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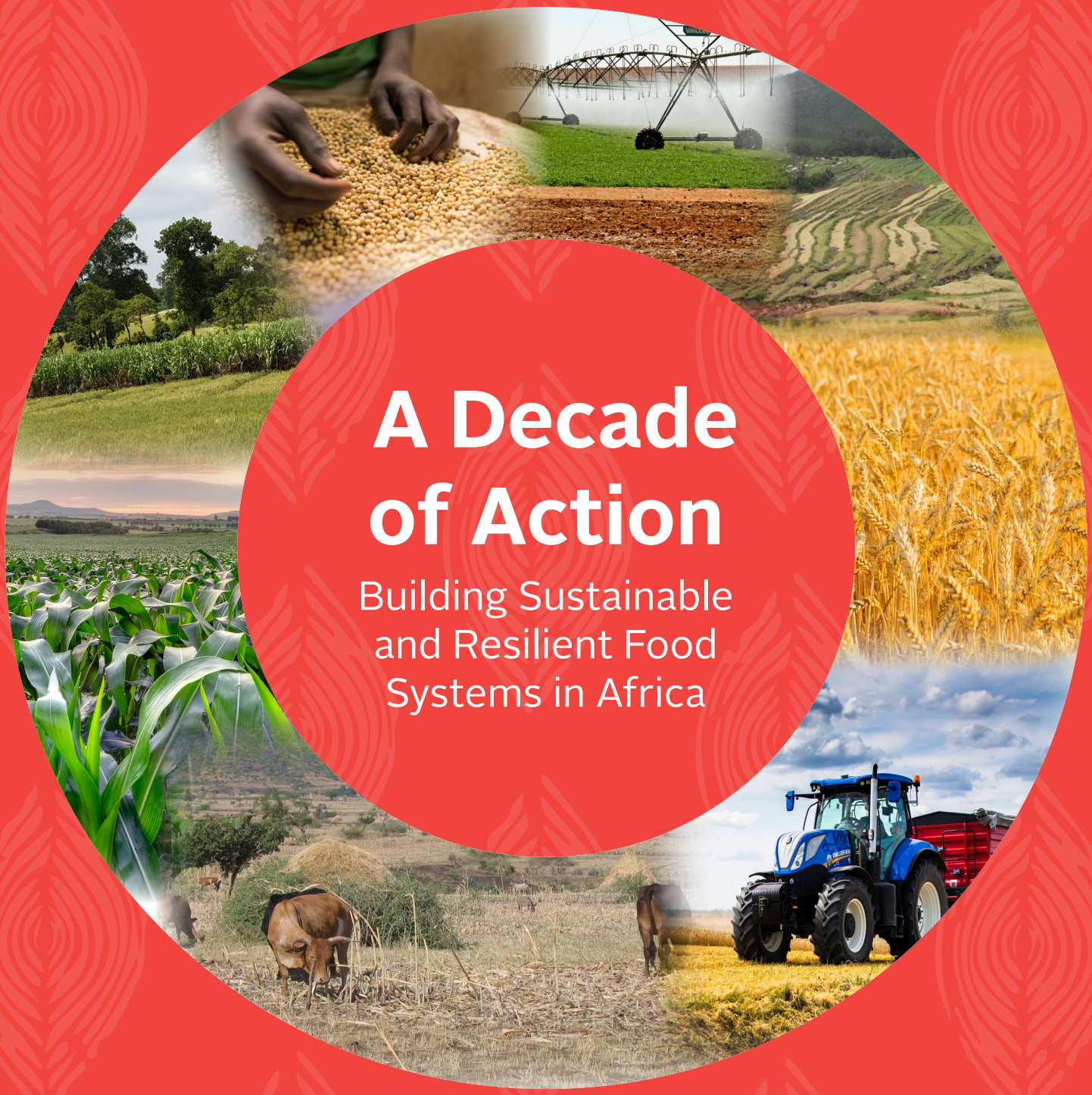
AFRICA AGRICULTURE STATUS REPORT 2021



A Decade of Action

Building Sustainable and Resilient Food Systems in Africa

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Foreword

Global food systems are in disarray and impose increasing pressure on our planetary habitat. In this next decade of action for sustainable development, we need to think about food systems differently – taking into account the true values and full costs involved in getting food onto consumers' plates.

As currently organized, food systems impose massive costs on human health (due to hunger, and foods that contribute to obesity and disease) costs on the environment today (due to area expansion and soil and water degradation, and costs on our children and grandchildren (for instance due to the food systems contribution to climate change and biodiversity loss). Building resilient and sustainable African food systems will require adopting policies and making investments that minimize the damage to human health, our environment, and to future generations. The food systems can and must become climate positive, and must not contribute about 30% to green-house gas emissions – as currently.

To do so will require integration of modern science and local knowledge to promote food systems resilience and sustainability. Improved seed varieties generated by modern technology are absolutely essential for sustainable food systems in Africa. Africa's own seed production systems must grow. So is increased use of fertilizers applied at the appropriate dose for the crops and contexts. Africa's own fertilizer production and distribution systems must be strengthened. Sustainable crop and livestock practices, as well as agro-forestry systems are hugely diverse – actually as diverse as the landscapes and farming systems in Africa.

Africa does not need to choose between stereotyped approaches, such as "technological approaches" or "agro-ecology approaches", but farmers and their partners in value chains can identify and develop "African approaches". These will be based on locally adaptive agricultural research, new science, the creativity of farmers, and extension, and entail context-specific, climate-smart, sustainable improved practices in the highly varied conditions of rural Africa. Strengthening the skills of farming entrepreneurs – including women and youth, and facilitating their access to markets (finance, inputs and outputs) remains critical.

This year's AASR arrives at an important time, as African governments are charting clear pathways to food system transformation in the context and aftermath of the UN Food Systems Summit 2021. Given the scale and dynamism of Africa's food systems, AGRA's longstanding commitment and that of AGRF Partners Group to smallholder agriculture now requires a shift in focus towards building resilience and sustainability of the entire system.

I applaud AGRA and their many stakeholders and partners for addressing the challenge of food system transformation and for viewing this challenge as an opportunity to embed resilience and sustainability in Africa's food system.

Joachim von Braun
Professor for Economic and Technological Change, Bonn University, Germany
President of the Pontifical Academy of Science, The Vatican

Preface

Globally, 2021 is a critical year for recovery and food system transformation. If we do not transform our food systems, we will hardly attain the Sustainable Development Goals (SDGs), particularly ending hunger. In this decade, Africa will need to chart clear pathways and identify concrete actions that can build sustainable and resilient food systems. Food systems that can deliver sufficient and nutritious food to feed the 256 million food insecure people on the continent. Food systems that are environmentally sustainable and can reverse the trend in deforestation and soil degradation. Food systems that create dignified jobs and shared prosperity for African youth now entering the labor market at a rate of 11 million per year with only 25 percent getting employed.

Africa is making progress. In the first two decades of the 21st century, Sub-Sahara Africa (SSA) has changed rapidly and many of these improvements, including those in gross domestic product (GDP) per capita, poverty rates, health, life expectancy, education, and agriculture have been mutually reinforcing. The region has achieved the highest rate of growth in agricultural production value (crops and livestock) of any region in the world since 2000 expanding by 4.3 percent per year in inflation-adjusted US dollars (USD) between 2000 and 2018, roughly double that of the prior three decades. The world average over the same period was 2.7 percent per year (World Bank, 2021). Agricultural value added per worker in real 2010 USD rose from $846 in 2000 to $1,563 in 2019, a 3.2 percent annual growth rate.

While the region has made impressive progress since 2000, African food systems remain fragile. Roughly 75 percent of the agricultural production growth came from the expansion of area under cropland, and only 25 percent from crop yield improvements.

In the downstream stages of the food system, the prospect of a single market under the African Continental Free Trade Area (AfCFTA) with more than a billion consumers and a combined GDP of more than U$2.5 trillion presents vast opportunities for agribusiness. Investment in Africa's agri-food system is no longer simply the preserve of multinational companies. African-owned enterprises are expanding their footprint. However, Africa's food value chains are largely fragmented with most marketed food output such as grains, tubers, and pulses going through under-capitalized informal markets. The vast majority (over 80 percent) of those employed in these food systems are involved in small-scale trading or transporting; their businesses are generally seasonal operations and many of them live near or below the poverty line.

In this decade, the African Union (AU)-led Africa Common Position to the United Nations Food Systems Summit (UNFSS)[1] underscores the urgent need for sustainability and resilience as a means of achieving food systems transformation. The Africa Agriculture Status Report 2021 (AASR21) provides evidence and insights on the prospects of achieving resilience and sustainability in Africa's food systems. The Report identifies immediate actions and steps that African governments, Pan-African organizations, development partners and the private sector need to take to build a food system with the (i) ability to self-organize and adapt in response to tipping-points and ever-changing landscapes; and (ii) the capacity to preserve and increase the welfare of current and future generations.

1 The Africa Common Position to the UNFSS constitutes the voice of the continent at the UNFSS to demonstrate the commitment of the region to contribute as a partner in setting the agenda for global food systems transformation. Https://au.int/en/pressreleases/20210715/africa-mobilizes-common-position-upcoming-un-food-systems-summit-unfss published July 15, 2021.

As in prior years, AASR21 is the product of intense scholarly work on the core chapters that I hope will stimulate intense discussion and a productive synthesis of ideas that will lead us forward in our ongoing work. Unlike prior years, this year's report aimed to elevate the African voice by involving a diverse set of African experts with proven track records and a wealth of experience. Through the AASR, AGRA and its partners can take pride in amplifying African voices to address the challenges of building a resilient and sustainable agri-food system over the next decade in the context of AU Comprehensive Africa Agriculture Development Programme (CAADP) Malabo targets, the SDGs, and Africa Agenda 2063. I am most grateful to the contributors and to a truly exceptional set of external reviewers for their professionalism and guidance.

