6	2.9	699.1	3.3	752.8
CAADP Level 3 (CL3)	656.8	0.8	655.9	676.9	1.7	819.7	1.6	801.6	0.1	803.9
CAADP Level 4 (CL4)	1,241.0	2.2	1,474.9	1,396.6	−1.1	1,570.2	2.2	1,892.7	2.7	2,077.0
NAIP00 (N00)	5,288.4	−2.4	4,012.3	3,761.6	−2.0	4,197.3	2.9	4,968.2	−1.1	4,751.1
NAIP01 (N01)	2,763.6	0.8	2,726.6	2,532.2	−3.0	2,585.6	0.3	3,093.6	3.9	3,535.7
NAIP10 (N10)	594.5	−11.8	341.0	338.0	1.7	421.2	1.9	492.5	2.6	516.2
NAIP11 (N11)	1,230.0	2.0	1,384.4	1,342.6	0.1	1,488.9	1.4	1,628.8	0.7	1,661.3

Source: ReSAKSS based on World Bank (2023).

ANNEX 2d: Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.4

TABLE L2.1.4—LAND PRODUCTIVITY (agriculture value-added per hectare of arable land, constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	206.5	3.1	238.2	244.1	2.2	293.7	2.1	357.5	2.7	390.4
Central	137.8	–4.5	115.6	120.5	2.9	144.3	2.0	180.2	2.5	190.7
Eastern	197.9	1.4	204.3	227.3	5.4	286.7	3.3	337.0	1.5	349.6
Northern	401.0	–0.6	390.7	393.6	0.1	467.0	2.5	593.6	3.1	650.5
Southern	57.1	0.9	58.1	60.9	3.7	71.9	2.4	91.7	2.5	103.9
Western	352.6	5.7	475.8	462.3	0.6	545.8	1.3	651.4	3.2	726.2
Less favorable agriculture conditions	53.8	2.9	60.9	65.8	3.6	82.5	4.8	111.3	2.8	119.6
More favorable agriculture conditions	152.0	–1.7	149.4	175.9	7.3	260.7	5.2	352.5	4.9	416.2
Mineral-rich countries	176.8	2.1	181.2	194.5	4.8	208.9	–0.9	173.5	–6.8	119.5
Lower middle-income countries	395.2	3.8	480.9	479.3	0.8	567.4	1.8	705.9	3.5	792.7
Upper middle-income countries	52.7	2.3	60.5	56.3	–0.1	58.2	–0.1	71.0	0.9	71.3
CEN-SAD	292.3	4.6	354.4	356.6	1.6	412.9	1.4	481.0	2.2	515.2
COMESA	281.0	1.0	280.5	298.2	3.3	350.5	1.9	407.0	2.3	439.0
EAC	276.2	–3.2	248.1	264.7	2.9	334.1	3.4	446.7	5.3	534.8
ECCAS	115.7	–3.4	102.2	109.4	3.6	141.3	4.0	192.9	3.1	215.2
ECOWAS	352.6	5.7	475.8	462.3	0.6	545.8	1.3	651.4	3.2	726.2
IGAD	224.3	2.4	233.0	259.6	5.8	327.6	3.2	371.5	1.0	381.3
SADC	83.0	–2.6	76.9	81.7	3.7	100.0	3.1	131.2	2.9	144.5
UMA	158.0	4.2	183.4	178.0	–2.2	215.7	5.3	299.8	2.1	309.2
CAADP Compact 2007–09 (CC1)	386.0	5.5	516.1	512.0	1.7	630.8	1.9	764.7	3.6	871.0
CAADP Compact 2010–12 (CC2)	159.0	–1.7	151.6	158.5	2.0	194.3	3.2	262.2	4.5	297.1
CAADP Compact 2013–15 (CC3)	123.7	3.1	131.1	141.7	4.4	151.8	–0.2	141.9	–5.2	109.3
CAADP Compact not yet (CC0)	213.3	2.8	233.0	235.9	0.8	281.7	2.1	350.8	2.9	383.9
CAADP Level 0 (CL0)	213.3	2.8	233.0	235.9	0.8	281.7	2.1	350.8	2.9	383.9
CAADP Level 1 (CL1)	117.6	3.0	124.0	134.6	4.6	142.1	–0.7	126.0	–6.7	89.7
CAADP Level 2 (CL2)	140.9	–4.4	117.9	120.0	1.6	139.9	1.7	185.4	4.6	208.9
CAADP Level 3 (CL3)	105.7	2.4	112.6	120.7	3.5	160.7	3.4	186.1	2.9	205.2
CAADP Level 4 (CL4)	373.4	4.4	478.0	480.6	1.8	590.1	2.3	741.8	3.9	845.3
NAIP00 (N00)	69.8	10.3	90.3	89.4	0.4	113.5	5.6	168.5	2.6	183.2
NAIP01 (N01)	257.9	2.0	272.3	281.4	1.4	327.8	1.0	386.9	3.0	427.9
NAIP10 (N10)	276.5	–9.3	180.4	186.8	3.0	202.6	–1.4	232.3	3.4	248.9
NAIP11 (N11)	235.9	4.0	285.1	291.6	2.4	353.6	2.3	424.6	2.7	462.8

Source: ReSAKSS based on World Bank (2023) and FAO (2023).

ANNEX 2e: Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.5A

TABLE L2.1.5A—YIELD, CASSAVA (metric tons per hectare)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	8.6	1.0	8.9	9.3	1.8	9.0	–2.8	8.5	0.6	8.7
Central	7.8	–0.2	7.6	7.8	1.3	8.1	0.3	8.2	0.0	8.2
Eastern	8.0	0.1	7.7	7.5	1.0	6.2	–3.2	5.4	1.3	5.5
Northern										
Southern	6.4	8.3	8.0	8.5	3.0	9.4	0.6	10.7	6.8	13.0
Western	10.1	–0.4	10.3	10.8	1.5	10.3	–5.4	9.1	–0.6	9.0
Less favorable agriculture conditions	7.1	7.1	8.3	7.4	–6.0	7.4	5.8	9.0	0.3	9.5
More favorable agriculture conditions	7.5	3.0	7.7	7.6	0.6	6.9	–0.9	6.9	3.5	7.6
Mineral-rich countries	7.4	–0.4	7.3	7.3	0.0	7.8	1.6	8.4	1.2	8.7
Lower middle-income countries	9.9	0.2	10.4	11.1	2.8	10.9	–6.0	9.2	–0.6	9.1
Upper middle-income countries	4.2	0.5	4.3	4.3	0.9	4.5	0.9	4.6	0.1	4.6
CEN-SAD	9.8	–0.3	10.0	10.5	1.4	10.0	–5.0	9.0	–0.5	8.9
COMESA	8.1	2.4	8.6	8.6	–0.2	8.1	–0.8	8.2	0.7	8.3
EAC	8.2	0.1	8.1	7.9	–0.2	7.3	–0.4	7.2	0.6	7.3
ECCAS	7.6	1.9	8.3	8.7	2.4	9.1	–1.6	8.4	0.1	8.5
ECOWAS	10.1	–0.4	10.3	10.8	1.5	10.3	–5.4	9.1	–0.6	9.0
IGAD	10.2	9.1	12.6	11.9	–7.3	5.7	–12.1	3.4	–1.9	3.2
SADC	7.3	1.3	7.5	7.8	2.8	8.2	0.3	8.5	2.4	9.1
UMA										
CAADP Compact 2007–09 (CC1)	10.3	–0.7	10.4	10.9	1.5	10.5	–5.4	9.3	–0.7	9.2
CAADP Compact 2010–12 (CC2)	7.4	1.4	7.5	7.4	0.1	7.1	0.4	7.6	2.3	8.1
CAADP Compact 2013–15 (CC3)	7.3	4.3	8.5	9.7	6.5	11.2	–2.5	9.4	0.7	9.7
CAADP Compact not yet (CC0)	7.1	0.7	7.3	7.3	–0.1	7.4	0.3	7.5	0.2	7.5
CAADP Level 0 (CL0)	7.1	0.7	7.3	7.3	–0.1	7.4	0.3	7.5	0.2	7.5
CAADP Level 1 (CL1)	6.9	6.5	8.8	9.6	4.6	10.7	–3.3	8.6	1.1	9.1
CAADP Level 2 (CL2)	7.8	–0.5	7.6	7.9	1.7	8.2	0.1	8.2	0.1	8.3
CAADP Level 3 (CL3)	8.2	5.3	9.0	8.5	–4.3	6.2	–3.1	6.5	3.1	7.1
CAADP Level 4 (CL4)	9.2	0.1	9.4	9.8	2.1	9.5	–3.4	9.0	0.3	9.2
NAIP00 (N00)	7.0	11.9	10.8	11.7	5.6	13.0	–5.9	9.0	1.1	9.7
NAIP01 (N01)	6.6	0.5	6.1	6.8	4.4	7.2	0.7	7.5	0.5	7.6
NAIP10 (N10)	7.7	–0.1	7.7	7.6	–0.2	7.8	0.6	7.9	0.2	7.9
NAIP11 (N11)	9.1	0.4	9.2	9.6	1.8	9.1	–3.2	8.7	0.6	9.0

Source: ReSAKSS based on FAO (2023).

Note: Data only available up to 2021. Cassava production data are not available in Northern Africa and UMA.

ANNEX 2f: Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.5B

TABLE L2.1.5B—YIELD, YAMS (metric tons per hectare)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	10.0	−0.5	10.3	10.6	0.3	9.3	−5.6	8.8	−0.4	8.5
Central	7.4	0.1	7.2	7.7	3.4	8.3	−0.2	8.4	0.0	8.4
Eastern	4.4	0.3	4.3	4.2	0.8	4.1	−8.1	3.0	0.1	3.0
Northern	6.3	−0.1	6.3	6.3	0.0	6.3	−0.1	6.3	0.1	6.3
Southern										
Western	10.3	−0.6	10.5	10.8	0.2	9.4	−5.9	8.9	−0.5	8.5
Less favorable agriculture conditions	8.8	1.7	9.3	9.8	2.3	10.3	1.1	10.3	0.2	10.5
More favorable agriculture conditions	10.3	2.2	11.5	11.1	−0.1	12.1	0.4	12.2	−0.6	11.8
Mineral-rich countries	5.1	−1.9	4.7	4.7	1.0	5.0	−1.6	4.8	1.2	5.0
Lower middle-income countries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upper middle-income countries	10.2	−0.8	10.4	10.8	0.2	9.3	−6.1	8.8	−0.4	8.4
CEN-SAD	10.1	−0.5	10.4	10.7	0.2	9.3	−5.8	8.8	−0.4	8.5
COMESA	4.6	−0.7	4.3	4.3	0.6	4.2	−6.0	3.3	0.2	3.4
EAC	5.3	0.5	5.4	5.6	−0.3	5.6	−2.4	4.5	−0.5	4.6
ECCAS	7.4	0.1	7.1	7.7	3.3	8.3	0.1	8.4	0.0	8.4
ECOWAS	10.3	−0.6	10.5	10.8	0.2	9.4	−5.9	8.9	−0.5	8.5
IGAD	4.4	0.3	4.3	4.2	0.7	3.9	−11.3	2.5	−0.1	2.5
SADC	5.9	−5.6	4.5	4.5	0.1	4.5	−0.1	4.6	0.3	4.6
UMA	6.3	−0.1	6.3	6.3	0.0	6.3	−0.1	6.3	0.1	6.3
CAADP Compact 2007–09 (CC1)	10.4	−0.4	10.8	11.3	0.8	10.0	−6.7	9.5	−0.1	9.2
CAADP Compact 2010–12 (CC2)	8.8	−1.2	8.4	8.1	−2.3	6.8	−1.4	6.0	−1.7	5.7
CAADP Compact 2013–15 (CC3)	5.8	0.9	5.8	6.4	4.0	6.8	−1.4	6.6	−0.1	6.5
CAADP Compact not yet (CC0)	5.3	0.2	5.3	5.4	0.2	4.2	−14.3	2.6	0.1	2.6
CAADP Level 0 (CL0)	5.3	0.2	5.3	5.4	0.2	4.2	−14.3	2.6	0.1	2.6
CAADP Level 1 (CL1)	5.2	−0.1	5.2	5.3	1.4	5.3	−1.5	5.1	−0.2	5.1
CAADP Level 2 (CL2)	7.3	−0.6	6.8	7.5	4.7	8.6	0.0	8.7	0.0	8.6
CAADP Level 3 (CL3)	10.0	3.2	10.6	10.7	0.6	9.9	−3.4	9.2	0.6	9.2
CAADP Level 4 (CL4)	10.2	−0.6	10.5	10.8	0.2	9.4	−5.8	8.9	−0.5	8.5
NAIP00 (N00)										
NAIP01 (N01)	8.4	0.4	8.5	8.6	0.5	8.3	−1.0	8.1	0.1	8.1
NAIP10 (N10)	6.5	−1.2	6.1	6.3	1.4	6.8	0.7	7.1	−0.1	7.0
NAIP11 (N11)	10.1	−0.5	10.4	10.7	0.3	9.3	−5.8	8.8	−0.4	8.5

Source: ReSAKSS based on FAO (2023).
Note: Data only available up to 2021. Yam production data are not available for Southern Africa.

ANNEX 2g: Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.5C

TABLE L2.1.5C—YIELD, MAIZE (metric tons per hectare)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	1.7	1.5	1.7	1.7	2.3	2.0	0.7	2.1	1.9	2.3
Central	1.1	0.3	1.1	1.1	1.6	1.1	–0.9	1.1	–0.1	1.1
Eastern	1.6	0.2	1.6	1.5	4.5	1.8	3.7	2.2	2.6	2.3
Northern	5.5	3.6	6.1	6.3	0.8	6.5	1.4	6.5	–1.1	6.9
Southern	1.6	2.0	1.6	1.7	2.2	2.2	2.9	2.2	2.1	2.5
Western	1.4	1.9	1.5	1.6	2.0	1.7	–2.2	1.8	3.0	2.1
Less favorable agriculture conditions	1.1	0.4	1.2	1.3	2.4	1.8	2.5	2.0	1.6	2.1
More favorable agriculture conditions	1.4	0.2	1.3	1.3	5.5	1.7	3.7	2.0	2.1	2.1
Mineral-rich countries	0.9	0.9	0.9	0.9	0.0	0.9	–1.1	0.9	0.4	0.9
Lower middle-income countries	1.8	1.9	1.9	1.9	0.2	2.0	0.0	2.0	1.3	2.2
Upper middle-income countries	2.4	5.1	2.8	3.3	6.7	4.5	0.3	4.7	3.4	5.2
CEN-SAD	1.9	2.3	2.0	2.1	0.6	2.1	–1.9	2.1	1.4	2.3
COMESA	1.8	0.7	1.8	1.9	1.8	2.2	3.4	2.4	1.6	2.6
EAC	1.6	–0.6	1.5	1.4	4.3	1.6	2.2	1.8	0.2	1.8
ECCAS	0.9	0.5	0.9	1.0	1.3	1.1	1.6	1.1	–0.1	1.1
ECOWAS	1.4	1.9	1.5	1.6	2.0	1.7	–2.2	1.8	3.0	2.1
IGAD	1.6	1.3	1.6	1.7	2.4	2.1	4.4	2.6	4.1	2.9
SADC	1.5	1.1	1.5	1.5	3.0	1.8	1.6	1.9	1.7	2.0
UMA	0.6	2.9	0.8	0.7	–1.9	0.8	–1.1	0.8	–3.0	0.6
CAADP Compact 2007–09 (CC1)	1.4	1.4	1.5	1.6	3.7	1.8	0.2	2.2	3.8	2.5
CAADP Compact 2010–12 (CC2)	1.4	–0.2	1.3	1.3	3.4	1.5	2.2	1.6	0.8	1.7
CAADP Compact 2013–15 (CC3)	1.0	0.0	1.0	1.0	–3.2	1.1	5.9	1.2	1.6	1.3
CAADP Compact not yet (CC0)	3.0	4.6	3.5	4.0	5.8	4.9	–0.8	4.9	1.8	5.4
CAADP Level 0 (CL0)	3.0	4.6	3.5	4.0	5.8	4.9	–0.8	4.9	1.8	5.4
CAADP Level 1 (CL1)	0.9	–1.5	0.8	0.8	–6.0	0.9	8.9	1.1	2.7	1.2
CAADP Level 2 (CL2)	1.1	1.3	1.1	1.1	0.9	1.1	–1.5	1.1	0.2	1.1
CAADP Level 3 (CL3)	1.4	1.7	1.5	1.6	3.4	2.1	1.8	2.3	0.3	2.4
CAADP Level 4 (CL4)	1.4	0.4	1.4	1.5	3.9	1.7	1.7	1.9	2.7	2.1
NAIP00 (N00)	2.0	4.4	2.3	2.5	4.6	3.2	–0.1	3.0	1.6	3.3
NAIP01 (N01)	4.3	3.2	4.8	4.8	–1.0	4.7	0.8	4.7	–0.9	5.0
NAIP10 (N10)	0.8	–0.9	0.8	0.8	–0.5	0.8	0.0	0.8	–0.1	0.8
NAIP11 (N11)	1.4	0.5	1.4	1.4	3.0	1.7	2.0	1.9	2.5	2.1

Source: ReSAKSS based on FAO (2023).
Note: Data only available up to 2021.