Dr. Agnes Kalibata
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This year's Africa Agriculture Status Report (AASR) focuses on sustainable and resilient agri-food systems. This theme requires a whole systems approach to agricultural production and food systems management throughout the value chain. As a result, the AASR21 has involved an unusually broad range of disciplinary specialties and institutional contributors. We wish to recognize a broad coalition of contributors who have helped to conceptualize, assemble empirical evidence, and summarize the current critical issues and key findings in this report.

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Andrew Cox
Chief of Staff and Strategy

Acronymns

AASR21	Africa Agriculture Status Report 2021
AATS	Africa Agriculture Transformation Scorecard
AC	Adaptive Capacity
ACE	African Centers of Excellence
ACF	African Competition Forum
ACLED	Armed Conflict Location and Events Database
AET	Agricultural education and training
AFAP	African Fertilizer and Agribusiness Partnership
AfCFTA	African Continental Free Trade Agreement
AfDB	African Development Bank
AFFM	Africa Fertilizer Financing Mechanism
AFS	Agri-food system
AgBiz	Agricultural Business Chamber of South Africa
AGRA	Alliance for a Green Revolution in Africa
AGRF	Africa Green Revolution Forum
APRU	Agricultural Policy Research Unit
ARC	Agricultural Research Council
ASDP II	Agricultural Sector Development Programme Phase II
ASFs	Animal-sourced foods
ASTGS	Agriculture Sector Transformation and Growth Strategy
ASTIA– Trust Fund	Agricultural Science, Technology, and Innovation Trust Fund for Africa
ATA	Agricultural Transformation Agency
AU	African Union
AUC	African Union Commission
AUSTC	African Union Specialized Technical Committee
BBB	Building back better
BFAP	Bureau of Food and Agricultural Policy (IFPRI)
BFS	Bureau for Food Security
BH	Boko Haram
BIAT	Boosting Intra-African Trade
BIFAD	Board for International Food and Agriculture Development (USAID)
BMGF	Bill & Melinda Gates Foundation
BRFS	Bureau for Resilience and Food Security
BSF	Black soldier fly
CA	Conservation agriculture
CAR	Central African Republic
CAADP	Comprehensive Africa Agriculture Development Programme
CBN	Central Bank of Nigeria
CDS	Capacity Development Strategy
CGE	Computable General Equilibrium
CGIAR	Consultative Group on International Agriculture Research
CGP	Child Grant Programme

CIMMYT	International Maize and Wheat Improvement Center
COVID-19	Coronavirus Disease 2019
CBOs	Community-based organizations
CSA	Climate-smart agriculture
CSOs	Civil society organizations
CT-OVC	Cash Transfer Programme for Orphans and Vulnerable Children
DRC	Democratic Republic of Congo
DUL	Doubled-up legume
EAGC	Eastern Africa Grain Council
ECA	Economic Commission for Africa
EU	European Union
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Corporate Statistical Database
FARA	Forum for Agricultural Research in Africa
FAW	Fall armyworm
FDI	Foreign direct investment
FF	Frass fertilizer (black soldier fly)
FSIN	Food Security Information Network
FTE	Full-time equivalent
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GERD	Gross expenditure on research and development
GMO	Genetically modified organism
GNI	Gross National Income
HAZ	Height-for-age Z-scores
HDDS	Household Dietary Diversity Score
HFCS	High fruticose corn syrup
IAPRI	Indaba Agricultural Policy Research Institute
ICIPE	International Centre for Insect Physiology and Ecology
ICRAF	International Council for Research in Agroforestry
ICT	Information and communication technology
IDPs	Internally displaced persons
IFIs	International finance institutions
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILO	International Labor Organization
ILRI	International Livestock Research Institute
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IRM	International Raw Materials Limited
ISP	Input Subsidy Programs
IT	Information technology
LMIC	Lower middle-income countries
LSMS	Living Standards Measurement Survey
MCP	Multiple Category Target Programme
MDGs	Millennium Development Goals
MoF	Ministry of Finance
MT	Metric ton(s)

NAIPs	National Agriculture Investment Plans
NAIS	National Agricultural Innovation Systems
NAROs	National Agricultural Research Organizations
NARS	National Agricultural Research Systems
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental organization
NIAPs	National Agricultural Development Plans
NIRSAL	Nigeria Incentive-Based Risk-Sharing System for Agricultural Lending
NSIA	Nigeria Sovereign Investment Authority
NSS	National statistical systems
NTBs	Non-tariff barriers
OFSP	Other Food Security Programme
PE	Partial Equilibrium
PFI	Presidential Fertilizer Initiative
PPP	Public-Private Partnership
PPVC	Policy Prioritization through Value Chain Analysis
PSNP	Productive Safety Nets Programme
PYD	Positive youth development
R&D	Research and Development
R&D&E	Research & Development & Extension
RCT	Randomized Control Trial
REAP	Rural Entrepreneur Access Programme
ReNAPRI	Regional Network of Agricultural Policy Research Institutes
RIMA	Resilience Index Measurement and Analysis
RMC	Regional Member Country
SCTP	Social Cash Transfer Programme
SDG	Sustainable Development Goal
SGBV	Sexual and gender-based violence
SMEs	Small and medium-sized enterprises
SOC	Soil organic carbon
SP	Social protection
SNNP	Southern Nations, Nationalities, and People's Region
SPRINGS	Sustainable Poverty Reduction through Income, Nutrition, and access to Government Services
SSA	Sub-Saharan Africa
TVET	Technical and vocational education and training
UN	United Nations
UNECA	United Nations Economic Commission for Africa
UNFSS	United Nations Food Systems Summit
UNHCR	United Nations High Commission for Refugees
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value-added tax
VCs	Value chains
WACCI	West African Center for Crop Improvement
WEF	World Economic Forum
WFP	World Food Program
WHO	World Health Organization

1 Overview: Building Sustainable and Resilient African Food Systems

Thomas Jayne[1]; Louise Fox[2]; Lulama Ndibongo Traub[3]; Kevin Urama[4]; Tinashe Kapuya[5]; Vine Mutyasira[6]

Key messages

1 Food systems are a fundamental part of our lives – we all depend on them for our sustenance. Many in Africa depend on food systems for employment and incomes. The functioning of food systems also influences the health of people and our environment, our identities, and cultures. Making food systems more sustainable means minimizing the disruptions they impose on environment, health, and cultures, including those of future generations.

2 Africa's food systems are fragile and need to become more resilient. The status quo is not sustainable. While adapting African food systems to become more resilient and sustainable requires substantial investments from both African governments and the private sector, the costs of maintaining the status quo and an unsustainable food system will be much greater.

3 Raising yields and productivity on existing farmland is among the most important ways to make African food systems more resilient and sustainable. Raising productivity on existing farmland will reduce pressures for continued expansion of cropland and preserve valued forest and grassland ecosystems and the biodiversity that they provide.

4 Raising systems productivity will also require utilizing "circular economy" practices such as converting organic wastes into productive inputs in farm production, water recycling, etc. Achieving these objectives will require greater attention to technical innovation and greater support to the agricultural institutions that generate it namely agricultural research, development, and extension (R&D&E) systems.

5 Productivity also has to improve in downstream value addition activities. The key here is for governments to provide the investments and policies that stimulate private investment, innovation, and competition in food systems.

6 Africa has the knowledge to build sustainable and resilient food systems, but the task is complex and will require new thinking as well as new capacities.

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A Decade of Action: Building Resilient and Sustainable African Food Systems

The United Nations Food Systems Summit (UNFSS) has thrust food systems transformation onto the main stage of international discourse in 2021. Concepts of resilience, sustainability, and "green growth" have also gained tremendous traction internationally. Consensus is emerging across the globe that our livelihoods, jobs, and indeed the health of the planet, are fundamentally dependent on developing resilient and sustainable economies.

Food systems are a fundamental part of the global economic system – the world's population depends on them for sustenance. As is the case elsewhere, in Africa, many people depend entirely on food systems for employment and incomes as well. For these reasons, building resilient and sustainable food systems is crucial to ensuring sustainable economies and achieving the Sustainable Development Goals (SDGs) and Agenda 2063 Goals·However, Africa remains food insecure, accounting for 256 million of the world's 795 million people suffering from hunger. Moreover, 239 million of the 256 million food insecure people are in sub-Saharan Africa (SSA), with 17 million people in North Africa·Africa is off-track from reaching its food security targets across all continental policy frameworks as well as the SDGs. Against this background, there has been a broad consensus that Africa's food systems as currently constructed are flawed due to the high levels of food and nutrition insecurity, food losses and waste, and prevailing human and environmental health concerns arising from unsustainable production systems.

The threat of multiple crises such as persistent droughts, famine, locusts, fall armyworm (FAW), civil conflicts, and, more recently, the COVID-19 pandemic, impede the continent's progress in overcoming the challenges faced in meeting its targets. These ever-more frequent shocks underscore the importance of the continent creating more resilient food systems that can withstand these multiple shocks.

The Africa Common Position to the UNFSS underscores the urgent need for sustainability and resilience as a means of achieving food systems transformation. The common position paper proposes a number of game-changing solutions, including (i) rapid adoption of biotechnology ranging from drought-tolerant seed varieties to bio-fortification of staple and other widely consumed foods, among other solutions; (ii) sustainable water and land use through sound agronomic practices which promote soil conservation, and preservation of the environment; (iii) the establishment of an enabling regulatory and policy environment that creates more space for competitive entrepreneurship, especially small and medium-sized enterprises (SMEs); and (iv) setting high food standards that promote human and animal health, especially in informal food value chains.

While there is broad agreement on the Common Position, there are divergent views on how inclusive agricultural transformation ought to be achieved. The question remains: what would a resilient and sustainable food system look like, what combination of policies and investments can reshape it, and what is the most appropriate approach to drive these changes? There are at least two dominant streams of thought worth noting: (a) a modified version of a Green Revolution as implemented in Asia in the 1960s and 1970s; and (b) an agroecological approach. Are there elements of both approaches that can be effectively drawn upon and merged? Addressing these questions should be central in discussions of how to achieve inclusive agricultural transformation. Moreover, the structural challenges besetting African food systems are likely to impede the effectiveness of any approach. Therefore, the pre-conditions for success should be identified and put in place before countries can expect to achieve resilient and sustainable food systems. This 2021 African Agriculture Status Report (AASR21) provides evidence and insights on the prospects of achieving resilience and sustainability in Africa's food systems.