ANNEX 2h: Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.5D

TABLE L2.1.5D—YIELD, MEAT (cattle, kilograms per head)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014–2021)	Annual avg. change (%) (2014–2021)	2021
Africa	150.8	0.6	157.3	161.3	0.9	162.5	–0.5	158.7	0.1	161.1
Central	134.4	–0.2	133.0	132.4	0.0	127.8	–0.9	124.8	–0.3	123.4
Eastern	115.3	1.0	125.5	130.0	1.0	128.1	–1.1	119.5	–0.3	121.5
Northern	191.7	3.0	223.6	228.6	1.7	237.0	–0.1	244.8	0.7	248.2
Southern	216.5	–0.2	214.7	224.4	1.2	232.8	0.2	244.9	1.5	257.3
Western	128.4	0.3	129.8	130.0	0.1	127.6	–0.6	123.5	0.1	125.4
Less favorable agriculture conditions	123.4	1.1	127.6	127.4	–0.3	124.0	–0.3	123.2	–0.2	122.5
More favorable agriculture conditions	113.3	–0.6	111.2	112.5	0.5	113.0	–0.2	119.9	1.8	122.8
Mineral-rich countries	121.6	1.3	127.1	126.9	0.1	130.1	0.1	133.0	1.0	137.7
Lower middle-income countries	166.4	1.6	184.2	191.1	1.4	191.3	–1.0	176.7	–0.5	182.1
Upper middle-income countries	244.9	–0.5	240.9	258.8	1.6	285.6	1.4	300.3	1.4	312.2
CEN-SAD	136.1	1.7	150.7	154.9	1.2	154.5	–1.2	139.6	–1.1	139.5
COMESA	148.0	1.3	160.7	165.0	1.1	167.2	–0.9	154.3	–0.5	157.0
EAC	121.9	1.5	142.4	152.4	2.0	147.5	–1.8	131.2	–0.4	136.2
ECCAS	139.9	0.2	138.3	135.7	–0.4	130.3	–0.8	127.1	–0.4	125.6
ECOWAS	128.4	0.3	129.8	130.0	0.1	127.6	–0.6	123.5	0.1	125.4
IGAD	118.2	1.7	132.4	138.2	1.2	137.0	–1.4	119.0	–1.8	117.7
SADC	186.8	–0.2	185.5	192.0	1.0	196.5	0.1	208.7	1.9	219.3
UMA	180.5	1.1	184.4	185.6	0.8	189.4	0.9	209.2	1.2	212.5
CAADP Compact 2007–09 (CC1)	123.5	0.2	124.4	124.7	0.0	120.7	–0.9	116.1	–0.8	114.1
CAADP Compact 2010–12 (CC2)	124.6	0.7	135.8	141.9	1.5	142.1	–0.8	134.2	0.6	141.4
CAADP Compact 2013–15 (CC3)	153.5	0.5	153.8	152.6	–0.1	151.1	–1.1	146.9	0.7	151.0
CAADP Compact not yet (CC0)	206.6	1.2	222.2	232.9	1.7	245.9	0.1	249.4	0.6	253.7
CAADP Level 0 (CL0)	206.6	1.2	222.2	232.9	1.7	245.9	0.1	249.4	0.6	253.7
CAADP Level 1 (CL1)	154.5	0.6	155.1	153.8	–0.1	153.9	–0.8	150.6	0.9	155.5
CAADP Level 2 (CL2)	136.6	–0.7	133.0	131.3	–0.1	128.5	–0.3	134.9	1.4	140.5
CAADP Level 3 (CL3)	147.2	2.7	160.2	162.2	0.4	161.0	–0.6	168.5	0.6	168.5
CAADP Level 4 (CL4)	118.8	0.3	125.5	129.9	1.2	127.4	–1.2	115.5	–0.4	118.1
NAIP00 (N00)	213.7	–0.1	213.7	225.9	1.4	243.5	1.0	258.6	1.4	267.8
NAIP01 (N01)	165.0	1.8	182.3	182.4	0.7	184.4	–0.4	177.7	–0.7	173.5
NAIP10 (N10)	163.7	0.0	162.7	160.6	0.2	164.0	0.5	167.1	0.1	167.2
NAIP11 (N11)	133.9	0.6	139.0	141.7	0.7	140.6	–0.9	134.4	0.4	138.5

Source: ReSAKSS based on FAO (2023).
Note: Data only available up to 2021.

ANNEX 2i: *Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.1.5E*

TABLE L2.1.5E—YIELD, MILK (whole fresh cow, kilograms per head)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	524.3	1.6	563.0	557.4	–0.4	551.5	0.4	575.0	2.4	623.1
Central	339.2	–0.9	328.0	329.3	0.5	335.2	1.1	319.7	–2.5	301.7
Eastern	378.9	2.8	436.6	409.2	–2.5	377.7	–0.5	397.7	3.8	452.5
Northern	1,104.5	5.0	1,302.2	1,510.4	5.4	1,824.2	2.6	1,867.4	1.7	1,997.9
Southern	1,402.0	–0.5	1,447.8	1,533.8	1.4	1,637.8	1.5	1,784.2	1.7	1,855.4
Western	225.1	–0.9	217.2	228.5	2.9	238.6	–0.6	239.0	–0.6	234.5
Less favorable agriculture conditions	283.0	–1.7	260.9	274.9	2.7	279.5	–1.1	273.5	–0.8	264.8
More favorable agriculture conditions	328.4	4.9	435.2	422.3	–2.0	382.2	–0.1	433.4	5.6	517.6
Mineral-rich countries	465.4	–1.7	431.6	392.2	–2.1	383.8	0.0	365.8	–0.5	366.1
Lower middle-income countries	651.2	4.6	762.0	810.6	2.1	913.8	1.2	961.1	2.8	1,045.0
Upper middle-income countries	2,292.6	–1.8	2,280.9	2,432.5	0.5	2,331.8	1.6	2,672.8	1.5	2,773.6
CEN-SAD	473.9	1.2	489.3	483.0	0.2	515.7	1.5	550.2	2.2	586.8
COMESA	483.8	2.5	548.9	528.8	–1.5	497.4	0.0	546.0	5.3	637.6
EAC	389.7	3.1	433.3	422.0	–1.8	419.1	–0.2	437.8	2.4	477.7
ECCAS	394.1	–0.4	384.2	385.7	0.4	399.0	1.8	376.1	–1.8	361.7
ECOWAS	225.1	–0.9	217.2	228.5	2.9	238.6	–0.6	239.0	–0.6	234.5
IGAD	417.2	2.7	482.7	448.5	–2.7	403.3	–1.2	413.6	3.9	468.7
SADC	701.7	–0.2	689.8	689.0	–0.6	714.9	2.0	812.5	2.2	868.0
UMA	1,066.9	5.4	1,240.8	1,415.9	5.8	1,803.9	4.6	1,847.2	–0.7	1,847.5
CAADP Compact 2007–09 (CC1)	279.4	6.1	410.0	391.8	–2.4	316.6	–2.7	327.9	6.0	399.8
CAADP Compact 2010–12 (CC2)	418.6	2.5	457.6	451.5	–0.8	481.1	1.4	539.0	3.3	594.3
CAADP Compact 2013–15 (CC3)	426.3	–0.4	413.5	381.2	–1.9	375.0	0.5	367.4	0.1	367.2
CAADP Compact not yet (CC0)	1,210.0	2.0	1,300.4	1,460.4	3.7	1,375.7	–7.6	1,061.0	0.2	1,084.6
CAADP Level 0 (CL0)	1,210.0	2.0	1,300.4	1,460.4	3.7	1,375.7	–7.6	1,061.0	0.2	1,084.6
CAADP Level 1 (CL1)	421.2	–0.3	409.5	377.1	–1.9	369.8	0.4	361.0	0.1	360.9
CAADP Level 2 (CL2)	331.0	–0.5	321.8	322.7	0.7	337.0	1.3	339.7	0.0	344.8
CAADP Level 3 (CL3)	427.6	–1.2	406.3	408.5	0.8	403.1	–0.6	404.9	–0.7	387.1
CAADP Level 4 (CL4)	353.5	5.2	462.0	447.5	–2.4	413.3	–0.3	466.5	6.1	563.4
NAIP00 (N00)	1,322.8	1.3	1,424.3	1,606.2	3.3	1,818.1	3.1	1,850.2	–0.2	1,860.0
NAIP01 (N01)	757.9	3.6	855.7	933.4	3.1	1,029.7	1.0	1,086.9	2.8	1,185.9
NAIP10 (N10)	286.5	0.0	281.6	281.9	0.5	289.3	0.5	276.7	–0.2	276.1
NAIP11 (N11)	388.4	2.3	436.0	415.4	–1.7	397.3	–0.2	418.6	3.1	464.0

Source: ReSAKSS based on FAO (2023).
Note: Data only available up to 2021.

ANNEX 2j: *Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.2.1A*

TABLE L2.2.1A—INTRA-AFRICAN AGRICULTURAL TRADE, EXPORTS (billion, constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	5.0	4.7	5.7	6.3	8.0	11.1	8.6	14.4	2.9	16.2
Central	0.1	0.6	0.2	0.2	0.6	0.2	–3.2	0.2	4.5	0.2
Eastern	1.1	2.7	1.3	1.4	9.6	2.1	6.8	3.2	7.2	3.9
Northern	0.5	7.6	0.7	1.1	17.7	2.0	5.3	2.5	3.0	2.8
Southern	2.4	4.6	2.5	2.5	4.9	5.0	13.0	6.4	–0.1	6.6
Western	0.8	7.0	1.0	1.1	6.0	1.8	4.3	2.2	6.0	2.7
Less favorable agriculture conditions	0.2	3.1	0.2	0.2	14.3	0.3	–9.0	0.5	14.7	0.6
More favorable agriculture conditions	0.5	8.1	0.8	1.0	12.1	1.7	9.5	2.3	4.1	2.6
Mineral-rich countries	0.3	7.0	0.4	0.5	3.4	0.7	10.8	1.3	11.7	1.7
Lower middle-income countries	2.5	5.6	2.8	3.2	8.1	4.9	5.4	6.0	3.1	6.9
Upper middle-income countries	1.4	1.8	1.4	1.4	5.5	3.5	14.4	4.4	–1.0	4.4
CEN-SAD	2.1	5.0	2.5	2.9	9.3	4.7	3.2	5.8	5.6	7.0
COMESA	2.3	7.4	2.7	3.0	8.7	4.7	6.9	6.2	4.4	7.1
EAC	3.1	5.5	3.7	4.3	9.4	6.5	6.0	8.4	4.1	9.6
ECCAS	1.0	1.0	1.3	1.5	9.9	2.0	3.3	2.6	4.6	3.2
ECOWAS	1.0	5.6	1.2	1.4	5.7	2.1	3.7	2.7	6.7	3.4
IGAD	1.7	5.3	2.0	2.2	7.7	3.2	3.6	4.4	7.2	5.3
SADC	3.0	3.4	3.4	3.6	6.8	6.6	10.3	8.8	2.1	9.6
UMA	3.3	4.8	3.6	4.0	8.3	7.6	11.0	9.8	1.2	10.7
CAADP Compact 2007–09 (CC1)	0.4	5.3	0.6	0.6	10.1	1.2	6.4	1.6	9.2	2.2
CAADP Compact 2010–12 (CC2)	1.9	4.1	2.3	2.8	8.1	3.8	5.2	4.8	3.4	5.7
CAADP Compact 2013–15 (CC3)	0.8	6.3	0.8	0.6	–1.7	0.8	13.0	1.5	6.8	1.6
CAADP Compact not yet (CC0)	1.8	4.3	2.0	2.3	10.2	5.3	11.0	6.5	0.3	6.7
CAADP Level 0 (CL0)	1.8	4.3	2.0	2.3	10.2	5.3	11.0	6.5	0.3	6.7
CAADP Level 1 (CL1)	1.0	6.4	1.0	0.8	–1.5	1.0	9.4	1.8	7.2	2.0
CAADP Level 2 (CL2)	0.2	–7.2	0.2	0.3	8.6	0.4	3.6	0.4	3.3	0.5
CAADP Level 3 (CL3)	0.4	9.7	0.6	0.9	15.8	1.3	6.0	1.8	3.0	1.9
CAADP Level 4 (CL4)	1.5	4.6	1.8	2.0	6.5	3.1	6.3	3.9	5.4	5.0
NAIP00 (N00)	1.4	1.3	1.4	1.4	5.8	3.5	14.6	4.4	–1.2	4.3
NAIP01 (N01)	0.5	13.3	0.7	1.1	15.5	1.9	5.0	2.3	3.3	2.7
NAIP10 (N10)	0.3	3.5	0.3	0.3	–1.9	0.3	–2.9	0.4	7.2	0.5
NAIP11 (N11)	2.8	5.1	3.2	3.5	7.7	5.4	7.1	7.3	5.1	8.7

Source: ReSAKSS based on UNCTAD (2023) and World Bank (2023).

Note: Aggregate value for a group is the sum of intra-African agricultural exports for countries in the group. The values of intra-African agricultural exports and imports for Africa as a whole are expected to be equal. However, Tables TL2.2.1A and TL2.2.1B show differing values due to differences in commodities categorized as agricultural by different countries, year of shipment of exports and arrival of imports, treatment of the origin of export versus shipment, and valuation of exports and imports (for details see UNCTAD: https://unctadstat.unctad.org/EN/FAQ.html).

ANNEX 2k: *Level 2—Agricultural Transformation and Sustained Inclusive Agricultural Growth, Indicator 2.2.1B*

TABLE L2.2.1B—INTRA-AFRICAN AGRICULTURAL TRADE, IMPORTS (billion, constant 2015 US$)										
Region	**Annual avg. level (1995–2003)**	**Annual avg. change (%) (1995–2003)**	**2003**	**Annual avg. level (2003–2008)**	**Annual avg. change (%) (2003–2008)**	**Annual avg. level (2008–2014)**	**Annual avg. change (%) (2008–2014)**	**Annual avg. level (2014-2022)**	**Annual avg. change (%) (2014-2022)**	**2022**
Africa	5.6	10.2	7.7	8.1	3.1	12.0	5.6	15.0	3.3	16.9
Central	0.5	1.3	0.7	0.9	7.2	1.2	5.6	1.3	2.2	1.6
Eastern	0.9	10.3	1.3	1.4	3.3	2.0	5.0	2.7	6.9	3.2
Northern	0.8	13.8	1.1	1.1	4.1	1.7	4.8	2.4	4.1	2.6
Southern	2.4	10.7	3.4	3.4	2.5	5.2	5.1	5.9	0.4	6.1
Western	1.0	10.9	1.2	1.3	1.6	2.0	7.9	2.7	6.7	3.5
Less favorable agriculture conditions	0.3	10.5	0.4	0.5	8.2	0.8	7.5	1.0	3.3	1.2
More favorable agriculture conditions	0.6	5.3	0.9	1.1	3.0	1.3	7.8	1.9	3.4	2.0
Mineral-rich countries	0.7	5.7	1.0	1.0	2.6	1.6	7.1	2.0	5.5	2.4
Lower middle-income countries	2.8	12.2	3.8	4.0	3.4	5.8	2.2	6.5	2.5	7.1
Upper middle-income countries	1.2	11.2	1.7	1.6	1.3	2.6	11.0	3.6	3.7	4.2
CEN-SAD	2.1	13.3	3.0	3.1	2.7	4.7	5.4	6.1	5.9	7.4
COMESA	2.4	11.5	3.7	4.1	4.6	5.8	4.1	6.5	3.3	7.5
EAC	0.7	4.4	1.1	1.4	8.0	1.9	3.0	2.0	1.8	2.1
ECCAS	0.5	1.2	0.7	0.9	8.5	1.4	7.0	1.5	2.0	1.9
ECOWAS	1.0	10.9	1.2	1.3	1.6	2.0	7.9	2.7	6.7	3.5
IGAD	0.6	12.1	0.9	1.0	6.5	1.4	1.0	1.9	8.5	2.2
SADC	2.5	6.1	3.5	3.7	4.0	5.9	6.6	6.8	1.4	7.4
UMA	0.5	17.7	0.8	0.7	1.8	1.1	8.5	1.8	5.6	2.1
CAADP Compact 2007–09 (CC1)	0.8	10.4	1.0	1.0	0.5	1.6	9.2	2.1	7.2	2.9
CAADP Compact 2010–12 (CC2)	1.6	7.3	2.3	2.7	4.3	3.4	4.5	4.5	4.1	5.3
CAADP Compact 2013–15 (CC3)	1.5	14.7	2.3	2.2	0.5	3.4	3.9	3.3	0.0	3.4
CAADP Compact not yet (CC0)	1.7	8.9	2.2	2.3	5.6	3.6	6.7	5.0	3.4	5.4
CAADP Level 0 (CL0)	1.7	8.9	2.2	2.3	5.6	3.6	6.7	5.0	3.4	5.4
CAADP Level 1 (CL1)	1.7	13.5	2.5	2.4	0.0	3.5	3.7	3.5	–0.1	3.5
CAADP Level 2 (CL2)	0.3	0.6	0.5	0.7	11.2	1.0	5.0	1.1	5.5	1.5
CAADP Level 3 (CL3)	0.5	9.2	0.7	0.8	3.8	1.0	5.3	1.5	6.0	1.9
CAADP Level 4 (CL4)	1.3	10.7	1.8	2.0	1.8	3.0	6.7	3.9	4.9	4.7
NAIP00 (N00)	1.3	11.8	1.6	1.4	–2.1	2.4	7.8	3.4	0.5	3.2
NAIP01 (N01)	1.2	12.9	1.8	1.7	2.7	2.4	4.4	3.0	3.7	3.5
NAIP10 (N10)	0.5	2.0	0.7	0.8	6.3	1.0	3.1	1.0	3.8	1.3
NAIP11 (N11)	2.6	10.1	3.7	4.2	4.7	6.2	5.6	7.6	4.4	9.0

Source: ReSAKSS based on UNCTAD (2023) and World Bank (2023).