The AASR21 is organized as follows: This overview chapter presents the key messages and conclusions of the AASR21. Chapter 2 presents the report's

framework for considering how resilience and sustainability relate to African food systems while Chapter 3 reviews evidence on the mounting impacts of shocks such as civil disruption and climate change on SSA's agri-food systems, with a discussion of approaches for building in greater resilience. Chapter 4 synthesizes evidence on building more sustainable and resilient food systems through actions at the farm level, while Chapter 5 analyzes the same issue but from the standpoint of actions in the downstream stages of food systems. Chapter 6 explores the co-dependence between nutrition, resilience, and sustainable food systems. Chapter 7 addresses capacity development challenges for African policy makers to be increasingly guided by high-quality African-led technical expertise in agriculture and food systems. Chapter 8 explores the importance of exploiting the synergies between more resilient food systems and improved livelihood opportunities for youth. Chapter 9 highlights under-exploited opportunities for social protection programs, which are traditionally viewed as a safety net tool, to contribute to more resilient, sustainable, and productive food systems. Finally, Chapter 10 assembles the main policy and programmatic actions recommended in the previous chapters, for four groups of actors: African governments, pan-African organizations, the private sector, and international development partners.

Resilience, sustainability, and food systems: Why they matter

What is a food system?

Agri-food systems are defined as the totality of activities, people, institutions, and natural resources (e.g., land, water, and air) involved in supplying a population with food and agricultural products. The agri-food system encompasses the generation and distribution of farming inputs and services, production at farm level, post-farm marketing, processing, packaging, distribution and retail, and the policy and regulatory environment in which these activities take place. At every stage, food systems utilize natural resources, many of which are non-renewable. There is growing recognition that we need food systems that use these resources sustainably and do not destabilize the environment.

Food systems include (i) farming: those involved directly in producing crops, raising animals, and managing fisheries; (ii) upstream agri-food stages involving pre-farm value addition activities, e.g., farm input distribution, irrigation equipment, crop and animal science and technology generation, and farmer extension services; and (iii) downstream agrifood stages involving post-farm value addition such as crops aggregation, transportation, wholesaling, storage, processing, retailing, restaurants, beverage manufacturing, etc.

Performance at any stage of the system depends on performance at earlier stages of the system. Policies constraining investment in input delivery systems, for example, depress productivity at the farm-level and constrain volumes through the downstream system, constraining investment and employment growth at those stages too. A systemic approach explicitly recognizes these interrelationships and calls for holistic and comprehensive solutions all the way to consumers' tables.

Sustainability

Sustainability is defined as the capacity to preserve and increase the welfare of current and future generations of humans and the planet. Investments and policies to ensure systems sustainability may impose short-term costs on society, but evidence is growing that the costs of unsustainable development are much greater (World Bank, 2020). Nowhere is this more evident than for agriculture where lack of attention to sustainability can result in catastrophic losses in terms of income, social capital, and common-pool resources such as water and animal habitat. In general, food systems that use technologies that destabilize the natural environment (e.g., through excessive greenhouse gas emissions, water pollution, soil erosion, soil nutrient depletion, deforestation, habitat loss, fossil-fuel-dependent processing, and transportation, etc.) are not sustainable. Sustainable food systems

can provide safe, healthy, and affordable food for all without endangering population health or the welfare of future generations.

There are also important social and economic dimensions of sustainable food systems. They provide food security to all, contribute to the livelihoods of all groups, including the socially disadvantaged and vulnerable, and deliver seed types, technologies, and diets that fit local preferences.

Resilience

Resilience refers to the ability to dampen the impact of, and quickly recover from, shocks and to adapt flexibly in response to stressors (e.g., Cutter et al, 2008). Applied to food systems, resilience is defined as the ability of African food systems to withstand major shocks and stressors emanating from climate/weather, conflict, disease, economic shocks outside the region, and other sources which, if not prevented or mitigated, would delay or limit economic progress, transformation, prosperity, and self-reliance.

Food systems incur shocks and are influenced by stressors. Shocks are "external short-term deviations from long-term trends that have substantial negative effects on people's current state of well-being, level of assets, livelihoods and safety" (Choularton et al., 2015). Floods, droughts, pests and diseases, military conflicts, and rapid changes in important economic conditions such as fuel prices, exchange rates, or inflation, are examples of shocks. Stressors are "long-term trends or pressures that undermine the stability of a system and increase vulnerability within it (Zseleczky and Yosef, 2014). Climate change, population pressures, and protracted political instability are examples of stressors.

Figure 1.1 illustrates the concept of resilience: a resilient food system minimizes the effect of a negative shock and recovers more quickly than a less resilient system.

System resilience is necessary for sustainability. Lack of resilience impedes progress in any domain as losses slow down or impede system progress.

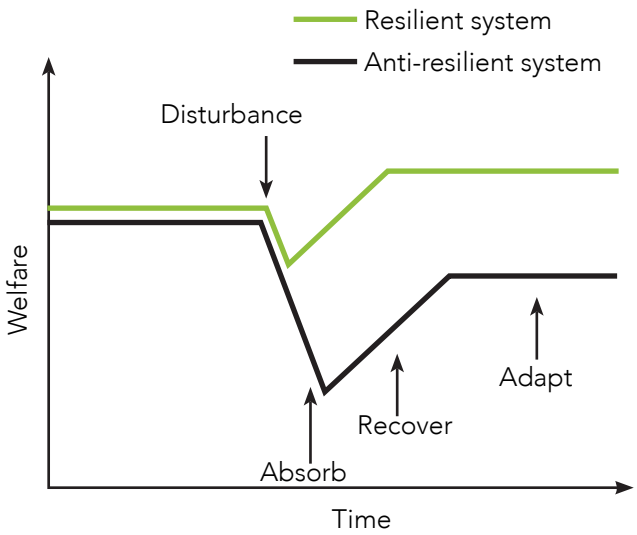

Figure 1.1: Resilient systems

Source: adapted from Marchese et al., (2018)

Key terminology

Agri-food systems (AFS): the totality of activities, people, institutions, and natural resources involved in supplying a population with food and agricultural products.

Sustainability: the capacity to preserve and grow welfare for both current and future generations.

Resilience: the capacity to dampen the impact of, and quickly recover from, shocks such as diseases, droughts, and human conflict; and to adapt flexibly in response to stressors such as climate change and rising land scarcity.

What does a resilient and sustainable food system look like and why should African leaders care?

African economies and their food systems remain fragile. Shocks from disease, climate change, extreme weather, and conflict, for example, are already common occurrences and may be becoming more common as temperature and rainfall patterns discernibly change (Engelbrecht et al., 2015; Souverijns et al., 2016). African food systems' vulnerability to climate-induced shocks is acute due to the region's reliance on rain-fed production systems, transport systems that are hard-pressed to import food quickly enough in response to major food production shortfalls, and limited coping abilities of a large fraction of the region's population, which lives in poverty. Africa needs to develop strategies to adapt to stressors and mitigate the impact from shocks on people's lives and livelihoods so that societies can more rapidly return to a sustainable development trajectory and "build back better" in ways that better attain societal values. For many, a more resilient food system may be the difference between life and death.

Africa also needs more sustainable food systems that efficiently and reliably deliver food to its rapidly growing populations while conserving water and energy, minimizing pollution, and preserving forests, grasslands, and the ecosystem services that they provide. Rapid population and economic growth will put mounting stress on Africa's natural resources to grow more food, and provide more water, energy, and land. SSA's population is projected to double from 1.2 to 2.3 billion people over the next 30 years (Jayne et al, 2021). Africa needs to avoid the massive costs that more developed nations are incurring from failing to realize the importance of sustainability. For example, some countries are experiencing (i) dead zones in their seas from agricultural nutrient runoff, killing livelihoods in areas here that rely on fishing; (ii) toxic water effects that destroy aquaculture potential; and (iii) insufficient water reserves to continue agricultural production because of overuse of water, threatening local economies and community livelihoods. Other countries have failed to protect local land rights, allowing land concentration to create a class of impoverished rural dwellers, fueling inequality, social tensions, and eventually, conflict. These are just a few examples of how Africa can benefit when its governments incorporate sustainability and resilience principles into the development of food systems on the continent. This is an overview of "what's in it" for Africa. In fact, every one of Africa's 1.2 billion people will benefit from the transformative power of a more resilient food system on inclusive growth, improved food security, poverty reduction, and the preservation of Africa's natural resources and environment. Finding and implementing sustainable solutions is thus an urgent priority for African governments and pan-African organizations.

What's in it for Africa?

By building capacity to respond effectively to shocks and stressors, resilient food systems can be the difference between life and death for millions of Africans.

Creating sustainable food systems can enable Africa to avoid the massive costs that some high-income countries are incurring from failing to realize the importance of sustainability.

Characteristics of resilient and sustainable African food systems

Sustainable food systems continue to increase the quantity and quality of food available at an affordable price while producing limited impacts on the environment and human health. There are two central features of resilient food systems: (i) a reduced likelihood that shocks to the food system occur, and (ii) measures are taken either ex ante or ex post to ensure that individuals, communities, and regions recover quickly and resume normal

performance after inevitable shocks occur. Food systems have multiple stages and each stage influences performance of the overall system. Sustainability and resilience are critical at all stages of the food system – upstream, during technical innovation before anything is planted, during on-farm production and harvesting, and during post-harvest aggregation, wholesaling, processing, and retail distribution (see Annex Table 1.1 for detail).