Note: Aggregate value for a group is the sum of intra-African agricultural imports for countries in the group. The values of intra-African agricultural exports and imports for Africa as a whole are expected to be equal. However, Tables TL2.2.1A and TL2.2.1B show differing values due to differences in commodities categorized as agricultural by different countries, year of shipment of exports and arrival of imports, treatment of the origin of export versus shipment, and valuation of exports and imports (for details see UNCTAD: https://unctadstat.unctad.org/EN/FAQ.html).

ANNEX 3a: Level 3—Strengthening Systemic Capacity to Deliver Results, Indicator 3.5.1

TABLE L3.5.1—GOVERNMENT AGRICULTURE EXPENDITURE (billion, constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	10.6	2.0	11.8	13.3	5.3	14.5	1.5	17.1	0.3	17.0
Central	0.5	–27.5	0.2	0.3	12.5	0.5	9.6	0.7	7.3	1.0
Eastern	1.9	2.3	2.4	3.1	9.4	3.3	–1.1	4.2	1.0	3.9
Northern	5.2	4.0	5.6	5.1	–4.2	4.0	–0.8	4.4	–0.6	4.4
Southern	1.4	3.2	1.7	2.4	15.5	3.2	1.7	3.0	–3.9	2.9
Western	1.7	4.5	2.0	2.5	11.1	3.4	5.4	4.8	2.4	4.8
Less favorable agriculture conditions	0.4	0.6	0.4	0.5	2.0	0.5	9.7	1.0	3.3	0.9
More favorable agriculture conditions	1.1	5.1	1.5	2.1	13.0	2.9	4.5	4.0	1.6	3.9
Mineral-rich countries	1.2	–14.2	0.9	1.2	11.1	1.0	–4.1	1.4	–2.3	1.0
Lower middle-income countries	7.1	3.2	7.6	7.8	2.2	8.1	0.9	8.9	0.4	9.3
Upper middle-income countries	0.9	13.6	1.4	1.7	8.1	1.9	–0.4	1.8	–2.7	1.8
CEN-SAD	7.2	1.7	7.4	7.5	0.7	7.6	2.2	9.8	1.7	10.0
COMESA	5.7	–1.2	5.5	5.8	2.0	5.9	1.2	7.1	–1.0	6.7
EAC	1.1	–11.7	0.8	0.9	6.0	1.2	–0.2	1.8	2.7	1.8
ECCAS	0.6	–25.9	0.2	0.3	12.6	0.6	11.8	1.0	7.7	1.3
ECOWAS	1.7	4.5	2.0	2.5	11.1	3.4	5.4	4.8	2.4	4.8
IGAD	1.5	2.3	2.0	2.6	10.5	2.7	–0.4	3.2	0.1	3.0
SADC	2.0	–5.0	1.9	2.5	10.4	3.4	1.4	3.5	–2.3	3.4
UMA	2.6	3.4	3.0	3.1	0.6	2.5	–3.0	2.6	1.0	2.6
CAADP Compact 2007–09 (CC1)	1.6	12.7	2.3	3.2	13.0	4.2	5.3	5.8	0.8	5.6
CAADP Compact 2010–12 (CC2)	2.5	–7.3	2.1	2.3	5.9	2.9	3.1	3.9	1.6	4.0
CAADP Compact 2013–15 (CC3)	1.2	–7.9	1.1	1.7	16.0	1.8	–5.6	1.5	1.8	1.6
CAADP Compact not yet (CC0)	5.4	6.3	6.3	6.2	–0.8	5.6	0.0	5.9	–1.4	5.9
CAADP Level 0 (CL0)	5.4	6.3	6.3	6.2	–0.8	5.6	0.0	5.9	–1.4	5.9
CAADP Level 1 (CL1)	1.1	–8.6	1.0	1.5	15.2	1.5	–9.1	1.1	2.3	1.1
CAADP Level 2 (CL2)	1.4	–12.9	0.9	0.8	–2.4	0.7	0.6	0.8	2.7	1.0
CAADP Level 3 (CL3)	0.4	8.3	0.6	0.8	11.9	1.1	7.4	2.1	–1.6	1.7
CAADP Level 4 (CL4)	2.3	6.3	3.0	4.0	12.4	5.6	4.6	7.1	1.7	7.4
NAIP00 (N00)	1.6	14.1	2.6	3.4	10.1	3.1	–5.0	2.2	–5.2	2.1
NAIP01 (N01)	4.2	2.6	4.0	3.4	–7.3	3.2	3.2	4.2	1.8	4.6
NAIP10 (N10)	0.5	–38.6	0.1	0.0	–5.3	0.1	13.5	0.1	13.4	0.2
NAIP11 (N11)	4.4	1.2	5.2	6.5	10.2	8.2	3.3	10.5	0.8	10.2

Source: ReSAKSS based on IFPRI (2019), World Bank (2023), and national sources.

Note: Aggregate value for a group is the sum of government agriculture expenditure for countries in the group.

ANNEX 3b: *Level 3—Strengthening Systemic Capacity to Deliver Results, Indicator 3.5.2*

TABLE L3.5.2—GOVERNMENT AGRICULTURE EXPENDITURE AS SHARE OF TOTAL GOVERNMENT EXPENDITURE (%)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	3.8	3.4	3.8	3.7	−4.2	2.6	−0.8	2.8	−0.1	2.9
Central	3.1	−0.1	2.3	2.4	−4.0	2.1	0.1	2.4	8.5	3.5
Eastern	5.5	2.6	6.1	6.5	2.3	6.2	−4.3	6.1	−1.7	5.5
Northern	5.2	−1.1	4.2	3.5	−9.6	2.0	−3.9	2.1	1.9	2.4
Southern	1.8	5.2	2.3	2.6	4.0	2.4	−2.3	2.6	5.6	4.9
Western	3.8	−3.6	3.7	3.8	−4.3	2.5	7.9	2.9	−6.3	2.3
Less favorable agriculture conditions	14.7	−4.5	11.5	10.5	−4.9	6.6	0.7	8.3	2.2	7.8
More favorable agriculture conditions	7.6	−1.4	8.0	9.6	5.9	9.9	−3.5	8.0	−3.2	6.7
Mineral-rich countries	4.4	10.4	5.3	5.0	−16.9	1.2	1.7	1.5	−6.5	1.3
Lower middle-income countries	4.2	−1.1	3.6	3.3	−3.9	2.5	−2.3	2.6	−0.1	2.6
Upper middle-income countries	1.7	13.2	2.4	2.4	−2.5	1.8	−4.0	2.1	7.6	4.4
CEN-SAD	5.2	−2.6	4.3	3.7	−8.4	2.4	1.8	2.9	−1.4	2.8
COMESA	5.2	6.7	4.9	4.4	−4.2	3.5	−2.1	4.0	1.5	4.5
EAC	4.5	8.2	3.7	3.2	−0.7	3.6	−7.6	3.8	0.0	3.4
ECCAS	2.1	−4.2	1.5	2.1	8.5	1.9	−3.7	2.2	9.0	3.2
ECOWAS	3.8	−3.6	3.7	3.8	−4.3	2.5	7.9	2.9	−6.3	2.3
IGAD	5.4	3.4	6.4	7.0	3.5	6.5	−2.3	6.8	−1.3	6.6
SADC	2.1	5.9	2.5	2.7	2.1	2.5	−4.1	2.5	3.6	3.7
UMA	5.0	−2.6	4.3	3.9	−5.1	2.3	−5.7	2.2	2.0	2.4
CAADP Compact 2007–09 (CC1)	3.7	1.2	4.4	5.0	−2.9	3.1	7.6	3.7	−7.3	2.8
CAADP Compact 2010–12 (CC2)	6.4	5.3	4.9	4.6	0.7	4.6	−3.6	4.0	−3.0	3.5
CAADP Compact 2013–15 (CC3)	3.0	−1.5	3.3	3.9	1.9	2.8	−8.4	2.7	8.3	3.8
CAADP Compact not yet (CC0)	3.5	3.4	3.5	3.0	−7.8	2.0	−3.1	2.1	3.7	2.9
CAADP Level 0 (CL0)	3.5	3.4	3.5	3.0	−7.8	2.0	−3.1	2.1	3.7	2.9
CAADP Level 1 (CL1)	3.0	−1.4	3.4	3.9	0.7	2.4	−11.4	2.2	10.0	3.0
CAADP Level 2 (CL2)	10.7	10.8	5.4	4.5	−6.1	3.3	−5.5	2.7	1.2	3.0
CAADP Level 3 (CL3)	5.7	−0.5	5.9	5.9	−17.7	1.5	12.4	2.2	−7.6	1.8
CAADP Level 4 (CL4)	4.1	−1.4	4.2	4.8	6.3	5.2	1.0	5.5	−6.2	3.9
NAIP00 (N00)	1.7	11.7	2.6	2.8	−0.2	1.7	−8.2	1.2	0.7	1.7
NAIP01 (N01)	5.6	−1.5	4.2	3.2	−12.8	2.2	−0.1	3.0	5.4	3.9
NAIP10 (N10)	4.0	−2.4	1.6	1.2	−18.6	0.7	5.7	1.5	15.1	1.8
NAIP11 (N11)	4.8	−1.2	4.8	5.0	−1.5	3.8	2.8	3.9	−5.1	3.3

Source: ReSAKSS based on IFPRI (2019), World Bank (2023), and national sources.

ANNEX 3c: *Level 3—Strengthening Systemic Capacity to Deliver Results, Indicator 3.5.3*

TABLE L3.5.3—GOVERNMENT AGRICULTURE EXPENDITURE AS SHARE OF AGRICULTURE GDP (%)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	5.4	–2.1	4.9	5.4	2.3	4.8	–0.4	4.6	–2.8	4.2
Central	4.0	–24.0	1.7	2.2	7.3	3.2	6.2	3.6	4.8	4.9
Eastern	3.4	0.4	4.1	4.7	3.2	4.2	–2.7	4.5	–1.0	4.1
Northern	12.3	–2.8	10.8	9.6	–4.9	6.3	–3.3	5.5	–3.9	4.8
Southern	10.5	5.5	13.4	18.2	9.2	19.5	1.0	15.9	–5.6	14.4
Western	2.3	–1.9	1.9	2.4	9.5	2.7	3.6	3.0	–1.4	2.7
Less favorable agriculture conditions	5.1	–2.9	5.1	5.3	–2.8	4.7	4.6	6.2	0.8	5.5
More favorable agriculture conditions	4.1	6.0	5.3	6.2	4.3	5.8	–1.3	5.7	–3.7	4.6
Mineral-rich countries	3.7	–16.3	2.5	3.1	5.7	2.5	–1.2	4.0	3.2	4.5
Lower middle-income countries	5.8	–2.5	4.8	4.9	1.1	4.2	–1.0	3.7	–3.2	3.4
Upper middle-income countries	12.1	13.1	17.6	21.7	3.4	21.7	0.2	16.8	–4.8	15.7
CEN-SAD	4.9	–3.3	4.0	3.9	–1.6	3.4	1.5	3.8	–0.9	3.9
COMESA	6.3	–2.6	5.9	5.7	–2.5	4.8	0.3	5.1	–3.3	4.6
EAC	3.7	–9.0	3.0	3.1	2.6	3.4	–4.9	3.7	–0.8	3.2
ECCAS	4.8	–17.7	2.6	4.6	20.5	5.7	–0.7	5.0	1.5	5.3
ECOWAS	2.3	–1.9	1.9	2.4	9.5	2.7	3.6	3.0	–1.4	3.2
IGAD	3.4	–0.3	4.1	4.8	3.9	4.1	–1.1	4.5	–1.5	4.2
SADC	7.3	–0.7	7.9	10.1	8.0	10.7	–2.5	8.2	–5.7	6.9
UMA	16.9	–7.3	13.7	13.6	1.7	9.2	–8.1	6.6	–1.5	6.0
CAADP Compact 2007–09 (CC1)	2.0	5.9	2.2	2.9	9.9	3.0	2.6	3.4	–3.2	2.8
CAADP Compact 2010–12 (CC2)	6.1	–6.0	5.3	5.4	2.9	5.4	–0.8	5.1	–3.3	4.5
CAADP Compact 2013–15 (CC3)	3.6	–10.2	3.1	4.2	9.7	4.3	–2.7	4.7	9.1	7.4
CAADP Compact not yet (CC0)	11.0	0.2	10.7	10.3	–2.0	7.9	–2.0	6.7	–4.4	5.9
CAADP Level 0 (CL0)	11.0	0.2	10.7	10.3	–2.0	7.9	–2.0	6.7	–4.4	5.9
CAADP Level 1 (CL1)	3.8	–10.8	3.2	4.3	8.6	3.9	–5.5	4.2	12.5	7.1
CAADP Level 2 (CL2)	10.6	–8.9	8.1	7.4	–5.1	5.3	–2.1	4.3	–1.8	4.5
CAADP Level 3 (CL3)	3.5	4.5	4.3	5.1	6.8	5.0	3.2	8.3	–4.3	6.0
CAADP Level 4 (CL4)	2.4	1.5	2.4	3.1	9.7	3.5	1.7	3.4	–2.8	3.0
NAIP00 (N00)	13.3	–2.1	14.3	19.5	10.8	15.3	–9.3	7.6	–7.3	6.6
NAIP01 (N01)	10.2	–0.3	8.9	7.1	–9.5	5.6	2.1	6.3	–1.4	6.0
NAIP10 (N10)	5.5	–32.3	1.1	1.0	–10.1	0.8	11.3	1.3	8.7	1.5
NAIP11 (N11)	3.2	–3.0	3.0	3.7	6.7	3.7	1.4	3.9	–2.3	3.5

Source: ReSAKSS based on IFPRI (2019), World Bank (2023), and national sources.

ANNEX 3d: Level 3—Strengthening Systemic Capacity to Deliver Results

TABLE L 3(a)—PROGRESS IN CAADP IMPLEMENTATION PROCESS AS OF SEPTEMBER 2023

Country/Region	JSR assessment conducted/ initiated	First generation NAIP drafted, reviewed, and validated	Second generation investment plan			
			Malabo domestication event held	Malabo status assessment and profile finalized	Malabo goals and milestones report finalized	Malabo compliant NAIP drafted, reviewed, and/or validated
AFRICA*	**21**	**36**	**25**	**31**	**25**	**42**
Central Africa*	**1**	**6**	**2**	**2**	**2**	**5**
Burundi		Yes				Yes
Cameroon		Yes		Yes	Yes	Yes
Central African Republic		Yes				
Chad						Yes
Congo, Dem. Republic	Yes	Yes	Yes			
Congo, Rep. of		Yes				Yes
Equatorial Guinea						
Gabon			Yes	Yes	Yes	Yes
Sao Tome and Principe		Yes				
Eastern Africa*	**6**	**9**	**5**	**6**	**1**	**12**
Comoros						Yes
Djibouti		Yes				Yes
Eritrea						Yes
Ethiopia	Yes	Yes	Yes	Yes		Yes
Kenya	Yes	Yes	Yes	Yes	Yes	Yes
Madagascar						Yes
Mauritius	Yes					Yes
Rwanda		Yes	Yes	Yes		Yes
Seychelles	Yes	Yes		Yes		
Somalia						
South Sudan		Yes				Yes
Sudan		Yes				Yes
Tanzania	Yes	Yes	Yes	Yes		Yes
Uganda	Yes	Yes	Yes	Yes		Yes

ANNEX 3d: Level 3—Strengthening Systemic Capacity to Deliver Results, continued

TABLE L 3(a)—PROGRESS IN CAADP IMPLEMENTATION PROCESS AS OF SEPTEMBER 2023 *continued*

			Second generation investment plan			
Country/Region	JSR assessment conducted/ initiated	First generation NAIP drafted, reviewed, and validated	Malabo domestication event held	Malabo status assessment and profile finalized	Malabo goals and milestones report finalized	Malabo compliant NAIP drafted, reviewed, and/or validated
Northern Africa*		**1**				**5**
Algeria						
Egypt						Yes
Libya						Yes
Mauritania		Yes				Yes
Morocco						Yes
Tunisia						Yes
Southern Africa*	**6**	**5**	**9**	**8**	**7**	**5**
Angola	Yes		Yes	Yes	Yes	
Botswana			Yes	Yes	Yes	Yes
Eswatini	Yes	Yes	Yes	Yes	Yes	
Lesotho			Yes	Yes	Yes	
Malawi	Yes	Yes	Yes	Yes		Yes
Mozambique	Yes	Yes	Yes			Yes
Namibia			Yes	Yes	Yes	
South Africa						
Zambia	Yes	Yes	Yes	Yes	Yes	Yes
Zimbabwe	Yes	Yes	Yes	Yes	Yes	Yes
Western Africa*	**8**	**15**	**9**	**15**	**15**	**15**
Benin	Yes	Yes	Yes	Yes	Yes	Yes
Burkina Faso	Yes	Yes	Yes	Yes	Yes	Yes
Cabo Verde		Yes		Yes	Yes	Yes
Côte d'Ivoire	Yes	Yes	Yes	Yes	Yes	Yes
Gambia		Yes		Yes	Yes	Yes
Ghana	Yes	Yes	Yes	Yes	Yes	Yes
Guinea		Yes		Yes	Yes	Yes
Guinea-Bissau		Yes		Yes	Yes	Yes

ANNEX 3d: *Level 3—Strengthening Systemic Capacity to Deliver Results, continued*

TABLE L 3(a)—PROGRESS IN CAADP IMPLEMENTATION PROCESS AS OF SEPTEMBER 2023 *continued*

Country/Region	JSR assessment conducted/ initiated	First generation NAIP drafted, reviewed, and validated	Second generation investment plan			
			Malabo domestication event held	Malabo status assessment and profile finalized	Malabo goals and milestones report finalized	Malabo compliant NAIP drafted, reviewed, and/or validated
Western Africa* cont'd	**8**	**15**	**9**	**15**	**15**	**15**
Liberia		Yes		Yes	Yes	Yes
Mali	Yes	Yes	Yes	Yes	Yes	Yes
Niger	Yes	Yes	Yes	Yes	Yes	Yes
Nigeria		Yes	Yes	Yes	Yes	Yes
Senegal	Yes	Yes	Yes	Yes	Yes	Yes
Sierra Leone		Yes		Yes	Yes	Yes
Togo	Yes	Yes	Yes	Yes	Yes	Yes
RECS**	**2**	**3**				
CEN-SAD						
COMESA						
EAC	Yes					
ECCAS		Yes				
ECOWAS	Yes	Yes				
IGAD		Yes				
SADC						
UMA						

Source: Authors' compilation based on NEPAD (November 2015) and ReSAKSS (2023).
Note: * The items in this row are the number of countries in the subregion that have achieved the milestone. ** The items in this row are the number of RECs that have achieved the milestone.
JSR=Joint Sector Review. NAIP= National Agriculture Investment Plan. BR=Biennial Review.

ReSAKSS-ECA

Burundi (COMESA, EAC, ECCAS)
Central African Rep. (CEN-SAD, ECCAS)
Comoros (CEN-SAD, COMESA)
Congo, Dem. Rep. (COMESA, ECCAS, SADC, EAC)
Congo, Rep. (ECCAS)
Djibouti (CEN-SAD, COMESA, IGAD)
Egypt (CEN-SAD, COMESA)
Eritrea (COMESA, IGAD)
Ethiopia (COMESA, IGAD)
Gabon (ECCAS)
Kenya (CEN-SAD, COMESA, EAC, IGAD)
Libya (CEN-SAD, COMESA, UMA)
Rwanda (COMESA, EAC, ECCAS)
Seychelles (COMESA, SADC)
South Sudan (IGAD, EAC)
Sudan (CEN-SAD, COMESA, IGAD)
Tanzania (SADC)
Uganda (COMESA, EAC, IGAD)

ReSAKSS-SA

Angola (ECCAS, SADC)
Botswana (SADC)
Eswatini (COMESA, SADC)
Madagascar (COMESA, SADC)
Malawi (COMESA, SADC)
Mauritius (COMESA, SADC)
Mozambique (SADC)
Namibia (SADC)
Lesotho (SADC)
Zambia (COMESA, SADC)
Zimbabwe (COMESA, SADC)

ReSAKSS-WA

Benin (CEN-SAD, ECOWAS)
Burkina Faso (CEN-SAD, ECOWAS)
Cabo Verde (ECOWAS)
Cameroon (ECCAS)
Chad (CEN-SAD, ECCAS)
Côte d'Ivoire (CEN-SAD, ECOWAS)
Gambia (CEN-SAD, ECOWAS)
Ghana (CEN-SAD, ECOWAS)
Guinea (CEN-SAD, ECOWAS)
Guinea-Bissau (CEN-SAD, ECOWAS)
Liberia (CEN-SAD, ECOWAS)
Mali (CEN-SAD, ECOWAS)
Mauritania (CEN-SAD, UMA)
Niger (CEN-SAD, ECOWAS)
Nigeria (CEN-SAD, ECOWAS)
Senegal (CEN-SAD, ECOWAS)
Sierra Leone (CEN-SAD, ECOWAS)
Togo (CEN-SAD, ECOWAS)

ANNEX 3d: *Level 3—Strengthening Systemic Capacity to Deliver Results*

TABLE L 3(b)—PROGRESS IN STRENGTHENING SYSTEMIC CAPACITY

Country/region	L2.4.2-Existence of food reserves, local purchases for relief programs, early warning systems, and school feeding programs**	L3.1.1-Existence of a new NAIP/NAFSIP developed through an inclusive and participatory process	L3.2.1-Existence of inclusive institutionalized mechanisms for mutual accountability and peer review	L3.3.1-Existence of and quality in the implementation of evidence-informed policies and corresponding human resources	L3.4.1-Existence of a functional multisectoral and multistakeholder coordination body	L3.4.2-Cumulative number of agriculture-related public-private partnerships (PPPs) that are successfully undertaken	L3.4.3-Cumulative value of investments in the PPPs	L3.4.6-Existence of an operational country SAKSS***
AFRICA*	**42**	**42**	**28**	**36**	**31**	**22**	**22**	**14**
Central Africa*	**4**	**5**	**2**	**3**	**1**	**3**	**3**	**1**
Burundi	Yes	Yes	Yes	Yes	Yes	Several PPPs	€18 million	
Cameroon		Yes						
Central African Republic	Yes					2	US$1.25	
Chad		Yes						
Congo, Dem. Rep.	Yes		Yes	Yes		Several PPPs	Not stated	Yes
Congo, Rep.	Yes	Yes		Yes				
Equatorial Guinea								
Gabon		Yes						
Sao Tome and Principe								
Eastern Africa*	**14**	**12**	**6**	**12**	**8**	**8**	**8**	**4**
Comoros	Yes	Yes		Yes				
Djibouti	Yes	Yes		Yes		Several PPPs	Not stated	
Eritrea	Yes	Yes						
Ethiopia	Yes	Yes	Yes	Yes	Yes	Several PPPs	Over US$10 million	
Kenya	Yes	Yes		Yes	Yes	Several PPPs	Over US$200 million	Yes
Madagascar	Yes	Yes	Yes	Yes	Yes	4	Not stated	
Mauritius	Yes	Yes	Yes	Yes	Yes	1	Not stated	
Rwanda	Yes	Yes	Yes	Yes	Yes	Several PPPs	Over US$20 million	Yes
Seychelles	Yes			Yes	Yes			
Somalia	Yes							
South Sudan	Yes	Yes		Yes				
Sudan	Yes	Yes		Yes				

ANNEX 3d: Level 3—Strengthening Systemic Capacity to Deliver Results, continued

TABLE L 3(b)—PROGRESS IN STRENGTHENING SYSTEMIC CAPACITY *continued*

Country/region	L2.4.2-Existence of food reserves, local purchases for relief programs, early warning systems, and school feeding programs**	L3.1.1-Existence of a new NAIP/NAFSIP developed through an inclusive and participatory process	L3.2.1-Existence of inclusive institutionalized mechanisms for mutual accountability and peer review	L3.3.1-Existence of and quality in the implementation of evidence-informed policies and corresponding human resources	L3.4.1-Existence of a functional multisectoral and multistakeholder coordination body	L3.4.2-Cumulative number of agriculture-related public-private partnerships (PPPs) that are successfully undertaken	L3.4.3-Cumulative value of investments in the PPPs	L3.4.6-Existence of an operational country SAKSS***
Eastern Africa** cont'd	**14**	**12**	**6**	**12**	**8**	**8**	**8**	**4**
Tanzania	Yes	Yes	Yes	Yes	Yes	Several PPPs across the country and many of them in SAGCOT with several projects	US$ 3.2 billion by 2030	Yes
Uganda	Yes	Yes	Yes	Yes	Yes	Several PPPs	Over US$218 million	Yes
Northern Africa*	**2**	**5**		**2**	**1**	**1**	**1**	
Algeria								
Egypt	Yes	Yes		Yes	Yes	Several PPPs	Over US$30 million	
Libya	Yes	Yes		Yes				
Mauritania		Yes						
Morocco		Yes						
Tunisia		Yes						
Southern Africa*	**10**	**5**	**10**	**10**	**9**	**7**	**7**	**2**
Angola	Yes		Yes	Yes	Yes	5	Not stated	
Botswana	Yes	Yes	Yes	Yes	Yes	3	Not stated	
Eswatini	Yes		Yes	Yes	Yes	4	Not stated	
Lesotho	Yes		Yes	Yes	Yes	4	Over US$ 87 million	
Malawi	Yes	Yes	Yes	Yes	Yes	4	Not stated	
Mozambique	Yes	Yes	Yes	Yes	Yes	4	Not stated	Yes
Namibia	Yes		Yes	Yes		1	Not stated	
South Africa	Yes		Yes	Yes	Yes			
Zambia	Yes	Yes	Yes	Yes	Yes			
Zimbabwe	Yes	Yes	Yes	Yes	Yes			Yes

ANNEX 3d: Level 3—Strengthening Systemic Capacity to Deliver Results, continued

TABLE L 3(b)—PROGRESS IN STRENGTHENING SYSTEMIC CAPACITY *continued*

Country/region	L2.4.2-Existence of food reserves, local purchases for relief programs, early warning systems, and school feeding programs**	L3.1.1-Existence of a new NAIP/NAFSIP developed through an inclusive and participatory process	L3.2.1-Existence of inclusive institutionalized mechanisms for mutual accountability and peer review	L3.3.1-Existence of and quality in the implementation of evidence-informed policies and corresponding human resources	L3.4.1-Existence of a functional multisectoral and multistakeholder coordination body	L3.4.2-Cumulative number of agriculture-related public-private partnerships (PPPs) that are successfully undertaken	L3.4.3-Cumulative value of investments in the PPPs	L3.4.6-Existence of an operational country SAKSS***
Western Africa*	**12**	**15**	**10**	**9**	**12**	**3**	**3**	**7**
Benin	Yes	Yes	Yes		Yes			Yes
Burkina Faso	Yes	Yes		Yes	Yes			Yes
Cabo Verde		Yes						
Côte d'Ivoire		Yes		Yes	Yes	2	Not stated	
Gambia	Yes	Yes	Yes	Yes	Yes			
Ghana	Yes	Yes	Yes	Yes	Yes			Yes
Guinea	Yes	Yes	Yes	Yes				
Guinea-Bissau		Yes						
Liberia	Yes	Yes			Yes			
Mali	Yes	Yes	Yes	Yes	Yes	3	More than 50 billion FCFA	Yes
Niger	Yes	Yes	Yes	Yes	Yes			Yes
Nigeria	Yes	Yes	Yes		Yes			
Senegal	Yes	Yes	Yes	Yes	Yes			Yes
Sierra Leone	Yes	Yes	Yes		Yes			
Togo	Yes	Yes	Yes	Yes	Yes	4	Not stated	Yes

Note: * The items in this row are the number of countries in Africa of the sub region corresponding to each indicator.
** This indicator is from level 2 of the CAADP Results Framework.
*** This refers to SAKSS platforms established between 2010 and 2017. Due to limited resources, the SAKSS platforms are not fully operational.
SAKSS = Strategic Analysis and Knowledge Support System
NAIP = National Agriculture Investment Plan
NAFSIP = National Agriculture and Food Security Investment Plan

ANNEX 3d: *Level 3—Strengthening Systemic Capacity to Deliver Results, continued*

TABLE L 3(c)—PROGRESS IN BIENNIAL REVIEW PROCESS AS OF SEPTEMBER 2023									
Country/Region	Inaugural Biennial Review process			Second Biennial Review process			Third Biennial Review process		
	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments
AFRICA*	**46**	**3.6**	**20**	**49**	**4.03**	**4**	**51**	**4.32**	**1**
Central Africa*	**9**	**2.35**	**1**	**8**	**3.22**		**8**	**3.33**	
Burundi	Yes	4.71	On track	Yes	5.82		Yes	5.63	
Cameroon	Yes	2.14		Yes	4.21		Yes	4.58	
Central African Republic	Yes	2.4		Yes	4.41		Yes	2.61	
Chad	Yes	2.22		Yes	3.89		Yes	3.88	
Congo, Dem. Republic	Yes	1.44		Yes	3.33		Yes	4.46	
Congo, Rep. of	Yes	2.8		Yes	3.46		Yes	3.32	
Equatorial Guinea	Yes	3.61		Yes	2.46		Yes	2.82	
Gabon	Yes	2.86		Yes	3.99		Yes	4.98	
Sao Tome and Principe	Yes	1.54							
Eastern Africa*	**10**	**4.19**	**6**	**13**	**4**	**1**	**12**	**4.56**	**1**
Comoros							Yes	1.5	
Djibouti	Yes	3.19		Yes	2.82		Yes	4	
Eritrea				Yes	3.89		Yes	3.17	
Ethiopia	Yes	5.35	On track	Yes	5.31		Yes	6.03	
Kenya	Yes	4.77	On track	Yes	4.88		Yes	5.62	
Madagascar	Yes	3.1		Yes	4.92		Yes	4.37	
Mauritius	Yes	5	On track	Yes	5.95				
Rwanda	Yes	6.09	On track	Yes	7.23	On track	Yes	7.43	On track
Seychelles	Yes	4.01	On track	Yes	4.53		Yes	4.92	
Somalia				Yes	0.55				
South Sudan	Yes (after the continental BR)			Yes	2.89		Yes	4.05	
Sudan	Yes	1.91		Yes	3.33		Yes	3.32	
Tanzania	Yes	3.08		Yes	5.08		Yes	6.14	
Uganda	Yes	4.45	On track	Yes	5.68		Yes	5.89	

ANNEX 3d: *Level 3—Strengthening Systemic Capacity to Deliver Results, continued*