The vision for a resilient and sustainable food system in Africa has the following characteristics. First, technical innovation driven by supportive policies and public investments in infrastructure, research and development (R&D), and education drive productivity growth at the farm level. Second, in the face of rapid population growth as in SSA, productivity growth at all stages must become a central feature of resilient and sustainable food systems. Productivity growth can be referred to as increases over time in the ratio of value produced to costs incurred at farm level, all other stages of the food system, and even outside the food system, e.g., costs that the food system imposes on the environment and human health. Third, rising farm productivity and output drive private investment and technical innovation at various stages of downstream food systems, contributing to productivity growth of the entire food system (AASR, 2019). Fourth, rising productivity growth is shared among workers who create the value produced through higher earnings and better working conditions. Fifth, consumers are empowered and incentivized to make healthy food choices, avoiding costly health repercussions later. Finally, at all stages, resilient and sustainable food systems increase productivity after explicitly considering the costs incurred to society, including the disadvantaged and most vulnerable, outside the system.

The AASR21 explores in detail how these characteristics can be developed and nurtured at different stages of the food system as well as in areas outside the food system including at the broader state and society levels.

Resilience and sustainability in Sub-Saharan Africa: the status quo

Africa is making progress

In the first two decades of the 21st century, SSA has changed rapidly for the better in many ways, counter to many outdated narratives. Many of these improvements, including those in gross domestic product (GDP) per capita, poverty rates, health, life expectancy, education, and agriculture, have been mutually reinforcing (Jayne et al., 2021). SSA achieved the highest rate of growth in agricultural production value (crops and livestock) of any region in the world since 2000, expanding by 4.3 percent per year in inflation-adjusted US dollars (USD)

Dimensions of sustainable food systems

The Food and Agriculture Organization (FAO) defines a sustainable food system as one 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" (p.1, FAO, 2018). Sustainable food systems would thus not compromise environmental bases through other elements of the system including upstream (such as unsustainable methods of fertilizer production, which generate greenhouse gas emissions), and downstream (e.g., overreliance on modes of processing and transportation that destabilize the environment). Sustainable food systems are also economically and socially sustainable: they are characterized by enabling environments that encourage innovation, new investment, and productivity growth, and support the livelihoods of all social groups including vulnerable and disadvantaged groups.

between 2000 and 2018, roughly double that of the prior three decades. The world average over the same period was 2.7% per year (World Bank, 2021). Agricultural value added per worker in real 2010 USD rose from $846 in 2000 to $1563 in 2019, a 3.2 percent annual rate of growth. While the number of people in SSA living in extreme poverty has increased from 376 to 413 million between 1999 and 2015, the region's population increased over this same period from 652 million to 1.01 billion, resulting in a marked decline in the share of people in poverty, from 58 percent in 1999 to 41 percent in 2015 (World Bank, 2021).

Most African countries show a strong correlation between agricultural growth and GDP. Even for the region as a whole, the degree of correlation is notable (Figure 1.2) further confirming the reinforcing synergies between agriculture and African economies. When agriculture grows, its extensive linkages with off-farm stages of the agri-food system and non-farm sectors expand employment and livelihoods in the rest of the economy.

But African food systems are fragile, and some trends are alarming

Notwithstanding the region's impressive progress since 2000, African food systems remain fragile. Roughly 75 percent of the agricultural production growth came from the expansion of area under cropland, and only 25 percent from crop yield improvements. Cereal yields in SSA rose by only 38 percent in the 38 years between 1980 and 2018, roughly a third that of South Asia and Southeast Asia during the same period (Fuglie et al., 2020). Expansion of area under cultivation accounts for a significant share of deforestation in Africa and the percentage of SSA's land area covered by forests has declined from 31.6 percent in 2000 to 26.6 percent in 2018 (World Bank, 2020).

Indicators of sustainability and resilience for SSA show mainly negative trends (Table 1). Most African countries are losing their forests and the pace of loss has accelerated in the decade between 2010 and 2020. Some countries such as Cote d'Ivoire and Ghana have lost over a third of forestland in

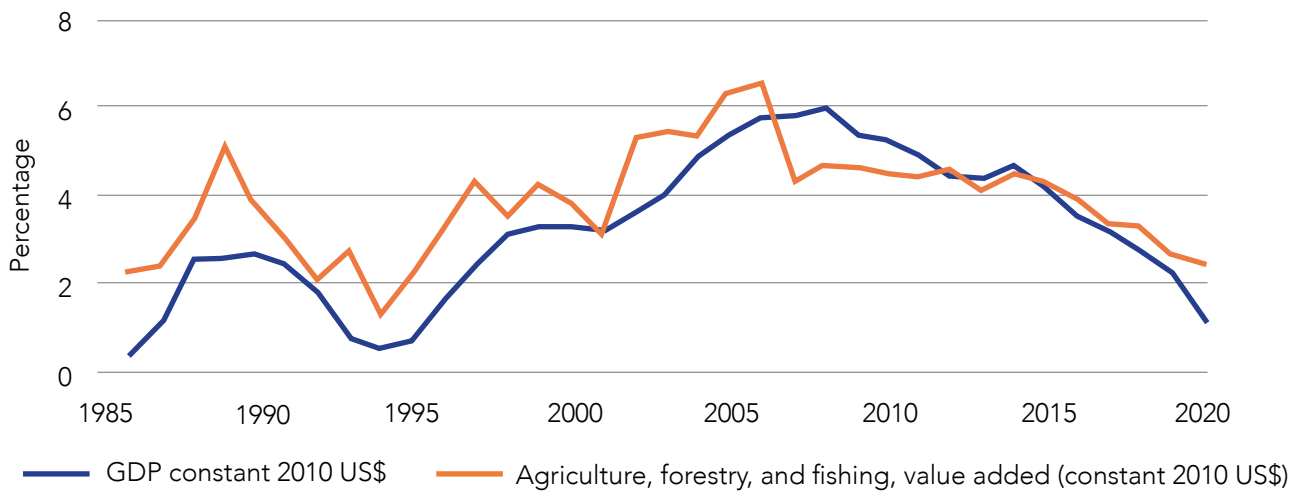

Figure 1.2: Annual growth rates in agricultural output and gross domestic product for Sub-Saharan Africa, both expressed in 2010 US$ and as five-year moving averages.

Notes: Moving average for year is expressed as the value for that year and the prior four years.

Source: World Development Indicators, the World Bank (2021).

the past three decades. The percentage of rural farm households residing on land that is degrading, eroded of nutrients by poor land management, rose at an alarming rate from 21 percent to 28 percent between 2000 and 2010, (Sitko and Jayne, 2018). Indicators of energy and water stress also increased between 2010 and 2020. Population and economic growth will put further stress on Africa's natural resources to grow more food and provide more water and energy.

Main conclusions from the AASR21

More sustainable and resilient food systems in Africa will increase the pace of the region's overall economic transformation and raise living standards in the process. Moreover, investing in resilient and sustainable food systems today will spare African governments from incurring considerably greater costs down the road. Other key messages include the following:

1. ***The recent COVID-19 crisis has highlighted the need for food systems that are more resilient to shocks*** (Chapter 2). Resilience is needed in all system domains:
    a. Economic, through continuously: raising productivity throughout the system; raising incomes and savings relative to the costs of adjusting to shocks; exploiting opportunities for harnessing and converting conventional wastes into valued inputs (e.g., organic wastes from urban areas into compost for improved soil health and farm productivity).
    b. Social, by prioritizing an inclusive, equitable, and empowering system that ensures access to affordable and safe food and adequate nutrition for all; and
    c. Environmental, by conserving and regenerating natural assets such as soils, water, forests, and biodiversity, and minimizing the release of carbon and industrial pollutants into the atmosphere.
2. Resilience can be measured empirically as the ability to bounce back from shocks and avoid prolonged downturns. In this respect, ***SSA has become more resilient over the past three decades*** (Chapter 2). The annual growth rates of agricultural production and overall economic growth have progressively risen and become less variable in every decade since the 1980s.
3. Food systems function according to the capacities and decisions of the individuals, organizations, and institutions engaging in these systems.

Table 1.1: Indicators of resilience and sustainability by decade, Sub-Saharan Africa

Average value by decade	1980-1989	1990-1999	2000-2009	2010-2019
% of households residing on degrading soils			20.8	28.4
Energy depletion (% of Gross National Income, GNI)	2.90	2.86	5.22	4.15
Forest area (% of land area)	-	32.43	30.84	27.51
Water stress ratio	-	295.17	419.99	575.44

Notes: Soil nutrient budget is calculated as the sum of inputs (synthetic fertilizer, manure applied to soils, atmospheric deposition, and biological fixation), minus the output (crop removal); higher levels mean soil nutrient depletion. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime. Water stress ratio is defined as freshwater withdrawal as a proportion of available renewable freshwater resources (World Development Indicators, 2021); higher levels mean greater water stress.

Source: World Bank (2021) for all indicators except forest area (FAO Corporate Statistical Database, FAOSTAT) and percentage of households residing on degrading soils (Sitko and Jayne, 2018).

Resilience requires substantial state capacity in government ministries and agencies to respond effectively to shocks and stressors, which in turn require improvements in nations' education systems (Chapters 2 and 7).

4. ***Unless effectively addressed today, the growing incidence of conflict and climate-related shocks and the prevalence of health, economic, and other shocks and stressors will slow down Africa's economic transformation and progress toward sustainable development*** (Chapter 3). Risks and shocks are unavoidable and are likely to occur with greater frequency and severity due to global climate change. Bold, timely response today can build the resilience to mitigate the effects of these shocks and stressors and avoid potentially catastrophic impacts.

5. ***Productivity-led growth is one of the central features of a resilient food system*** (Chapters 2, 4, and 5). Sustained productivity growth is one of the key drivers of improved livelihoods and resilience. This is particularly true for agriculture in countries where a large share of the labor force is employed in the food system. Food systems cannot grow sustainably in environments where farm productivity is not improving. When real incomes and savings rise compared to the cost of food, consumers become more resilient – they are better able to absorb shocks.