TABLE L 3(c)—PROGRESS IN BIENNIAL REVIEW PROCESS AS OF SEPTEMBER 2023

Country/Region	Inaugural Biennial Review process			Second Biennial Review process			Third Biennial Review process		
	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments
Northern Africa*	**3**	**3.83**	**2**	**3**	**2.65**	**1**	**6**	**4.62**	
Algeria							Yes	1.47	
Egypt	Yes	3.37					Yes	6.52	
Libya							Yes	1.14	
Mauritania	Yes	4.78	On track	Yes	5.37		Yes	5.4	
Morocco	Yes	5.54	On track	Yes	6.96	On track	Yes	6.89	
Tunisia					6.2		Yes	6.28	
Southern Africa*	**10**	**4.02**	**6**	**10**	**4.27**		**10**	**4.11**	
Angola	Yes	2.1		Yes	4.77		Yes	3.77	
Botswana	Yes	4.38	On track	Yes	3.35		Yes	4.95	
Eswatini	Yes	3.74	On track	Yes	3.25		Yes	5.73	
Lesotho	Yes	4.92		Yes	4.81		Yes	3.98	
Malawi	Yes	4.13	On track	Yes	4.05		Yes	5.33	
Mozambique	Yes	4.11	On track	Yes	3.38		Yes	4.14	
Namibia	Yes	4.08	On track	Yes	2.88		Yes	4.08	
South Africa	Yes	4	On track	Yes	4.19		Yes	4.05	
Zambia	Yes	3.6		Yes	5.11		Yes	5.55	
Zimbabwe	Yes	3.2		Yes	4.58		Yes	5.17	
Western Africa*	**13**	**3.62**	**5**	**15**	**4.94**	**2**	**15**	**4.75**	
Benin	Yes	4.32	On track	Yes	5.76		Yes	4.78	
Burkina Faso	Yes	4.24	On track	Yes	5.31		Yes	5.2	
Cabo Verde	Yes	4.61	On track	Yes	4.82		Yes	4.55	
Côte d'Ivoire	Yes	3.51		Yes	4.79		Yes	4.62	
Gambia	Yes	3.13		Yes	4.95		Yes	5.56	
Ghana	Yes	3.91		Yes	6.67	On track	Yes	6.61	
Guinea	Yes	3.26		Yes	4.43		Yes	4.02	
Guinea-Bissau				Yes	2.49		Yes	2.18	

ANNEX 3d: Level 3—Strengthening Systemic Capacity to Deliver Results, continued

TABLE L 3(c)—PROGRESS IN BIENNIAL REVIEW PROCESS AS OF SEPTEMBER 2023

Country/Region	Inaugural Biennial Review process			Second Biennial Review process			Third Biennial Review process		
	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments	BR report drafted, validated, and submitted to REC	BR Score (out of 10)	Country on track to meet Malabo Commitments
Western Africa* cont'd	**13**	**3.62**	**5**	**15**	**4.94**	**2**	**15**	**4.75**	
Liberia	Yes	0.95		Yes	3.05		Yes	3.93	
Mali	Yes	5.57	On track	Yes	6.82	On track	Yes	6.66	
Niger	Yes	3.52		Yes	4.11		Yes	3.64	
Nigeria	Yes	3.36		Yes	5.18		Yes	5.42	
Senegal	Yes	3.84		Yes	5.18		Yes	5.07	
Sierra Leone	Yes	1.53		Yes	5.34		Yes	4.33	
Togo	Yes	4.92	On track	Yes	5.14		Yes	4.67	

Source: Authors' compilation based on AUC (2018, 2020, and 2022).

Note: * The items in this row are the number of countries in the subregion corresponding to each indicator.

The BR benchmark scores (or the minimum score out of 10) required to be on track are 3.94 for the first BR, 6.66 for the second BR, and 7.28 for the third BR.

ANNEX 4: Country Categories by Geographic Regions, Economic Classification, and Regional Economic Communities

TABLE 4.1—GEOGRAPHIC REGIONS

Western Africa	Eastern Africa	Southern Africa	Central Africa	Northern Africa
Benin	Comoros	Angola	Burundi	Algeria
Burkina Faso	Djibouti	Botswana	Cameroon	Egypt
Cabo Verde	Eritrea	Eswatini	Central African Republic	Libya
Côte d'Ivoire	Ethiopia	Lesotho	Chad	Mauritania
Gambia	Kenya	Malawi	Congo, Dem. Rep.	Morocco
Ghana	Madagascar	Mozambique	Congo, Rep.	Tunisia
Guinea	Mauritius	Namibia	Equatorial Guinea	
Guinea-Bissau	Rwanda	South Africa	Gabon	
Liberia	Seychelles	Zambia	Sao Tome and Principe	
Mali	Somalia	Zimbabwe		
Niger	South Sudan			
Nigeria	Sudan			
Senegal	Tanzania			
Sierra Leone	Uganda			
Togo				

ANNEX 4: Country Categories by Geographic Regions, Economic Classification, and Regional Economic Communities

TABLE 4.2—ECONOMIC CLASSIFICATIONS

Mineral-rich countries	Less favorable agriculture conditions	More favorable agriculture conditions	Lower middle-income countries	Upper middle-income countries
Central African Republic	Burundi	Benin	Algeria	Botswana
Congo, Dem. Rep.	Chad	Burkina Faso	Angola	Equatorial Guinea
Liberia	Eritrea	Ethiopia	Cabo Verde	Gabon
Sierra Leone	Mali	Gambia	Cameroon	Libya
South Sudan	Niger	Guinea-Bissau	Comoros	Mauritius
Sudan	Rwanda	Madagascar	Congo, Rep.	Namibia
	Somalia	Malawi	Côte d'Ivoire	Seychelles
		Mozambique	Djibouti	South Africa
		Tanzania	Egypt	
		Togo	Eswatini	
		Uganda	Ghana	
			Guinea	
			Kenya	
			Lesotho	
			Mauritania	
			Morocco	
			Nigeria	
			Sao Tome and Principe	
			Senegal	
			Tunisia	
			Zambia	
			Zimbabwe	

ANNEX 4: Country Categories by Geographic Regions, Economic Classification, and Regional Economic Communities

TABLE 4.3—REGIONAL ECONOMIC COMMUNITIES

CEN-SAD	COMESA	SADC	ECOWAS	ECCAS	IGAD	EAC	UMA
Benin	Burundi	Angola	Benin	Angola	Djibouti	Burundi	Algeria
Burkina Faso	Comoros	Botswana	Burkina Faso	Burundi	Eritrea	Congo, Dem. Rep.	Libya
Cabo Verde	Congo, Dem. Rep.	Comoros	Cabo Verde	Cameroon	Ethiopia	Kenya	Mauritania
Central African Republic	Djibouti	Congo, Dem. Rep.	Côte d'Ivoire	Central African Republic	Kenya	Rwanda	Morocco
Chad	Egypt	Eswatini	Gambia	Chad	Somalia	Tanzania	Tunisia
Comoros	Eritrea	Lesotho	Ghana	Congo, Dem. Rep.	South Sudan	South Sudan	
Côte d'Ivoire	Eswatini	Madagascar	Guinea	Congo, Rep.	Sudan	Uganda	
Djibouti	Ethiopia	Malawi	Guinea-Bissau	Equatorial Guinea	Uganda		
Egypt	Kenya	Mauritius	Liberia	Gabon			
Eritrea	Libya	Mozambique	Mali	Rwanda			
Gambia	Madagascar	Namibia	Niger	Sao Tome and Principe			
Ghana	Malawi	Seychelles	Nigeria				
Guinea	Mauritius	South Africa	Senegal				
Guinea-Bissau	Rwanda	Tanzania	Sierra Leone				
Kenya	Seychelles	Zambia	Togo				
Liberia	Somalia	Zimbabwe					
Libya	Sudan						
Mali	Tunisia						
Mauritania	Uganda						
Morocco	Zambia						
Niger	Zimbabwe						
Nigeria							
Sao Tome and Principe							
Senegal							
Sierra Leone							
Somalia							
Sudan							
Togo							
Tunisia							

Note: CEN-SAD = Community of Sahel-Saharan States; COMESA = Common Market for Eastern and Southern Africa; EAC = East African Community; ECCAS = Economic Community of Central African States; ECOWAS = Economic Community of West African States; IGAD = Intergovernmental Authority for Development; SADC = Southern African Development Community; UMA = Arab Maghreb Union.

ANNEX 5: Distribution of Countries by Year of Signing CAADP Compact and Level of CAADP Implementation Reached by End of 2015

TABLE 5.1—CAADP COMPACT SIGNING AND LEVEL OF CAADP IMPLEMENTATION

Period when CAADP compact was signed				Level or stage of CAADP implementation reached by end of 2015				
2007–2009	2010–2012	2013–2015	Not signed	LEVEL 0 Not started or pre-compact	LEVEL 1 Signed compact	LEVEL 2 Level 1 plus NAIP	LEVEL 3 Level 2 plus one external funding source	LEVEL 4 Level 3 plus other external funding source
CC1	CC2	CC3	CC0	CL0	CL1	CL2	CL3	CL4
Benin	Burkina Faso	Angola	Algeria	Algeria	Angola	Cameroon	Burundi	Benin
Burundi	Central Afr. Rep.	Cameroon	Comoros	Comoros	Chad	Cabo Verde	Gambia	Burkina Faso
Cabo Verde	Congo, Dem. Rep.	Chad	Egypt	Egypt	Congo, Rep.	Central Afr. Rep.	Liberia	Côte d'Ivoire
Ethiopia	Côte d'Ivoire	Congo, Rep.	Eritrea	Eritrea	Eswatini	Congo, Dem. Rep.	Mali	Ethiopia
Gambia	Djibouti	Eq. Guinea	Libya	Libya	Eq. Guinea	Djibouti	Niger	Ghana
Ghana	Eswatini	Gabon	Morocco	Morocco	Gabon	Guinea	Sierra Leone	Kenya
Liberia	Guinea	Lesotho	Somalia	Somalia	Lesotho	Guinea Bissau	Togo	Malawi
Mali	Guinea Bissau	Madagascar	South Africa	South Africa	Madagascar	Mauritania	Uganda	Mozambique
Niger	Kenya	Mauritius	South Sudan	South Sudan	Mauritius	Sao Tome and Principe	Zambia	Nigeria
Nigeria	Malawi	Sudan	Tunisia	Tunisia	Seychelles			Rwanda
Rwanda	Mauritania	Sao Tome and Principe			Sudan			Senegal
Sierra Leone	Mozambique	Zimbabwe			Zimbabwe			Tanzania
Togo	Senegal							
	Seychelles							
	Tanzania							
	Uganda							
	Zambia							
Count								
13	17	12	10	10	12	9	9	12
AgShare in GDP (%)								
26.1	20.3	16.3	7.7	7.7	16.1	19.0	26.5	24.2

Note: NAIP = national agriculture investment plan. There are three external funding sources considered—Grow Africa, New Alliance Cooperation, and the Global Agriculture and Food Security Program (GAFSP). AgShare in GDP is the average share of agricultural GDP in total GDP for 2003–2022.

ANNEX 6: *Distribution of Countries in Formulating First-Generation Investment Plan (NAIP1.0) and Second-Generation Investment Plan (NAIP2.0) Reached by September of 2022*

TABLE 6.1—PROGRESS IN NAIP FORMULATION

NAIP00	NAIP01	NAIP10	NAIP11	
Algeria	Botswana	Central African Republic	Benin	Mali
Angola	Chad	Congo, Dem. Republic	Burkina Faso	Mauritania
Equatorial Guinea	Comoros	Eswatini	Burundi	Mozambique
Lesotho	Egypt	Sao Tome and Principe	Cabo Verde	Niger
Namibia	Eritrea	Seychelles	Cameroon	Nigeria
Somalia	Gabon		Congo Rep.	Rwanda
South Africa	Libya		Côte d'Ivoire	Senegal
	Madagascar		Djibouti	Sierra Leone
	Mauritius		Ethiopia	South Sudan
	Morocco		Gambia	Sudan
	Tunisia		Ghana	Tanzania
			Guinea	Togo
			Guinea Bissau	Uganda
			Kenya	Zambia
			Liberia	Zimbabwe
			Malawi	
Count				
7	11	5	31	
AgShare in GDP (%)				
5.1	10.7	19.4	23.9	

Note: NAIP00 = countries that have neither NAIP1.0 nor NAIP2.0, NAIP01= countries that do not have a NAIP1.0 but have NAIP2.0, NAIP10 = countries that have a NAIP1.0 but do not have NAIP2.0, NAIP11 = countries that have both NAIP1.0 and NAIP2.0.

ANNEX 7a: Supplementary Data Tables

TABLE O.1.1A—AGRICULTURAL ODA (% total ODA)

Region	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	3.7	3.5	3.1	5.5	5.6	6.2	–4.4	5.0
Central	1.8	2.1	25.7	3.2	17.2	4.3	0.8	4.1
Eastern	4.6	4.2	–1.6	5.9	4.1	6.4	–6.1	4.9
Northern	3.6	3.6	–1.8	4.8	7.9	5.0	–14.0	3.3
Southern	2.9	3.4	3.4	5.5	6.4	6.0	–3.4	5.1
Western	5.1	4.0	–0.8	6.8	3.6	7.7	–0.7	7.0
Less favorable agriculture conditions	6.2	5.7	0.3	8.1	3.5	7.8	0.0	7.3
More favorable agriculture conditions	4.9	5.1	–2.1	6.8	3.6	7.6	–3.5	6.5
Mineral-rich countries	1.4	1.4	12.2	3.5	17.8	3.6	–8.5	2.6
Lower middle-income countries	3.9	3.3	3.7	5.5	3.4	6.3	–4.2	5.2
Upper middle-income countries	4.0	3.8	–12.9	2.0	2.2	1.6	–3.9	1.2
CEN-SAD	4.7	3.7	–2.3	5.8	5.0	6.1	–5.2	4.8
COMESA	3.2	3.4	6.9	5.3	7.6	6.1	–7.9	4.5
EAC	2.8	3.9	20.5	5.0	2.4	6.6	1.8	6.3
ECCAS	1.8	2.3	28.7	3.9	12.7	5.4	–0.1	4.9
ECOWAS	5.1	4.0	–0.8	6.8	3.6	7.7	–0.7	7.0
IGAD	4.3	3.8	–1.9	5.9	7.1	6.2	–6.6	4.8
SADC	2.6	3.3	11.9	4.7	3.6	5.3	–4.1	4.2
UMA	5.1	4.0	–11.2	4.9	7.8	4.3	1.8	4.7
CAADP Compact 2007-09 (CC1)	4.2	3.4	–2.7	6.7	7.3	8.0	–0.4	7.4
CAADP Compact 2010-12 (CC2)	3.7	4.5	12.3	5.4	1.2	6.6	–1.4	6.0
CAADP Compact 2013-15 (CC3)	3.6	2.6	–5.3	5.5	17.6	5.1	–12.6	3.0
CAADP Compact not yet (CC0)	3.4	3.3	–4.9	4.0	11.1	4.1	–12.7	2.8
CAADP Level 0 (CL0)	3.4	3.3	–4.9	4.0	11.1	4.1	–12.7	2.8
CAADP Level 1 (CL1)	3.6	2.7	–4.9	5.7	17.0	4.9	–14.1	2.8
CAADP Level 2 (CL2)	2.5	2.5	16.1	3.0	3.6	3.7	3.3	3.7
CAADP Level 3 (CL3)	4.2	4.5	2.2	6.9	8.1	7.7	2.1	7.9
CAADP Level 4 (CL4)	4.5	4.2	1.5	6.5	2.1	7.8	–2.5	6.7
NAIP00 (N00)	2.2	2.2	7.0	2.5	–2.0	2.3	6.1	2.7
NAIP01 (N01)	4.5	4.0	–5.1	4.9	8.2	5.1	–12.3	3.4
NAIP10 (N10)	0.9	1.7	54.0	2.7	8.9	2.8	–3.8	2.4
NAIP11 (N11)	4.3	3.9	–0.3	6.3	5.7	7.2	–3.6	6.0

Source: ReSAKSS based on OECD (2023) and World Bank (2023).
Note: ODA refers to gross disbursements.

ANNEX 7a: Supplementary Data Tables

TABLE O.1.1B—AGRICULTURAL ODA DISBURSEMENTS (as % of agricultural ODA commitments)

Region	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	80.5	75.5	–5.2	73.9	2.7	75.7	–0.6	73.9
Central	67.7	78.2	13.6	71.6	2.6	72.8	–1.6	63.3
Eastern	71.7	77.1	–2.5	78.3	3.7	81.5	5.2	101.4
Northern	121.9	71.4	–18.7	65.3	16.9	147.5	14.7	197.8
Southern	85.7	88.7	–1.8	84.0	0.9	86.2	–5.0	82.2
Western	85.9	76.3	–7.6	75.5	–2.5	69.9	–3.9	56.7
Less favorable agriculture conditions	92.7	89.2	–8.4	78.2	4.7	74.8	3.4	83.7
More favorable agriculture conditions	81.4	87.5	–2.7	82.6	–1.8	74.3	0.2	76.4
Mineral-rich countries	55.8	58.9	–2.2	79.2	14.4	77.4	–6.8	73.2
Lower middle-income countries	88.4	65.6	–7.3	70.5	3.4	82.4	–1.8	68.7
Upper middle-income countries	86.0	120.7	5.6	105.8	14.6	102.7	–8.2	93.8
CEN-SAD	88.1	67.8	–9.1	70.3	5.0	74.9	–1.3	71.1
COMESA	76.3	77.5	–5.4	72.7	3.4	81.8	4.5	96.3
EAC	59.0	82.0	16.0	85.8	–0.3	80.6	5.5	92.9
ECCAS	70.4	77.3	7.8	73.4	2.2	76.0	–0.3	73.0
ECOWAS	85.9	76.3	–7.6	75.5	–2.5	69.9	–3.9	56.7
IGAD	66.2	73.1	–5.0	77.5	6.6	82.7	5.5	110.2
SADC	81.2	87.4	2.8	86.9	–1.0	81.3	–3.1	74.8
UMA	99.6	77.4	–22.8	106.6	48.3	143.7	5.8	239.4
CAADP Compact 2007-09 (CC1)	81.1	75.9	–11.6	75.4	–0.6	71.7	–0.3	62.7
CAADP Compact 2010-12 (CC2)	72.4	84.3	8.4	82.0	–1.4	78.9	–1.7	78.4
CAADP Compact 2013-15 (CC3)	88.6	77.1	–9.4	72.8	11.6	70.7	–1.7	73.0
CAADP Compact not yet (CC0)	127.8	88.1	–24.5	65.8	20.5	141.6	9.7	153.1
CAADP Level 0 (CL0)	127.8	88.1	–24.5	65.8	20.5	141.6	9.7	153.1
CAADP Level 1 (CL1)	79.0	73.1	–10.1	80.5	16.8	70.6	–3.3	71.3
CAADP Level 2 (CL2)	81.1	87.5	7.4	78.3	–7.8	67.1	–3.6	57.1
CAADP Level 3 (CL3)	78.5	100.8	–0.1	79.7	0.6	67.5	3.1	77.0
CAADP Level 4 (CL4)	77.6	70.4	–2.5	78.7	–2.0	80.0	–1.8	70.2
NAIP00 (N00)	79.1	86.9	2.3	96.8	1.9	97.1	–5.4	103.6
NAIP01 (N01)	122.7	89.0	–19.9	65.6	14.4	105.8	4.7	101.5
NAIP10 (N10)	57.7	66.8	6.2	83.7	7.7	77.5	–8.5	47.7
NAIP11 (N11)	75.7	74.9	–2.6	75.2	0.6	74.8	–0.8	72.1

Source: ReSAKSS based on OECD (2023) and World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.1.1C—EMERGENCY FOOD AID (% of total ODA)

Region	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014–2021)	2021
Africa	5.1	5.7	−0.8	5.0	−11.0	4.6	4.1	4.3
Central	1.8	3.2	26.1	4.8	0.3	6.4	8.6	7.8
Eastern	11.4	12.0	−9.4	8.9	−12.6	6.6	−0.6	5.4
Northern	1.2	1.6	8.5	1.6	−15.1	1.2	8.3	1.1
Southern	4.4	4.2	8.1	3.1	−21.8	2.1	10.5	2.6
Western	1.0	0.9	−8.6	1.5	24.1	3.3	3.6	2.5
Less favorable agriculture conditions	4.7	5.3	−16.6	6.6	15.6	7.2	−4.7	4.7
More favorable agriculture conditions	6.4	6.3	−15.9	4.3	−13.4	4.3	4.6	4.3
Mineral-rich countries	7.3	10.4	13.6	8.3	−9.1	6.3	4.5	6.3
Lower middle-income countries	3.1	3.4	17.9	3.6	−17.9	3.0	6.6	2.6
Upper middle-income countries	0.2	0.1	−11.4	0.4	19.6	0.5	35.8	0.7
CEN-SAD	5.4	6.5	1.4	5.8	−9.2	5.1	2.1	4.1
COMESA	8.2	10.4	3.2	8.5	−13.4	6.4	1.5	5.8
EAC	2.6	3.7	11.2	3.6	−7.1	3.4	5.0	3.5
ECCAS	3.5	3.3	5.2	4.1	0.1	5.3	7.9	6.2
ECOWAS	1.0	0.9	−8.6	1.5	24.1	3.3	3.6	2.5
IGAD	15.7	16.7	−9.5	12.0	−12.8	8.4	−3.1	6.4
SADC	2.6	2.9	17.2	2.8	−14.6	2.8	14.5	3.7
UMA	1.2	1.6	8.5	1.6	−15.1	1.2	8.3	1.1
CAADP Compact 2007-09 (CC1)	6.5	5.5	−14.7	4.7	−7.7	5.4	1.2	4.5
CAADP Compact 2010-12 (CC2)	1.8	2.5	11.7	2.8	−4.1	2.9	3.8	3.0
CAADP Compact 2013-15 (CC3)	14.3	14.8	3.6	14.4	−12.1	8.2	−0.4	7.2
CAADP Compact not yet (CC0)	6.0	4.7	−47.0	1.5	32.1	4.4	7.3	2.9
CAADP Level 0 (CL0)	6.0	4.7	−47.0	1.5	32.1	4.4	7.3	2.9
CAADP Level 1 (CL1)	17.8	17.8	3.7	16.1	−11.5	9.0	−1.5	7.5
CAADP Level 2 (CL2)	1.4	2.3	23.8	3.4	0.4	5.1	8.3	6.4
CAADP Level 3 (CL3)	3.5	3.3	−10.7	2.9	9.5	3.3	−5.0	2.3
CAADP Level 4 (CL4)	4.5	4.4	−9.7	3.9	−12.2	3.9	2.8	3.5
NAIP00 (N00)	9.2	4.2	−39.6	2.4	39.5	7.3	1.4	4.2
NAIP01 (N01)	4.9	4.6	−22.1	3.5	−17.3	2.6	13.9	2.8
NAIP10 (N10)	1.6	3.6	44.9	4.5	−1.6	6.9	12.9	9.2
NAIP11 (N11)	5.8	6.4	−2.8	5.4	−12.7	4.4	2.5	4.1

Source: ReSAKSS based on OECD (2023) and World Bank (2023).
Note: ODA and food aid refer to gross disbursements.

ANNEX 7a: Supplementary Data Tables

TABLE O.1.2A—GENERAL GOVERNMENT GROSS DEBT (% of GDP)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	50.9	–2.8	43.2	30.2	–15.1	22.1	2.4	35.8	6.5	39.5
Central	82.9	1.5	79.3	55.0	–14.6	21.7	–11.3	24.8	1.4	23.6
Eastern	88.3	–6.0	69.4	46.3	–18.8	40.5	7.8	63.2	6.6	73.1
Northern	43.9	–6.2	36.1	26.0	–15.3	16.1	–0.3	25.8	8.4	28.7
Southern	37.8	–3.5	30.4	24.4	–4.2	28.4	6.3	47.7	4.3	48.2
Western	45.7	4.0	42.3	26.8	–21.1	13.6	–2.8	24.3	8.9	28.6
Less favorable agriculture conditions	73.4	–2.2	60.4	38.7	–21.1	25.7	7.5	40.7	3.4	44.1
More favorable agriculture conditions	67.2	–4.9	58.0	39.4	–22.0	24.7	5.8	39.8	4.4	43.4
Mineral-rich countries	138.2	–2.3	118.0	79.8	–17.0	51.8	0.2	81.9	9.8	97.9
Lower middle-income countries	46.2	–3.5	38.1	25.6	–17.8	15.8	–0.1	27.9	8.4	31.9
Upper middle-income countries	24.7	–0.3	21.8	19.8	4.0	29.7	8.9	43.9	2.1	42.6
CEN-SAD	52.2	–1.8	46.1	32.4	–16.1	21.4	0.8	35.5	8.4	40.8
COMESA	61.8	–3.4	56.7	41.6	–14.9	29.4	1.9	46.9	7.8	54.0
EAC	49.6	1.9	52.3	38.4	–15.4	26.4	0.3	38.6	5.8	46.9
ECCAS	87.6	–3.7	68.7	44.1	–18.8	20.5	–5.4	35.4	7.5	38.5
ECOWAS	45.7	4.0	42.3	26.8	–21.1	13.6	–2.8	24.3	8.9	28.6
IGAD	95.1	–5.7	75.6	50.3	–18.5	42.3	7.1	66.3	7.0	76.4
SADC	42.4	–2.5	35.9	28.3	–6.8	29.5	4.8	46.2	3.9	47.2
UMA	53.0	–6.4	38.4	24.4	–18.2	17.3	2.4	24.2	5.3	26.5
CAADP Compact 2007-09 (CC1)	39.1	6.2	39.3	23.4	–26.1	11.2	2.2	23.8	9.2	28.3
CAADP Compact 2010-12 (CC2)	72.4	–0.6	66.0	47.2	–15.2	31.6	–1.2	44.8	4.2	48.2
CAADP Compact 2013-15 (CC3)	105.4	–7.2	75.4	50.1	–16.7	38.6	3.4	69.5	10.9	85.7
CAADP Compact not yet (CC0)	34.8	–4.4	29.6	23.2	–8.4	20.8	4.3	31.5	4.5	32.1
CAADP Level 0 (CL0)	34.8	–4.4	29.6	23.2	–8.4	20.8	4.3	31.5	4.5	32.1
CAADP Level 1 (CL1)	108.3	–7.1	78.0	52.5	–15.9	41.8	3.5	75.8	11.1	94.1
CAADP Level 2 (CL2)	78.8	5.3	84.7	61.5	–14.9	27.2	–11.8	25.9	1.4	26.3
CAADP Level 3 (CL3)	93.6	2.2	90.3	54.6	–25.1	22.5	–0.4	43.4	7.8	50.5
CAADP Level 4 (CL4)	44.6	0.5	39.5	25.2	–21.4	15.9	2.8	29.7	7.5	34.3
NAIP00 (N00)	37.8	–6.2	26.8	18.9	–8.6	20.5	7.0	32.2	3.0	31.0
NAIP01 (N01)	40.4	–4.7	36.7	29.4	–11.2	22.0	2.1	34.8	7.4	38.7
NAIP10 (N10)	77.2	15.2	105.0	82.5	–11.1	36.2	–15.6	25.4	–3.2	22.3
NAIP11 (N11)	65.4	–1.8	55.6	36.2	–19.7	22.5	1.2	38.6	7.9	44.8

Source: ReSAKSS based on AfDB (2023) and World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.1.2B—GENERAL GOVERNMENT GROSS REVENUE (% OF GDP)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	20.8	3.4	22.9	25.1	2.3	22.6	–3.5	18.5	–1.1	17.6
Central	16.2	5.2	18.5	23.8	8.7	21.2	–0.1	16.1	–4.3	14.5
Eastern	13.6	3.5	16.3	17.9	1.3	16.2	–3.3	13.7	–1.4	13.2
Northern	26.3	2.1	28.8	32.3	4.0	31.1	–1.5	27.1	–0.3	26.0
Southern	23.7	0.9	23.3	25.4	3.4	28.2	0.8	25.9	–1.6	25.1
Western	15.6	8.9	19.2	19.4	–3.3	11.5	–16.5	6.4	0.3	6.4
Less favorable agriculture conditions	16.0	1.2	18.4	22.0	5.9	19.0	–1.9	17.2	1.3	18.2
More favorable agriculture conditions	15.1	2.7	17.2	18.1	1.9	16.4	–3.9	14.7	–1.0	14.1
Mineral-rich countries	9.0	7.3	12.4	15.0	3.3	15.2	–0.1	11.8	–3.9	11.1
Lower middle-income countries	21.4	3.1	23.0	24.4	0.6	20.8	–5.5	15.6	–1.5	14.8
Upper middle-income countries	25.1	3.5	28.0	32.2	5.4	32.8	0.6	32.5	0.8	32.5
CEN-SAD	18.6	5.1	21.8	23.7	1.6	19.4	–6.5	15.1	0.4	14.8
COMESA	19.9	3.1	22.8	25.5	3.3	24.0	–2.5	20.8	–0.5	19.9
EAC	14.6	2.7	16.6	17.4	0.7	17.6	1.4	15.9	–3.1	14.8
ECCAS	21.3	4.6	21.9	27.9	9.3	28.3	–1.8	18.4	–4.1	16.5
ECOWAS	15.6	8.9	19.2	19.4	–3.3	11.5	–16.5	6.4	0.3	6.4
IGAD	13.3	3.8	16.3	18.0	1.5	16.1	–4.1	12.8	–2.0	12.3
SADC	21.8	1.3	21.8	23.9	3.3	26.1	0.7	23.7	–2.0	22.6
UMA	29.3	4.1	34.0	39.5	5.6	37.6	–1.0	33.4	1.9	33.5
CAADP Compact 2007-09 (CC1)	15.5	10.8	19.8	19.9	–3.6	11.5	–16.9	6.1	–1.0	5.8
CAADP Compact 2010-12 (CC2)	16.0	1.2	17.1	18.1	1.6	17.3	–1.1	16.4	–1.0	15.9
CAADP Compact 2013-15 (CC3)	17.3	4.3	19.3	23.9	6.3	23.6	–2.3	15.9	–2.5	15.3
CAADP Compact not yet (CC0)	25.1	1.8	26.7	29.5	3.6	29.9	–0.4	27.4	–0.7	26.3
CAADP Level 0 (CL0)	25.1	1.8	26.7	29.5	3.6	29.9	–0.4	27.4	–0.7	26.3
CAADP Level 1 (CL1)	17.9	3.6	19.8	23.7	5.2	24.5	–2.3	16.4	–2.2	16.0
CAADP Level 2 (CL2)	11.2	7.3	13.3	18.8	10.5	15.3	2.9	14.3	–4.3	12.5
CAADP Level 3 (CL3)	16.7	1.2	18.0	19.7	2.8	16.1	–1.4	16.4	0.1	16.7
CAADP Level 4 (CL4)	16.1	7.4	19.4	19.5	–2.9	12.9	–12.6	8.5	–0.2	8.3
NAIP00 (N00)	26.1	1.8	26.9	29.8	3.4	30.9	–0.3	27.2	–1.1	26.3
NAIP01 (N01)	24.2	2.1	26.3	29.4	4.3	29.0	–1.4	25.8	–0.3	24.8
NAIP10 (N10)	8.9	4.7	9.6	12.8	10.4	16.1	4.3	14.7	–6.0	12.6
NAIP11 (N11)	15.2	6.7	18.4	19.4	–1.0	13.8	–9.1	9.8	–0.7	9.6