6. ***Food system resilience and sustainability in Africa requires increasing the rate of growth in farm productivity on existing farmland***, relieving the need for rapid expansion of cropland and associated destruction of forests and grasslands to meet the continent's food needs (Chapter 4). This requires:

    a. technical innovation resulting from investments in agricultural research and development (e.g., crop science, animal science, agronomic management, etc.);

    b. increasing land yields without compromising environmental sustainability (avoiding soil degradation, erosion and depletion of soil organic matter through the use of cover crops and water management to prevent depleted aquifers); and

    c. increasing use of organic inputs to restore and preserve degraded soils. One tactic is the increased use of circular economy principles, recycling wastes – outputs from the production process with negative value such as wastes from urban markets and sanitation systems – back into food production.

7. ***Achieving farm productivity growth will require a faster pace of technical innovation and greater support to the agricultural institutions that generate it: agricultural R&D&E systems*** (Chapters 4 and 7). On average, African governments spend much less on agricultural R&D than governments in Asia and Latin America do, and generally less than their own commitments under the Malabo Declaration Agreements[7]. African governments need to take charge of developing their respective national agricultural R&D&E systems to build sustainable and resilient food systems.

8. ***Productivity must also improve in downstream value addition activities.*** The key here is for governments to provide the investments and policies that stimulate private investment, innovation, and competition in food systems (Chapter 5). It is generally not necessary or desirable for the state to directly engage or control activities in the downstream stages of the food system.

7 In June 2014, African Heads of State and Government adopted the Malabo Declaration on Accelerated Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods, a set of goals to be attained by 2025. The goals show a more targeted approach to achieve Africa's agricultural vision, which is shared prosperity and improved livelihoods. The Malabo Summit reconfirmed that agriculture should remain high on Africa's development agenda and is a critical policy initiative for African economic growth and poverty reduction.

9. ***Africa's agri-food system offers growth potential to large-scale, multinational agribusinesses as well as medium-sized domestic businesses*** (Chapter 5). Over the past five years, some of the world's largest grain traders, food processors, and wholesale/retailers have expanded their investments on the continent. The prospect of a single market with more than a billion consumers and a combined GDP of more than U$2.5 trillion presents vast opportunities for agribusiness in Africa. The expanded markets create unprecedented opportunities to capitalize on economies of scale. Realizing this potential will require effective implementation of the African Continental Free Trade Agreement (AfCFTA). It will also require improving Africa's challenging business environment, strengthening customs and logistics systems, and increasing access to finance, especially for domestic firms.

10. ***Africa will benefit from "upgrading" value chains in the food system, but this process is best achieved through policies that support agricultural transformation more generally*** (Chapter 5). While employment in African food systems has grown rapidly over the past 20 years, few of these jobs provide attractive livelihoods. Over 80 percent of the jobs in African agri-food systems are estimated to be in the informal sector featuring mainly self-employed people making very little money and with no job security who must self-insure for theirs and their families' health care. Upgrading to salaried employment with benefits will take time. Governments should continue to support informal traders and markets while investing in physical infrastructure, improved educational systems, and a policy environment that provides an open and level playing field for private investment. These policies will attract more private registered formal sector firms into African food systems, gradually providing an increasing number of formal sector jobs to individuals formerly employed in low-paying informal sector jobs.

11. ***One of the most effective ways to attract youth to farming and employment in other stages of food systems is to make these activities more profitable*** (Chapter 8). Making agriculture "sexy" is not nearly as important as making it profitable. Attracting youth into gainful employment in upstream and downstream food systems will involve: (i) policies that expand investment opportunities in food systems by small, medium and large firms; (ii) public investments that improve the productivity of farming; (iii) investments in infrastructure that lower the costs of commerce; and (iv) rules-based marketing and trade policies that raise the level of predictability of government behavior in agricultural markets, and (v) upgrading education systems to improve the skill base of youth entering the labor force.

12. ***Africa still has the highest rates of stunting, anemia, and hungry people in the world, another food system weakness*** (Chapter 6). Key drivers include inadequate investment in pro-nutrition seed varieties that are appropriate for local conditions and consumer preferences, and rural poverty. Measures are needed to increase the supply of nutrient-rich crops and incentivize consumers to purchase healthier foods (for example, through public health campaigns and food subsidies for pregnant and nursing women).

13. ***Social protection programs are shown to have positive effect on a series of productive outcomes, including resiliency*** (Chapter 9). Programs enable households to make investments, take on risks, reallocate labor, and engage in markets. There are synergies and complementarities between social protection and agricultural interventions.

14. ***Resilience means adding redundancy*** (for example, alternative ways of getting food to consumers in the event of shocks). Building in these alternatives entails costs, which need to be shared fairly to ensure social sustainability. Financing investments in resilience and sus-

tainability will impede the rate at which other public infrastructure and services are built and upgraded, unless adequately financed. Financing for climate adaptation and sustainable resource use is needed throughout the food system, including in the public and private sectors. International finance institutions (IFIs) such as the African Development Bank (AfDB) and the World Bank lack the resources to fully cover needed investments. Rich countries, which have become wealthier by using production processes that have emitted greenhouse gasses on the planet for centuries, need to support sustainable and food system transformation in Africa, the region most affected by global climate change, yet with the lowest level of emissions. Governments and development partners may join forces to provide incentives for the private sector to finance some of the needed investments in food systems resilience.

15. ***Africa needs new ways of thinking to building resilient and sustainable food systems, including taking a holistic approach to the costs and benefits of alternative system development paths***. A recent AGRA study found that the locust attack affecting much of East Africa in 2020 was linked to climate change, especially a prolonged period of exceptionally wet weather related to several rare cyclones that struck the region prior to the invasion, which in turn were related to the conversion of forestland to agriculture and other forms of forest degradation (AGRA, 2021). A recent Rockefeller study indicates that the true cost of food delivered through the US food system is three times greater than the total consumer food expenditures after considering health outcomes, healthcare costs, environmental costs, subsidies, and other impacts. There are growing calls for the use of "true cost accounting" as a systemic and more comprehensive approach to illuminate policy makers and the public about the positive and negative impacts of current and alternative food systems on the environment, livelihoods, health, and the economy. Approaches such as "true cost accounting" illuminate key issues that intersect food systems, incomes, energy, environment, health, and welfare. Agricultural policymakers may not immediately consider some of these issues as their direct concerns, but rather as belonging to other ministries or agencies. However, these issues do not fall neatly under any one ministry - they are difficult and complex cross-ministry/sectoral issues that require new tools and ways of doing business. It is necessary that African governments and technical institutions devote time and resources to build up the muscle to address these challenges. Development partners can support African governments by providing demand-driven support rather than overloading development agendas with their own priorities.

The way forward

African states will develop more rapidly and African citizens experience more rapid livelihood improvements if African food systems become more resilient to major shocks and stressors affecting the continent. The future of African food systems, and smallholder farmers' roles in them, will be determined by the totality of government policies and investments.

The challenge ahead for Africa is daunting and complex but with adequate support, it can be met. Chapter 10 of this publication contains an agenda for action compiled from Chapters 3-9 and Annex Table 1 (below) and details priorities for African governments, pan-African organizations, the private sector, and bilateral and multi-lateral development partners. Chapter 10 argues that African governments must drive the specific agenda in their respective countries, including actions to:

- improve sustainability and resilience in farm production by raising productivity on existing farmland rather than continue relying on area expansion as the source of agricultural growth; this means technical innovation that requires, among other things, strengthening national agricultural research, development and extension systems;

- support the institutions involved in helping farmers to improve soil health with a focus on higher yielding seed varieties, increased and more efficient use of inorganic fertilizers, and organic inputs and integrated soil fertility management practices, which will improve yield stability in the face of various shocks and stressors on incomes;
- increase value addition, productivity, and quality in the downstream stages of food systems by making investments that reduce the costs of domestic, intra-African and international trade, supporting the implementation of AfCFTA, promoting safer and more nutritious food, and reducing the use of fossil fuels in production and transport;
- increase the pace of investment in transport and communications infrastructure to reduce the costs of national and regional food trade; and
- enhance capacity to prepare for shocks and adapt to stressors in the public and private sector.

African governments should direct pan-African organizations to support their priorities. This would entail:

- supporting efforts to project a unified African voice in global policy dialogue on agricultural system governance;
- supporting national government's capacity for resilience planning, and mitigation and coping measures by developing a continent-wide early warning system and knowledge management capability;
- developing and supporting Africa-wide data banks to benchmark national efforts, promote African-led analyses, and pilot new analytical approaches such as true cost accounting;
- AfDB commissioning a detailed stocktaking with development partner support to assess progress and chart a way forward for African countries to avoid repeating past mistakes of technical innovation being dominated by international research groups while national agricultural R&D, policy analysis, and knowledge management systems remain starved for resources and fail to build sustainable capacity.

International development partners should encourage African governments to formulate their own agendas for enhanced resilience and food system sustainability rather than create parallel ones. This implies supporting governments as they formulate and implement their agendas, including through technical assistance, and then following the lead of African governments' and regional institutions' own programs, or withdrawing altogether. Development partners should avoid overloading African national governments with their own demands and requirements and instead support African governments to build sustainable state capacity to manage and develop food systems at a suitable pace. In some cases, this may mean tolerating imperfections as governments and societies learn and develop. International development banks such as AfDB and the World Bank should deepen their commitment to African food system resilience investments with their longer-term financing.

Annex Table 1.1: What does a resilient and sustainable food system look like? Specific characteristics.

Stage of agri-food systems	Characteristics of resilience and sustainability
Upstream stages	
Technical innovation systems	• Effective in generating practical approaches for improving soil health that are appropriate to smallholder conditions. • Effective in generating moisture management technologies for semi-arid farming areas. • Generation of technical innovations that raise farm productivity (increases over time in the ratio of outputs to inputs) appropriate for use by small-holder farmers. • Bi-directional extension systems that enable learning between farmers and the R&D system and that support adaptation to specific farm conditions and resource levels. • Generates technologies that support energy and water conservation.
Input distribution	• Ability to satisfy farmer demand for inputs with low transaction costs to both farmers and suppliers. • Ability to provide finance to overcome purchasing power constraints and ability to recoup loans. • Ability to produce improved/more productive inputs, e.g., fertilizers that are more efficient in yield response and respond quickly with farm input needs in response to changes in climate, disease, and other shocks and stressors. • Seed system diversity, preservation of seed diversity, encouragement of competition to maintain input sourcing options for farmers..
Farm Stage	
On-farm production	• Access to sufficient clean water to maximize crop and animal productivity and efficient use of water. • Improvements over time in soil health drawing upon improved land management knowledge for specific varied conditions and farming systems in SSA. • Equitable access to inputs and practices necessary for productivity-enhancing technical innovation. • Yield and productivity growth on existing land; minimal loss of forestland, grasslands, and biodiversity. • Access to risk-reducing options including affordable insurance and a minimum social safety net. • Incentives/set aside to maintain/preserve biodiversity and forests, grassland, undisturbed environments, ecosystems services provided by forests, undisturbed lands. • Security of tenure for members of local communities. • Ability of system to shift land use between willing buyers/sellers with minimal transaction costs.

Stage of agri-food systems	Characteristics of resilience and sustainability
Downstream stages	
Aggregation of production from farms and wholesaling	• Capable of flexibly scaling-up transport and financing capacity to respond to variations in marketed farm output. • Capacity to efficiently reach farmers in remote areas. • Ability to release product to the local market in times of excess demand through efficient combinations of imports and stocks. • Absence of monopolies. • Ability to anticipate and respond to system shocks and stressors.
Agro-processing	• Processing costs decline relative to consumer incomes. • Minimizes adverse side-effects on health and the environment. • Carried out with less and less non-renewable energy sources. • Ensures food safety.
Retailing	• Retailing costs decline relative to consumer incomes. • Minimizes adverse side-effects on health and the environment. • Carried out with less and less non-renewable energy sources. • Ensures food safety. • Consumers incentivized and empowered to make better choices.
Restaurants, catering, etc.	• Retailing costs decline relative to consumer incomes. • Minimizes adverse side-effects on health and the environment. • Carried out with less and less non-renewable energy sources. • Ensures food safety.
System-wide	
Resilience planning	• Information/early warning systems to allow for rapid response. • Response system designed before shocks occur.
Evidence generation and policy analysis	• Timely and frequent generation of data to provide up-to-date evidence-based policy guidance. • Capacity to produce high-quality evidence-based analysis. • Capacity to effectively guide local policy processes.
Governance	• Timely and professional decision-making. • Predictability and transparency in public policies affecting food markets and trade in particular and food systems in general. • Ability to absorb or insulate national population from global food price and production shocks. • Ability to absorb/mitigate the effects of macroeconomic shocks.

Stage of agri-food systems	Characteristics of resilience and sustainability
Skill development for labor force in agri-food systems	• Educational system flexibly adapts to changes in demands for particular skills and competencies. • Cooperation and other soft skills are considered a desirable trait in individuals and institutions and taught in the educational system.
Insurance/reinsurance	• Progress in reducing system-wide risk; reducing spatially co-variant risks. • Progress in reducing risks at each stage in the system as opposed to accepting current levels of risk and insuring against them; risks create costs that are borne somewhere in the system; a resilient food system reduces the degree of risk. • Sufficient development of insurance and reinsurance in food systems to protect actors from at least most types of shocks.

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2 Towards Resilient, Sustainable, Transformed African Food Systems: Conceptual Framework

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Key messages

1 Creating and ensuring sustainability – the capacity to preserve and grow welfare for both current and future generations – is a critical objective of economic development policy. Sustainable agrifood systems are needed to sustainably improve Africans' welfare.

2 In the two decades since 2000, most African countries have become more resilient enjoying almost 20 years of uninterrupted and sustained economic growth and improvements in material well-being. This progress was interrupted by the onset of COVID-19 in 2020, which highlighted the need for increased resilience in African development strategies.

3 Resilience and stability are needed in all system domains, economic, social, and environmental, to respond to the growing shocks and stressors that African countries are facing. Developing resilience involves ex ante (preventative and mitigation) investments and ex post (coping) programs.

4 State capacity is an important component of developing resilience and sustainability. Weak government effectiveness hinders countries' capacity to develop resilient and sustainable food systems. Progress toward achieving sustainable and resilient food systems will co-evolve with the development of state capacity.

Introduction

Development is a process of social, political, and economic transformation which results in sustained increases in welfare. This happens by transforming a rural, traditional, low-income, subsistence economy and society into an industrialized, urbanized, modern, entrepreneurial high-income economy and society – with a relatively small farming sector - through a process of capital accumulation (human, physical, and financial), institution building, and technology adoption, adaptation, and innovation.

While the dominant narrative focuses on the importance of building the modern non-agricultural economy, the role of the agricultural sector in catalyzing this transformation has been increasingly recognized. When agriculture grows, its extensive linkages with off-farm stages of the AFS and non-farm sectors expand employment and livelihoods in the rest of the economy. Agricultural productivity growth has been a major plank of the structural transformation process in almost all upper middle-income and rich countries, because sustained agricultural and rural development stimulates even faster change off the farm (Jayne et al., 2021).[4]

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4 The only exceptions are in exceedingly mineral-rich countries such as the Gulf States.

This process is rarely linear as many factors can derail or even undo progress toward a sustained transformation. Development pathways that generate major environmental and/or social costs along the way may become unsustainable and erode the welfare of future generations. Countries that have transformed and realized a high standard of material welfare have been able to adapt and sustain progress in the face of emerging threats (shocks and stressors) to sustained development. These countries have developed resilience.

African countries need resilience. The sudden onset of the global COVID-19 pandemic and ensuing economic and social disruptions are only the most recent example of how an external shock can disrupt African development processes. The COVID-19 shock has underscored the vulnerability of African economies and societies to shocks and stressors, which may originate from external or internal sources, and has highlighted the importance of resilience as a development goal unto itself.

The need for resilience within the agricultural and rural context has been widely recognized at the household and farm level. Consequently, to date, national resilience strategies have focused on stabilizing crop yields and incomes. The importance of developing the resilience of entire AFSs has been under-recognized and under-appreciated. The objective of the 2021 AASR is thus to understand the factors affecting the resilience of AFSs as a whole, the cost of lack of resilience to the sustainable development of AFSs and therefore national development goals, and to consider in broad strokes the tools at the disposal of African governments, pan-African development organizations, international development partners, and the private sector to contribute to the resilience and sustainability of African food systems.

This chapter defines key terms and lays out the conceptual framework for the report. It starts by reviewing the concept of an AFS and why it is important for agricultural, rural, and national economic development. It then discusses the concept of sustainability, why it is an important dimension of development, and why food systems need to be sustainable if they are to support African development processes in improving welfare. Sustainability requires resilience – the capacity to bounce back from a shock or maintain an upward trajectory in the face of ongoing stressors. This chapter concludes with a discussion of why now more than ever, Africa needs to focus on resilience as an objective in development strategies, and in the development of the AFS.

Agri-food systems need sustainability

As development thinking increasingly recognized the catalytic role of the agricultural and rural sectors, it also began to understand interdependence between economic activities on the farm, and those which take place off the farm, but support or depend on the activities, productivity, and resilience of farmers and the farm system. Constraints on agricultural productivity growth and transformation often originate from other parts of the national and international economy. Bottlenecks in one part (e.g., trade, transportation and logistics, and finance) can impede progress on the farm and broader rural development. Issues affecting one agricultural commodity can also affect production of other commodities (multi-market effects). Reflecting this interdependence and endogeneity, agricultural development policy is increasingly taking a systems approach, using the concept of the AFS.

AFSs are defined as *the totality of activities, people, and institutions involved in supplying a population with food and agricultural products*. The AFS encompasses the provision of farming inputs and services, production at farm level, post-farm marketing, processing, packaging, distribution, and retail, and the policy, regulatory, environmental, and broader economic environment in which these activities take place. Specific activities and actors in the AFS include:

a. *Farming*: those involved directly in producing crops, raising animals, and managing fisheries.

b. *Downstream AFS*: those engaged in post-farm value addition, e.g., assembly trading, wholesaling, storage, processing, retailing, preparation of food for sale outside the home, beverage manufacturing, etc.

c. *Upstream AFS:* those engaged in pre-farm value addition activities, e.g., farm input distribution, irrigation equipment, and farmer extension services.

As a system, the AFS serves multiple development objectives including:

- Ensuring food security – inclusiveness and nutrition;
- Raising productivity and value added throughout the value chain;
- Creating empowerment and agency – to allow individuals and household to maximize their welfare including through migration out of the AFS to other parts of the economy and society; while
- Preserving renewable resources for the use of future generations (intergenerational justice).

A systems approach explicitly recognizes the interrelationships between different stages of commodity value chains from the farm all the way to consumers' dining tables as well as multi-market and indirect effects on other parts of the economy (general equilibrium effects). It also recognizes different dimensions (domains) of the system (i.e., economic, social, and environmental) and their interactions.

A major objective of AFS development is system sustainability. Creating and insuring sustainability – *the capacity to preserve and grow welfare for both current and future generations* – is a critical objective of economic development policy. Sustainability is necessary in all key development system domains in order for welfare to be preserved (Marchese et al., 2017). Failure to achieve sustainability in any one domain can have long-term costs, slowing the development trajectory. A clear example is the subsequent costs (in terms of morbidity, mortality, and loss of productivity) of ignoring the need for environmental sustainability in planning and implementing economic development programs.

National AFSs, a subset of national economic systems, need sustainability in all domains. An *economically* sustainable AFS is characterized by productivity-led growth in output and incomes on and off the farm, and increased household food security (urban and rural areas). This requires:

a. *Well-functioning factor markets* (land, labor, capital) characterized by low transaction costs, adequate information on all sides, and absence of monopoly/monopsony power (equity of rent sharing). In the case of land, it requires rights that are secure and tradeable.

b. *Public investments in public or community goods* that enable output and productivity increases including transportation, energy and ICT infrastructure, agricultural R&D (including post-harvest techniques), and investments in education to build up the human capital needed for innovation and adaptation.