Source: ReSAKSS based on AfDB (2023) and World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.1.3—ANNUAL INFLATION, GDP DEFLATOR (%)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	11.5	−2.6	9.7	10.4	0.7	8.7	−0.6	10.8	1.0	16.9
Central	5.0	−0.6	3.1	8.9	2.4	4.1	−1.9	2.3	1.2	11.0
Eastern	16.6	−4.7	8.6	11.2	1.0	15.2	0.1	21.5	2.0	42.0
Northern	7.0	−1.0	7.9	9.8	1.2	8.1	−1.1	8.6	0.8	13.1
Southern	9.2	−0.7	8.9	7.0	0.3	6.9	−0.3	12.2	1.0	13.1
Western	18.0	−5.9	14.4	13.9	−0.1	8.1	−0.5	7.7	0.7	10.0
Less favorable agriculture conditions	6.6	−1.8	3.0	7.3	1.9	4.7	−1.2	2.7	0.6	6.0
More favorable agriculture conditions	12.1	−2.3	8.0	8.8	1.6	11.9	−1.2	8.3	1.0	12.5
Mineral-rich countries	25.4	−9.1	12.7	13.9	−0.3	18.5	2.1	51.3	5.7	114.8
Lower middle-income countries	11.0	−3.0	9.5	10.7	0.6	8.4	−0.6	9.7	0.9	11.3
Upper middle-income countries	8.9	−0.3	10.2	9.4	0.8	6.2	−1.0	6.3	0.4	13.6
CEN-SAD	13.2	−3.8	10.9	11.6	0.5	9.4	−0.4	11.9	0.9	18.6
COMESA	10.5	−2.2	9.8	11.1	1.0	12.4	−0.3	19.7	1.6	30.5
EAC	11.9	−1.0	6.1	9.5	1.2	12.0	−1.1	5.2	−0.1	4.4
ECCAS	5.4	−0.7	3.4	9.1	2.2	4.2	−1.8	2.6	1.2	10.9
ECOWAS	18.0	−5.9	14.4	13.9	−0.1	8.1	−0.5	7.7	0.7	10.0
IGAD	17.2	−5.4	8.8	11.9	0.9	17.3	0.5	27.0	2.7	54.3
SADC	9.8	−0.9	8.7	7.2	0.4	7.1	−0.4	11.0	0.8	11.5
UMA	8.4	−1.4	8.4	10.0	1.3	4.9	−1.9	5.1	1.6	18.9
CAADP Compact 2007-09 (CC1)	18.9	−6.4	15.7	15.2	0.0	9.4	−0.6	9.4	1.0	13.3
CAADP Compact 2010-12 (CC2)	11.9	−1.3	6.8	8.4	1.0	8.9	−0.9	4.9	0.1	5.4
CAADP Compact 2013-15 (CC3)	11.9	−1.3	6.8	8.4	1.0	8.9	−0.9	4.9	0.1	5.4
CAADP Compact not yet (CC0)	7.6	−0.8	8.0	8.7	0.9	7.5	−0.8	7.6	0.5	10.9
CAADP Level 0 (CL0)	7.6	−0.8	8.0	8.7	0.9	7.5	−0.8	7.6	0.5	10.9
CAADP Level 1 (CL1)	16.3	−5.8	9.4	11.5	0.8	14.1	0.8	52.0	6.9	101.0
CAADP Level 2 (CL2)	4.2	−0.3	3.6	8.0	0.7	4.3	−1.0	3.2	0.7	6.5
CAADP Level 3 (CL3)	9.8	−1.2	7.8	8.2	0.6	10.3	−0.8	5.2	0.2	7.1
CAADP Level 4 (CL4)	17.6	−5.1	13.5	13.5	0.3	9.2	−0.6	8.3	0.7	11.1
NAIP00 (N00)	9.3	−6.7	7.9	8.4	4.9	6.4	−1.0	4.9	0.7	9.5
NAIP01 (N01)	5.8	−5.7	7.8	9.2	7.0	8.2	−0.8	9.3	0.4	12.0
NAIP10 (N10)	6.5	1.0	4.6	6.2	15.8	7.5	−0.8	3.6	−0.2	3.3
NAIP11 (N11)	16.6	−13.2	12.1	12.5	−1.7	10.3	−0.4	14.4	1.5	22.9

Source: ReSAKSS based on World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.2.1A—AGRICULTURAL EXPORTS (% of total merchandise exports)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	13.0	–5.5	10.4	8.3	–7.2	9.1	3.7	12.6	0.0	11.5
Central	5.9	–10.8	3.6	3.0	–5.8	3.0	–4.5	3.4	0.9	3.3
Eastern	46.3	–7.5	32.9	27.9	–5.9	32.0	10.3	42.3	–0.8	40.2
Northern	7.1	–11.4	4.7	4.6	0.0	6.5	6.1	10.5	–0.4	8.8
Southern	11.8	–2.3	10.5	8.0	–9.8	8.1	3.8	9.1	–1.1	8.4
Western	13.7	–0.3	13.6	10.6	–7.5	10.3	–2.4	14.8	0.1	13.6
Less favorable agriculture conditions	15.0	–8.9	8.9	6.7	5.1	9.8	1.4	14.5	0.1	13.6
More favorable agriculture conditions	51.6	–3.8	42.8	40.8	–0.3	38.5	–1.8	34.1	–3.5	29.6
Mineral-rich countries	18.0	–7.8	11.7	7.1	–19.7	6.2	12.6	12.2	5.2	11.4
Lower middle-income countries	12.5	–3.9	11.0	8.6	–7.7	9.0	1.1	12.4	1.2	12.0
Upper middle-income countries	8.6	–7.1	6.1	4.6	–8.3	6.2	9.3	8.6	–2.7	6.9
CEN-SAD	15.8	–6.1	12.0	9.5	–7.1	10.3	2.9	16.2	0.0	14.3
COMESA	24.0	–11.0	13.7	10.8	–7.5	13.3	9.6	18.8	–2.6	15.4
EAC	41.8	–0.8	35.9	32.9	–2.2	28.6	–2.1	24.7	–1.7	26.5
ECCAS	3.5	–11.3	2.2	1.7	–8.8	1.6	–1.3	2.2	4.4	2.6
ECOWAS	13.7	–0.3	13.6	10.6	–7.5	10.3	–2.4	14.8	0.1	13.6
IGAD	48.5	–8.9	31.5	26.0	–7.0	32.4	14.5	46.1	–0.7	44.3
SADC	13.3	–2.7	12.1	9.2	–10.3	9.1	4.1	10.0	–2.0	8.9
UMA	6.7	–14.5	3.6	3.4	–0.4	4.4	8.5	8.4	0.6	7.2
CAADP Compact 2007-09 (CC1)	8.3	0.3	8.8	7.2	–6.5	7.9	–1.3	10.6	1.2	10.3
CAADP Compact 2010-12 (CC2)	42.8	–1.2	38.4	34.1	–4.0	30.5	–2.4	26.9	–5.3	21.2
CAADP Compact 2013-15 (CC3)	12.6	–6.8	8.9	5.0	–21.4	4.1	12.2	9.1	9.0	10.4
CAADP Compact not yet (CC0)	8.0	–6.7	6.3	5.5	–2.9	7.4	5.5	10.3	–0.8	8.9
CAADP Level 0 (CL0)	8.0	–6.7	6.3	5.5	–2.9	7.4	5.5	10.3	–0.8	8.9
CAADP Level 1 (CL1)	12.9	–6.4	9.1	5.2	–21.1	4.3	13.2	9.2	9.1	10.6
CAADP Level 2 (CL2)	16.5	–4.3	14.6	12.9	–6.2	11.7	–4.3	10.8	–5.3	8.0
CAADP Level 3 (CL3)	23.4	–3.4	22.2	22.7	0.7	19.3	–6.4	17.5	–4.2	13.9
CAADP Level 4 (CL4)	51.3	–2.0	47.8	44.5	–2.4	40.4	–4.0	37.1	–2.7	33.3
NAIP00 (N00)	5.4	–4.6	4.4	3.3	–7.3	4.4	8.1	6.2	0.1	5.8
NAIP01 (N01)	10.8	–9.1	7.5	6.6	–3.7	8.7	6.5	13.0	–1.4	10.9
NAIP10 (N10)	17.1	1.8	15.1	13.0	–3.8	11.4	–5.4	6.4	–8.8	4.3
NAIP11 (N11)	21.3	–3.4	18.0	14.5	–6.3	14.2	0.8	19.8	0.6	18.9

Source: ReSAKSS based on UNCTAD (2023) and World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.2.1B—AGRICULTURAL IMPORTS (% of total merchandise imports)										
Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	15.6	−0.2	15.3	13.8	−3.4	14.6	1.5	15.6	2.1	16.5
Central	17.6	−2.0	17.6	18.2	−0.8	16.7	0.0	17.7	4.2	20.2
Eastern	14.7	0.0	14.2	12.4	−4.7	14.4	2.5	17.3	4.4	19.5
Northern	20.1	−2.7	17.9	15.8	−2.5	16.4	2.1	17.6	1.8	19.0
Southern	9.4	1.8	10.1	9.0	−3.9	10.0	−0.5	10.5	0.6	9.9
Western	17.3	2.5	18.3	16.7	−4.8	16.7	2.4	16.5	0.4	16.8
Less favorable agriculture conditions	21.1	−0.7	19.5	19.6	−3.2	18.7	1.4	20.3	0.7	20.8
More favorable agriculture conditions	15.9	−1.4	16.3	14.2	−6.7	12.7	−0.8	14.7	3.7	16.6
Mineral-rich countries	17.3	−2.6	15.5	14.1	−1.1	18.1	2.6	19.7	2.7	21.3
Lower middle-income countries	18.0	0.0	17.8	15.8	−3.2	16.5	1.6	16.7	1.5	17.6
Upper middle-income countries	8.2	3.8	9.0	7.9	−5.2	8.9	4.3	11.2	2.3	11.8
CEN-SAD	17.1	0.0	16.5	14.9	−3.0	16.2	2.5	17.0	1.3	17.7
COMESA	16.4	−0.2	16.3	14.7	−2.5	16.5	2.3	18.0	2.9	20.4
EAC	14.6	−3.3	13.5	13.1	−1.7	13.6	−0.1	13.2	0.3	13.3
ECCAS	19.7	−0.5	19.5	18.4	−2.7	16.8	0.4	18.1	4.2	20.0
ECOWAS	17.3	2.5	18.3	16.7	−4.8	16.7	2.4	16.5	0.4	16.8
IGAD	14.3	0.7	13.6	12.1	−3.7	14.8	1.7	18.2	5.6	21.4
SADC	10.5	0.8	11.2	10.1	−4.3	10.9	0.4	11.3	0.6	10.9
UMA	19.5	−3.6	16.5	14.8	−1.4	14.5	1.5	16.9	2.7	18.8
CAADP Compact 2007-09 (CC1)	15.9	3.2	17.0	15.2	−6.1	15.3	2.8	15.2	1.9	16.7
CAADP Compact 2010-12 (CC2)	17.3	−0.9	17.0	15.6	−2.8	15.0	−1.9	15.4	1.4	16.0
CAADP Compact 2013-15 (CC3)	16.2	1.2	16.9	15.4	−2.2	17.6	2.7	20.6	4.2	22.6
CAADP Compact not yet (CC0)	14.8	−1.7	13.9	12.5	−2.6	13.5	1.7	14.6	1.8	15.3
CAADP Level 0 (CL0)	14.8	−1.7	13.9	12.5	−2.6	13.5	1.7	14.6	1.8	15.3
CAADP Level 1 (CL1)	16.4	1.3	17.1	15.4	−2.5	17.6	3.0	20.4	4.0	22.3
CAADP Level 2 (CL2)	22.1	−0.8	22.4	22.5	0.6	22.4	−1.9	21.1	1.2	22.1
CAADP Level 3 (CL3)	16.0	−2.5	15.5	13.9	−4.7	12.2	−1.9	13.5	3.2	14.8
CAADP Level 4 (CL4)	15.8	2.2	16.4	14.7	−5.3	14.8	1.2	14.9	1.6	15.9
NAIP00 (N00)	13.5	−1.7	12.7	10.9	−4.4	11.7	1.8	13.7	2.2	14.1
NAIP01 (N01)	17.3	−1.3	16.3	14.7	−2.5	15.6	2.2	16.4	1.2	17.1
NAIP10 (N10)	21.5	−0.1	22.6	22.6	1.7	23.4	0.1	18.0	−2.1	17.6
NAIP11 (N11)	15.6	1.7	16.3	14.8	−4.1	15.4	0.9	16.2	2.6	17.4

Source: ReSAKSS based on UNCTAD (2023) and World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.2.2—RATIO OF AGRICULTURAL EXPORTS TO AGRICULTURAL IMPORTS

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	0.8	–2.6	0.8	0.7	–5.2	0.6	–1.4	0.7	0.6	0.7
Central	0.5	–8.4	0.4	0.3	–5.8	0.3	–9.9	0.2	2.3	0.3
Eastern	1.7	–4.7	1.4	1.2	–4.3	1.0	–0.5	1.1	–0.5	1.0
Northern	0.3	0.2	0.3	0.4	1.2	0.3	–3.3	0.4	3.3	0.4
Southern	1.3	–4.0	1.1	0.9	–4.3	0.9	3.3	1.0	–0.8	0.9
Western	1.1	–2.0	1.2	0.9	–7.2	0.8	–4.7	0.9	–2.2	0.7
Less favorable agriculture conditions	0.3	–9.0	0.2	0.3	10.5	0.3	0.6	0.4	–4.2	0.3
More favorable agriculture conditions	1.6	–4.5	1.2	1.2	3.5	1.2	–0.4	1.1	–1.9	1.1
Mineral-rich countries	0.9	–5.0	0.7	0.4	–14.5	0.3	4.0	0.6	12.3	0.7
Lower middle-income countries	0.7	–1.2	0.7	0.6	–7.1	0.5	–3.0	0.6	1.3	0.6
Upper middle-income countries	1.2	–6.7	0.9	0.8	–2.7	0.8	–0.9	0.8	–2.7	0.8
CEN-SAD	0.8	–2.5	0.8	0.7	–7.1	0.6	–3.8	0.7	0.8	0.7
COMESA	0.9	–3.9	0.8	0.7	–5.5	0.6	–1.1	0.6	1.1	0.7
EAC	1.9	–1.2	1.7	1.4	–6.7	1.0	–3.8	1.2	0.6	1.1
ECCAS	0.3	–11.6	0.2	0.2	–1.2	0.2	–6.1	0.2	2.0	0.2
ECOWAS	1.1	–2.0	1.2	0.9	–7.2	0.8	–4.7	0.9	–2.2	0.7
IGAD	1.8	–6.0	1.4	1.2	–4.3	0.9	0.3	1.0	0.0	1.0
SADC	1.3	–3.6	1.1	0.9	–5.0	0.8	2.6	1.0	0.0	1.0
UMA	0.4	–3.6	0.3	0.4	2.9	0.3	–2.4	0.4	4.5	0.4
CAADP Compact 2007-09 (CC1)	0.7	–2.5	0.8	0.7	–5.1	0.6	–4.1	0.6	–1.4	0.5
CAADP Compact 2010-12 (CC2)	2.0	–2.3	1.8	1.5	–5.0	1.3	–2.2	1.3	–2.4	1.2
CAADP Compact 2013-15 (CC3)	1.0	–5.6	0.7	0.5	–14.1	0.3	3.4	0.5	4.8	0.5
CAADP Compact not yet (CC0)	0.5	0.3	0.5	0.5	–1.8	0.5	–0.5	0.5	1.0	0.5
CAADP Level 0 (CL0)	0.5	0.3	0.5	0.5	–1.8	0.5	–0.5	0.5	1.0	0.5
CAADP Level 1 (CL1)	1.0	–4.8	0.8	0.5	–13.2	0.3	4.3	0.5	5.3	0.6
CAADP Level 2 (CL2)	0.8	–9.0	0.6	0.5	–5.6	0.4	–5.1	0.5	1.7	0.5
CAADP Level 3 (CL3)	0.9	–3.0	0.9	1.0	6.3	1.0	–1.0	0.9	–5.0	0.7
CAADP Level 4 (CL4)	1.4	–3.5	1.4	1.2	–5.3	1.0	–3.5	1.1	–1.9	0.9
NAIP00 (N00)	0.5	–0.1	0.4	0.4	–1.7	0.5	3.7	0.5	1.6	0.5
NAIP01 (N01)	0.4	–0.9	0.4	0.5	–2.8	0.4	–2.4	0.5	1.2	0.5
NAIP10 (N10)	0.9	–3.1	0.7	0.5	–6.5	0.5	–3.8	0.5	0.6	0.4
NAIP11 (N11)	1.4	–3.9	1.3	1.0	–5.8	0.9	–2.7	0.9	–1.5	0.8

Source: ReSAKSS based on UNCTAD (2023) and World Bank (2023).

ANNEX 7a: *Supplementary Data Tables*

TABLE O.3.1—TOTAL FERTILIZER CONSUMPTION (kilograms per hectare)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014–2021)	2021
Africa	19.4	1.5	21.1	20.7	−0.1	21.5	2.6	27.1	4.3	30.5
Central	3.7	4.6	4.3	3.6	0.0	3.7	3.4	5.3	4.1	5.6
Eastern	8.4	−0.7	8.0	8.5	6.3	12.6	4.7	17.2	5.2	20.0
Northern	75.7	3.9	91.3	93.8	−0.3	94.0	2.8	104.6	−0.2	102.8
Southern	35.2	−0.3	35.4	33.8	1.0	34.9	2.4	45.3	7.5	57.4
Western	6.0	1.3	6.3	6.8	−0.6	8.4	7.6	14.9	9.5	17.6
Less favorable agriculture conditions	3.1	7.3	4.0	4.2	5.6	4.4	−0.4	7.7	6.2	9.1
More favorable agriculture conditions	8.0	−2.2	7.7	8.5	9.3	12.7	5.8	19.0	7.9	25.2
Mineral-rich countries	4.0	−0.1	5.1	4.9	4.0	7.0	−1.0	9.6	4.6	10.4
Lower middle-income countries	28.9	3.0	32.7	33.2	−1.3	34.0	3.8	41.9	2.6	43.9
Upper middle-income countries	52.4	−0.9	53.0	51.2	1.2	54.5	3.5	68.8	7.6	82.9
CEN-SAD	20.3	2.4	22.8	23.1	−1.1	23.3	2.4	28.7	3.3	30.6
COMESA	31.9	1.2	34.4	32.9	−0.2	32.8	0.4	38.7	3.0	43.0
EAC	6.9	3.5	7.8	8.1	2.4	9.9	6.1	12.6	4.7	14.4
ECCAS	3.3	4.0	3.9	3.7	5.4	4.5	4.6	6.1	3.3	6.5
ECOWAS	6.0	1.3	6.3	6.8	−0.6	8.4	7.6	14.9	9.5	17.6
IGAD	9.3	−0.2	8.7	9.2	7.9	13.8	3.3	18.6	5.8	22.2
SADC	24.2	0.0	25.1	22.7	0.2	22.7	1.7	28.4	6.5	34.9
UMA	28.9	5.5	35.6	35.5	0.4	38.4	6.2	39.5	−2.3	36.2
CAADP Compact 2007-09 (CC1)	6.2	−0.4	5.8	6.9	8.4	9.9	6.4	17.2	10.2	21.3
CAADP Compact 2010-12 (CC2)	9.1	2.7	11.1	11.2	1.0	13.3	6.7	18.8	5.2	23.0
CAADP Compact 2013-15 (CC3)	9.1	2.7	11.1	11.2	1.0	13.3	6.7	18.8	5.2	23.0
CAADP Compact not yet (CC0)	66.2	2.5	77.6	78.3	0.2	75.7	1.1	85.0	2.3	89.8
CAADP Level 0 (CL0)	66.2	2.5	77.6	78.3	0.2	75.7	1.1	85.0	2.3	89.8
CAADP Level 1 (CL1)	9.7	−1.9	8.0	7.3	−1.6	8.7	−3.2	9.7	1.6	9.0
CAADP Level 2 (CL2)	3.4	4.9	4.4	3.5	−1.8	3.6	4.7	5.2	6.3	5.9
CAADP Level 3 (CL3)	4.3	4.6	6.0	6.2	3.5	7.8	5.2	12.5	4.3	13.8
CAADP Level 4 (CL4)	9.2	0.3	9.3	10.4	4.5	14.3	7.8	22.7	8.7	28.8
NAIP00 (N00)	33.9	0.2	36.2	34.2	0.5	35.3	3.9	43.6	5.9	51.1
NAIP01 (N01)	75.9	3.6	89.7	92.3	0.0	87.8	0.7	93.8	0.0	92.1
NAIP10 (N10)	1.8	2.6	2.7	1.5	8.9	1.7	1.2	2.4	2.8	2.5
NAIP11 (N11)	8.2	0.6	8.4	8.9	2.9	11.6	5.4	17.7	7.5	21.5

Source: ReSAKSS based on World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.3.2—AGRICULTURAL VALUE ADDED (% GDP)										
Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	18.5	−1.6	17.6	15.8	−3.3	15.0	−1.5	15.0	0.7	15.2
Central	24.1	−5.6	18.4	15.9	−5.4	14.7	−1.0	15.7	1.1	15.7
Eastern	34.4	−2.8	30.1	28.9	−1.4	26.9	−0.8	24.3	−1.8	22.3
Northern	13.9	−4.1	11.5	10.3	−4.8	10.1	0.6	10.7	0.2	10.7
Southern	5.5	−1.8	5.0	4.6	−1.8	4.5	−0.7	5.0	1.0	5.2
Western	27.5	1.8	31.1	26.6	−4.3	23.3	−4.0	22.0	1.4	23.0
Less favorable agriculture conditions	34.8	−1.2	32.4	31.2	−0.8	30.7	0.6	32.1	0.1	32.0
More favorable agriculture conditions	34.2	−5.3	28.5	28.9	0.8	30.8	−0.8	28.1	−0.1	28.5
Mineral-rich countries	37.9	−2.0	32.9	30.3	−2.4	25.2	−2.4	19.3	−8.0	12.2
Lower middle-income countries	19.3	−0.7	19.6	17.2	−4.5	15.6	−2.4	15.6	1.3	16.3
Upper middle-income countries	3.4	−1.8	3.2	2.6	−5.8	2.3	−1.0	2.7	0.4	2.7
CEN-SAD	23.3	−0.3	22.9	20.3	−3.6	18.4	−2.6	17.2	−0.3	16.9
COMESA	23.3	−3.3	19.2	18.0	−1.9	17.1	−1.4	15.7	−1.0	15.1
EAC	32.1	−5.2	25.6	23.4	−4.5	21.2	0.5	22.4	1.0	22.6
ECCAS	19.0	−6.0	14.3	12.3	−6.1	11.7	0.4	13.9	2.5	15.1
ECOWAS	27.5	1.8	31.1	26.6	−4.3	23.3	−4.0	22.0	1.4	23.0
IGAD	36.5	−2.0	32.1	30.7	−1.4	28.2	−0.9	24.9	−2.1	22.6
SADC	9.3	−5.0	7.6	7.1	−1.8	7.1	−0.1	8.0	1.6	8.4
UMA	12.1	−7.0	9.1	7.8	−6.6	8.2	4.2	10.3	0.8	10.2
CAADP Compact 2007-09 (CC1)	30.6	1.3	33.6	29.1	−3.8	25.8	−3.8	24.2	1.5	25.6
CAADP Compact 2010-12 (CC2)	26.1	−3.9	22.5	21.0	−2.8	20.3	−1.4	19.8	0.3	19.6
CAADP Compact 2013-15 (CC3)	23.6	−0.8	21.7	20.0	−2.6	16.8	−3.8	13.8	−4.9	10.7
CAADP Compact not yet (CC0)	9.1	−1.4	8.4	7.5	−4.4	7.3	0.2	8.0	0.9	8.2
CAADP Level 0 (CL0)	9.1	−1.4	8.4	7.5	−4.4	7.3	0.2	8.0	0.9	8.2
CAADP Level 1 (CL1)	23.9	−0.8	21.9	20.2	−2.7	16.6	−4.2	13.2	−6.0	9.6
CAADP Level 2 (CL2)	28.3	−5.6	21.6	19.5	−3.1	18.9	−1.8	18.6	0.8	18.6
CAADP Level 3 (CL3)	32.0	−1.6	29.0	28.0	−1.3	27.9	−1.7	24.4	−0.5	24.0
CAADP Level 4 (CL4)	28.3	0.4	30.3	26.5	−3.7	23.8	−3.3	22.8	1.3	23.8
NAIP00 (N00)	4.6	4.8	5.0	4.3	−5.4	4.5	2.8	6.0	2.4	6.5
NAIP01 (N01)	14.3	−2.9	12.2	11.0	−4.0	10.6	−0.7	10.4	−0.2	10.4
NAIP10 (N10)	34.5	−7.9	22.6	20.3	−2.6	19.9	−2.9	18.2	0.1	17.5
NAIP11 (N11)	28.9	0.1	29.6	26.6	−3.0	23.8	−3.0	22.1	0.3	22.2

Source: ReSAKSS based on World Bank (2023).

ANNEX 7a: Supplementary Data Tables

TABLE O.4.1—GROSS DOMESTIC PRODUCT (trillion, constant 2015 US$)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2022)	Annual avg. change (%) (2014-2022)	2022
Africa	1.2	4.8	1.4	1.6	5.9	2.1	3.6	2.6	2.2	2.8
Central	0.1	2.3	0.1	0.1	5.9	0.1	4.8	0.1	1.8	0.1
Eastern	0.2	4.8	0.2	0.2	7.6	0.3	2.6	0.4	3.4	0.4
Northern	0.4	6.9	0.5	0.5	5.3	0.6	1.9	0.8	2.9	0.9
Southern	0.3	3.0	0.3	0.4	5.7	0.5	3.3	0.5	0.4	0.5
Western	0.3	4.6	0.3	0.4	6.0	0.6	6.1	0.7	2.3	0.8
Less favorable agriculture conditions	0.0	4.8	0.0	0.0	5.8	0.0	5.9	0.1	3.8	0.1
More favorable agriculture conditions	0.1	4.6	0.1	0.1	7.5	0.2	6.8	0.3	5.5	0.3
Mineral-rich countries	0.1	4.6	0.1	0.1	7.7	0.2	–0.5	0.2	0.6	0.2
Lower middle-income countries	0.7	4.3	0.8	1.0	5.7	1.3	4.6	1.6	2.4	1.7
Upper middle-income countries	0.3	6.5	0.3	0.4	5.4	0.4	0.9	0.5	0.4	0.5
CEN-SAD	0.7	6.1	0.8	1.0	5.9	1.2	3.5	1.5	2.7	1.7
COMESA	0.4	6.3	0.5	0.6	5.9	0.7	2.4	0.9	3.7	1.0
EAC	0.1	2.4	0.1	0.1	8.5	0.2	4.3	0.2	2.4	0.2
ECCAS	0.1	3.5	0.1	0.1	8.5	0.2	4.9	0.2	0.9	0.2
ECOWAS	0.3	4.6	0.3	0.4	6.0	0.6	6.1	0.7	2.3	0.8
IGAD	0.1	4.8	0.2	0.2	8.0	0.2	2.0	0.3	3.2	0.3
SADC	0.4	2.8	0.4	0.5	5.8	0.6	3.7	0.7	1.1	0.7
UMA	0.2	8.6	0.3	0.3	4.8	0.4	1.1	0.4	1.3	0.4
CAADP Compact 2007-09 (CC1)	0.2	5.0	0.3	0.4	6.8	0.5	6.6	0.7	2.5	0.8
CAADP Compact 2010-12 (CC2)	0.2	2.6	0.2	0.2	5.5	0.3	5.6	0.4	4.6	0.4
CAADP Compact 2013-15 (CC3)	0.2	4.8	0.2	0.2	6.4	0.3	2.1	0.3	–0.3	0.3
CAADP Compact not yet (CC0)	0.6	5.4	0.7	0.8	5.5	1.0	1.9	1.2	1.9	1.2
CAADP Level 0 (CL0)	0.6	5.4	0.7	0.8	5.5	1.0	1.9	1.2	1.9	1.2
CAADP Level 1 (CL1)	0.1	4.8	0.2	0.2	6.6	0.3	1.9	0.3	–0.8	0.3
CAADP Level 2 (CL2)	0.0	1.2	0.1	0.1	4.9	0.1	5.4	0.1	4.2	0.1
CAADP Level 3 (CL3)	0.0	5.3	0.0	0.1	6.1	0.1	5.8	0.1	3.7	0.1
CAADP Level 4 (CL4)	0.3	4.3	0.4	0.5	6.5	0.7	6.3	0.9	3.0	1.0
NAIP00 (N00)	0.4	3.5	0.4	0.5	5.6	0.6	2.9	0.6	0.3	0.6
NAIP01 (N01)	0.3	7.5	0.4	0.5	5.7	0.6	1.8	0.7	3.2	0.7
NAIP10 (N10)	0.0	–1.4	0.0	0.0	5.7	0.0	5.9	0.1	4.2	0.1
NAIP11 (N11)	0.5	4.5	0.6	0.7	6.3	0.9	5.0	1.2	2.6	1.3

Source: ReSAKSS based on World Bank (2023).

Note: Aggregate value for a group is the sum of gross domestic product for countries in the group.

ANNEX 7a: Supplementary Data Tables

TABLE O.5.1—GLOBAL HUNGER INDEX (GHI)

Region	Annual avg. level (1995–2003)	Annual avg. change (%) (1995–2003)	2003	Annual avg. level (2003–2008)	Annual avg. change (%) (2003–2008)	Annual avg. level (2008–2014)	Annual avg. change (%) (2008–2014)	Annual avg. level (2014-2021)	Annual avg. change (%) (2014-2021)	2021
Africa	35.2	–1.5	33.0	31.5	–1.8	28.2	–2.9	24.3	–1.4	23.1
Central	43.6	–1.0	41.8	40.8	–0.9	37.9	–1.7	34.9	–0.8	33.8
Eastern	42.8	–1.7	39.5	37.5	–2.2	32.8	–3.6	27.7	–1.3	26.3
Northern	16.1	–1.6	15.2	14.6	–1.4	13.1	–2.1	11.4	–2.0	10.6
Southern	33.8	–1.7	31.4	29.8	–2.1	25.8	–4.1	20.9	–2.0	19.3
Western	38.9	–1.7	36.0	34.1	–2.3	30.3	–3.0	25.7	–1.7	24.3
Less favorable agriculture conditions	47.9	–1.7	44.3	42.0	–2.2	37.0	–3.1	31.3	–1.7	29.4
More favorable agriculture conditions	45.5	–1.9	41.6	39.1	–2.6	33.6	–4.1	27.5	–1.8	25.7
Mineral-rich countries	43.0	–0.9	41.4	40.5	–0.9	38.0	–1.4	35.3	–0.8	34.2
Lower middle-income countries	30.1	–1.6	28.1	26.7	–2.0	23.7	–3.1	20.2	–1.6	19.0
Upper middle-income countries	19.0	–1.4	18.0	17.5	–1.1	15.6	–2.8	13.8	–0.9	13.3
CEN-SAD	32.3	–1.4	30.3	29.1	–1.7	26.3	–2.6	23.0	–1.3	21.9
COMESA	36.8	–1.4	34.6	33.3	–1.5	30.0	–2.7	26.4	–1.1	25.4
EAC	41.5	–1.4	39.0	37.5	–1.6	34.0	–2.5	29.7	–2.4	26.3
ECCAS	46.9	–1.4	44.0	42.2	–1.7	37.8	–2.7	33.1	–1.2	31.6
ECOWAS	38.9	–1.7	36.0	34.1	–2.3	30.3	–3.0	25.7	–1.7	24.3
IGAD	43.9	–1.8	40.3	38.2	–2.2	32.8	–4.2	27.2	–1.3	25.8
SADC	38.2	–1.3	36.1	34.8	–1.5	31.7	–2.5	28.1	–1.1	26.9
UMA	14.9	–2.0	13.6	12.8	–2.7	11.1	–3.4	9.0	–2.5	8.2
CAADP Compact 2007-09 (CC1)	32.3	–1.6	30.1	28.8	–1.8	27.0	–1.9	22.8	–1.5	21.1
CAADP Compact 2010-12 (CC2)	35.7	–1.1	34.0	32.8	–1.4	31.3	–1.4	27.1	–1.1	25.5
CAADP Compact 2013-15 (CC3)	14.9	–1.7	13.9	13.3	–1.6	12.5	–2.2	10.5	–1.8	9.6
CAADP Compact not yet (CC0)	44.1	–2.1	40.1	37.6	–2.7	34.1	–2.8	26.2	–1.9	23.4
CAADP Level 0 (CL0)	14.9	–1.7	13.9	13.3	–1.6	11.8	–2.4	19.4	15.2	48.6
CAADP Level 1 (CL1)	35.6	–0.9	34.1	33.1	–1.3	30.7	–2.3	52.9	15.7	133.7
CAADP Level 2 (CL2)	38.3	–1.0	36.8	35.9	–0.9	33.6	–1.5	50.1	12.8	109.3
CAADP Level 3 (CL3)	29.1	–1.8	26.8	25.4	–2.2	22.1	–3.4	44.1	19.8	109.9
CAADP Level 4 (CL4)	41.0	–1.9	37.6	35.4	–2.5	30.7	–3.7	49.7	14.4	132.8
NAIP00 (N00)	22.7	–1.8	20.9	19.7	–2.3	18.1	–2.5	13.4	–2.1	12.4
NAIP01 (N01)	20.2	–0.8	19.5	19.1	–0.7	18.5	–1.0	16.9	–0.8	16.4
NAIP10 (N10)	45.0	–0.7	43.6	42.9	–0.7	41.7	–0.9	38.5	–0.6	37.6
NAIP11 (N11)	34.8	–1.7	32.1	30.4	–2.3	28.1	–2.1	22.2	–1.7	20.9

Source: ReSAKSS based on von Grebmer et al. (2023), World Bank (2023), and ILO (2023).

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