Box 2.1 Key terminology

Agri-food system (AFS): T*he totality of activities, people, and institutions involved in supplying a population with food and agricultural products.*

Sustainability: *the capacity to preserve and grow welfare for both current and future generations.*

Resilience: *the capacity to dampen the impact of, and quickly recover from, shocks and to adapt flexibly in response to shocks and stressors so as to better withstand them in the future.*

c. An *enabling environment for private investment* on and off the farm, that reduces transaction costs and risk enabling and encouraging the movement of goods and services along the value chain and the creation of new firms as well as increases in their productivity and market share.

d. Trade and other policies *which promote access to and adoption of technology* and lower the cost of importing inputs and exporting outputs thus increasing the size of the market and reducing logistics frictions.

A *socially* sustainable AFS is an inclusive, equitable, empowering system that ensures access to affordable and safe food and adequate nutrition for all and allows mobility of labor and resources within the AFS and out of it as the economy transforms itself. This requires:

a. *Voice for rural residents and political accountability* to rural and residents to ensure equitable policies which meet community needs.

b. *An effective cross-cutting public health system* including food safety regulation; health and nutrition promotion; taxation or other systems to discourage consumption of unhealthy food; publicly-funded research to develop more nutritious varieties of staple foods, etc.

c. *Social protection systems* that inclusively and effectively protect the poor and middle classes against social risks such as loss of income due to events of uncertain timing and magnitude (such as temporary or permanent disability); protect a minimum standard of living; and promote sustainable livelihood improvements.

d. Policies and programs to *promote equal employment opportunities and empowerment for disadvantaged groups.*

An *environmentally* sustainable AFS preserves and regenerates natural assets such as soil fertility, water quantity and quality, and biodiversity, and avoids the release of carbon or industrial pollutants into the atmosphere. This requires, for example:

a. *Systems of water management* for activities on and off the farm that preserve common pool resources such as lakes and aquifers and equitably distribute available water resources for use on and off the farm.

b. Energy, transportation, and production systems *less reliant on fossil fuels.*

c. *Environmental regulation of activities in all stages of the AFS* to prevent unsafe disposal of residuals (e.g., controlling fertilizer and animal waste runoff from on-farm activities, effluents from processing activities, and pollution from engines running tractors and trucks).

d. Effective *conservation policies* to retain non-renewable resources for future generations (e.g., protecting animal habitats to retain biodiversity and forest conservation).

e. Reduction of waste in production and consumption, and the reuse of resources (the circular economy).

The history of successful economic development suggests that development of the AFS undergirded the sustainable development success stories of the past 100 years (Gollin et al., 2019). Productivity-led growth on the farm driven in part by green revolution technology boosted overall GDP in Asia and Latin America through savings and multiplier effects as well as by incentivizing the growth of downstream and upstream value addition activities (Marsden, 2014). Public support for the smallholder farmer agricultural sector in East Asia enabled output and productivity growth increasing rural incomes (Studwell, 2013). Agricultural exports with increasing off-farm value added permitted the import of non-farm technology and inputs to develop export-led manufacturing sectors in China, Vietnam, and Thailand. Growth in agricultural productivity improved the nutrition and incomes of the poorest and facilitated mobility off the farm into higher-earning non-farm activities (Fuglie et al. 2020).

Sustainable system development requires state capability

AFS development requires balancing the objectives of economic, social, and environmental sustainability in a coherent policy framework. This is a complex task. It needs functional institutions (accepted legal and informal constraints on human behavior) that support the development and implementation of the policies and programs needed to support sustainable welfare gains in the AFS. Institutional change is important not only for the AFS but for national development as well. Broadberry and Wallis (2017) attribute the gains in economic well-being in Western European and North American countries during the industrial revolution to improvements in the institutions that support economic development.

Pritchett et al. (2010) labels the creation and nurturing of effective institutions the development of *state capability*. They cite four functional dimensions to state capability: (i) economic systems that support productivity growth; (ii) political processes that efficiently aggregate preferences; (iii) social systems that extend rights and opportunities equitably, and (iv) administrative systems that professionally handle complex tasks. The development of state capability progresses at a variable pace in developing countries both in terms of which of the four dimensions develops ahead of others and the overall pace of capability gain. These processes have a path dependency.

The development of state capability takes time and often requires overcoming collective action problems to create momentum for the development of administrative capacity and institutional change. Asking and expecting countries with a low level of state capacity to achieve economic, social, and environmental sustainability in their national food systems and to do so efficiently and effectively is unrealistic and, according to Pritchett et al., (2010), may lead to lack of reform or forward movement. This means that while system sustainability is an extremely desirable property, and indeed necessary for development, it is unlikely to progress in all domains at once. Because the development of state capacity is a continuous process, progress toward achieving sustainable and resilient food systems will co-evolve with the development of state capacity.

Sustainable agri-food systems in Africa support sustainable economic development

Africa needs sustainable and transformative development, including within its food systems. Africa is the poorest region with the largest share of the population in extreme poverty. Three-fourths of world's poorest countries are in Africa. In the two decades between 1980 and 2000, Africa's GDP growth per capita was slower than that of other developing regions and of most developed regions leading to a widening income gap in comparison with both other developing regions and with high-income countries. Adoption of technology has been slow in much of SSA (UNCTAD, 2018) reducing economic growth as well as the rate of return on public and private investment.

However, in the two decades since 2000, the development story for Africa has improved dramatically. In fact, this period has shown what economic policies focused on sustainability can produce in terms of per capita income growth, poverty reduction, and improvements in living standards in Africa (Jayne et al., 2021). After the previous two decades of GDP growth below population growth, from 2000, African national incomes grew at a rate well above population growth up until about 2018 when several resource-rich economies started to falter, and then in 2020, as the COVID-19 pandemic recession hit, regional income growth turned negative (Figure 2.1 and Table 2.1). Growth was enabled through a mix of external debt forgiveness, commitments to macroeconomic stability, policy changes to encourage more trade and participation in global value chains, improvements in the business enabling environment, expansion of infrastructure linking rural and urban areas, expansion in access to education and health services, and a

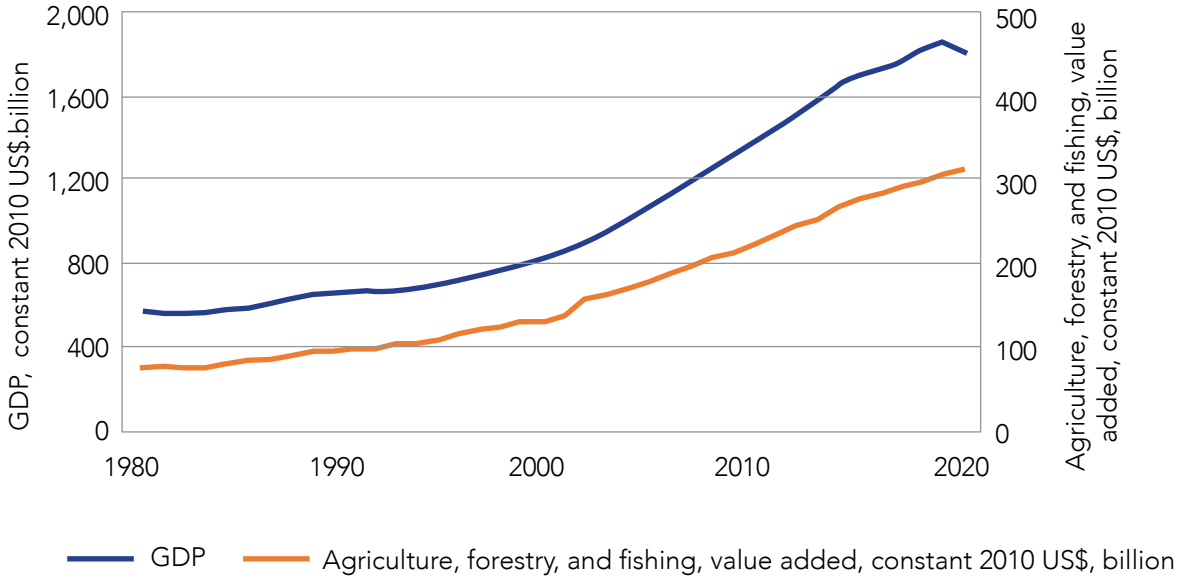

Figure 2.1: Change in GDP and Value Added in Agriculture, SSA, 1980-2020

Source: World Development Indicators, last accessed August 11, 2021

commitment to poverty reduction (Jayne et al., 2021). Private enterprise responded to the more stable macroeconomic environment and policy changes as new firms and jobs were created in the growing modern non-farm sector (Fox and Gandhi, 2021). Not surprisingly, indicators of state capability showed major gains during this period, especially in the fast-growing lower middle-income countries (LMIC) (Jayne, et al. 2021).

Sustainable AFS development supported overall economic and social progress. Overall, GDP growth tracked growth in agricultural value added throughout this period (Figure 2.2). Indeed, during 1981 to about 2005 period, agricultural sector income growth was higher than overall GDP growth showing both the role the sector played in helping countries realize the economic growth, albeit limited, of the last two decades of the 20th century, and the role of agricultural sector growth in the African economic take-off in this century. The agricultural sector was one of the only economic bright spots of the COVID-19 pandemic year of 2020.

Decadal growth rates were higher since 2000 because they were sustained. African economies and their AFSs have not always met sustainability criteria but the past two decades have shown an improvement. Until 2000, SSA agricultural

Table 2.1: SSA Decadal growth in GDP and Agricultural Value Added, 1981-2020

		1981-1990	1991-2000	2001-2010	2011-2020
Decadal growth rate	GDP	1.6	2.0	5.4	2.7
	Agricultural value added	2.6	3.0	5.5	3.4
Number of years negative	GDP	2	2	0	1
	Agricultural value added	3	1	0	0

Source: Calculated from WDI data. Note: Decadal growth calculated as: (value in year t+10 / value in year 10)^(1/10) – 1.

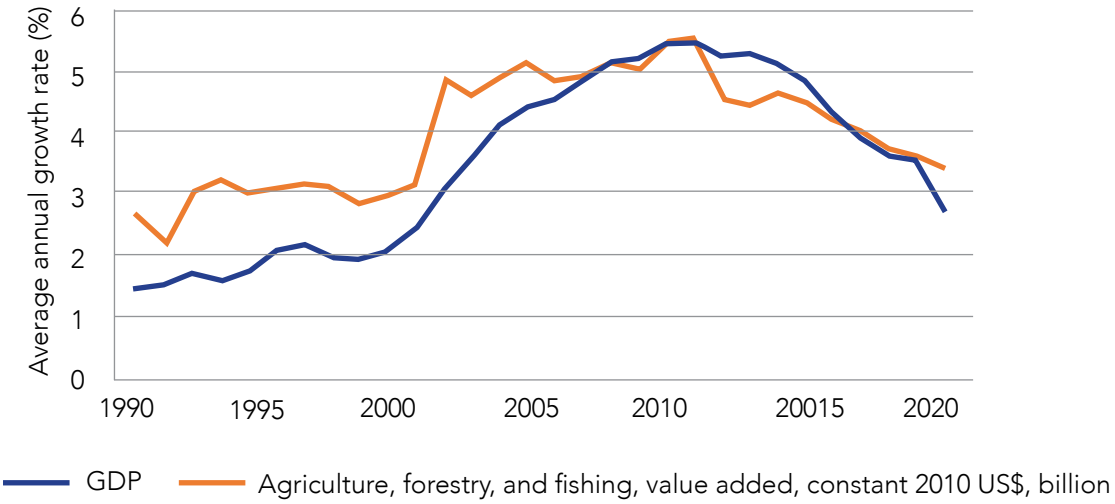

Figure 2.2: SSA Average annual growth rates (10 year moving average)

output grew slowly based on area expansion and productivity growth was limited. Growth of off-farm AFS output and productivity was slow and rural income growth was low. Since 2000, not only has on-farm output and productivity growth picked up but it has also been sustained. Value added per worker increased in both farming and off-farm AFS but value added on- and off-farm is still low compared with other countries as most exports are unprocessed and most imports are processed (Table 2.2).

Partly as a result of the rapid growth of value-added per worker between 2000 and 2019 and development of the AFS, extreme poverty rates in Africa, which had been rising and stubbornly high from 1990-1999, fell between 2000 and 2016. By 2005, the estimated poverty rate was 50 percent, below the 1990 level for the first time, and by 2015 the rate was estimated at about 40 percent (Beegle and Christiaensen, 2019). African AFSs still have not delivered food security for all but national and rural indicators of inadequate nutrition (stunting and wasting) have declined.

While economic and social sustainability has improved, African food systems are not environmentally sustainable. Mounting evidence points to yield-depressing soil degradation arising from unsustainable intensification in SSA's densely populated areas, which has lowered productivity and reduced the effectiveness of inputs especially fertilizer (Jayne et al., 2021). Carbon release through deforestation and the burning of crop residues has released greenhouse gases into the environment and led to more widespread soil erosion and water

Table 2.2: Value Added Per Worker in Farming (constant 2010 USD)

	1992	***2000***	***2019***
Latin America + Caribbean	3,827	4,456	7,486
E. Asia + Pacific	916	1,171	3,821
S. Asia	858	951	1,840
Sub-Saharan Africa	809	859	1448

Source: Derived using World Bank national accounts data and OECD National Accounts data files, and employment data from International Labour Organization, ILOSTAT. See: databasehttps://data.worldbank.org/indicator/NV.AGR.EMPL.KD?end=1992&start=1991&view=chart

pollution. Africa is already a water-challenged region with looming shortages for agricultural as well as human consumption. Transportation of agricultural products and downstream outputs of the AFS in old and poorly-maintained trucks contributes to severe air pollution in African cities. While not the largest energy-using sector on the continent, the AFS mostly depends on energy generated by burning fossil fuels, which creates more greenhouse gases. African's dependence on back-up diesel generators is especially polluting (IFC, 2019). The lags in environmental sustainability are only one indication of the complexity of the development task at hand in Africa.

Going forward in the post-COVID era, Africa must return to a sustainable development path that anticipates a doubling of the region's population between now and 2050, nationally, and within the AFS. This means not only arresting the economic decline of 2020 (projected to continue in 2021) but returning to a stable upward trajectory of the kind that brought much progress in the past 20 years. The COVID-19 pandemic has demonstrated an increasingly widely-recognized truth: that increased resilience is key to enhanced sustainability.

Resilience is key to sustainability

Sustainability implies a continued upward trajectory, albeit with possible variations in the slope of the trajectory. If the population is increasing – as it is in Africa - the components of economic development which deliver welfare must increase as well: the quantity and quality of social and economic infrastructure; household, community and national assets and wealth; technology (the capacity to produce more with a given set of inputs); opportunity sets for those entering or remaining in employment; political accountability and administrative responsiveness to an increasing diverse population; and protection and regeneration of environmental assets. Even in the best of circumstances, this is rarely possible as shocks and stressors are a part of life.

Shocks are defined as external short-term deviations from long-term trends that have substantial negative effects on people's current state of well-being, level of assets, livelihoods, and safety (Choularton et al., 2015). Natural hazards (including floods, droughts, pests) and armed conflicts are examples of shocks. On the other hand, stressors are long-term trends or pressures that undermine the stability of a system and increase vulnerability within it (Zseleczky and Yosef, 2014). Climate change, land degradation, population pressure, technological change, and protracted political instabilities are examples of stressors. While shocks can be positive (the discovery of mineral wealth, for example), most policy focus is on negative shocks (hazardous events), and stressors. Humans are psychologically highly vulnerable to negative events and trends, leading to risk aversion (Stiglitz, 1993). For those living on the edge, a negative shock can be very dangerous to their possible future upward trajectory and a stressor can remove the possible upward trajectory entirely. For this reason, resilience is key to sustainability.

Resilience *is the capacity to dampen the impact of, and quickly recover from, shocks and to adapt flexibly in response to shocks and stressors so as to better withstand them in the future*. Pictorially, a resilient system looks like Figure 2.3 below. In the system characterized by the colored line, a shock (or in systems terms, a disturbance) knocks the system off its pathway. But after a brief decline, the system recovers its function and trajectory, adapting to the new normal and learning along the way to protect itself. In the system characterized by the solid grey line, the system is unable to adapt and learn, and never recovers its function and trajectory. Welfare unambiguously declines.

Resilience has three fundamental dimensions: the ability to (1) *ex ante* dampen the impact of shocks (mitigation); (2) quickly recover from shocks and difficulties (coping); and (3) adapt to "new normal" conditions, given that some shocks may permanently alter the conditions facing a given household, community, or nation (plan for future prevention and mitigation).

Economic history and analysis have shown that resilience is key to sustainable development. Today's rich countries got there by avoiding periods

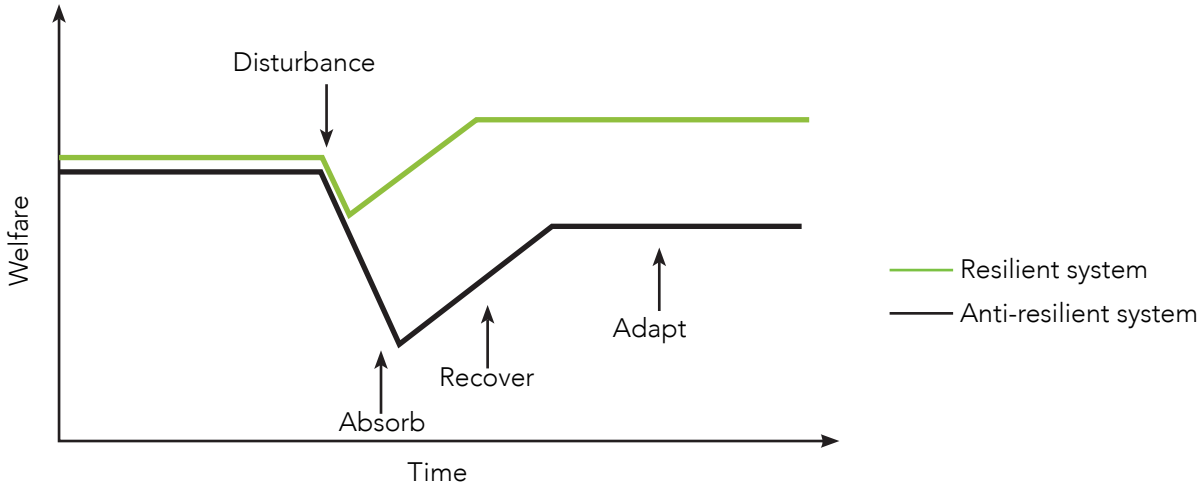

Figure 2.3: System resilience

Source: Adapted from Marchese et al., (2018)

of decline rather than through economic growth rates higher than today's developing countries (Broadberry and Wallis, 2017; Patel et al, 2021 for the most recent half-century). Increased resilience — maintaining economic growth in response to shocks and stressors —brought increased income and well-being to today's rich countries, as well as to countries about to enter the rich country club (e.g., upper middle-income countries). Countries that are not resilient suffer extended periods of decline in per capita production and income following the onset of a shock. They struggle to get back on a growth path and their net growth over an extended period is therefore lower, even if they do experience some years of rapid growth. Analysis has shown that this is exactly what prevented low-income countries from reaching the sustained high economic growth rates needed to catch up to richer countries in the 20th century. However, from about 1995, owing to a variety of factors including lower debt, better economic policies, improved terms of trade, and technological breakthroughs such as digitalization and containerization (which lowered the cost of trade), low-income countries began to experience both lower growth volatility (through reduced effects of shocks) and greater growth persistence (longer periods of sustained economic growth; see Patel et al., 2021).

Africa has gained resilience, and this has supported sustainable development

Nowhere was this increase in resilience more important than in SSA where after a period of highly volatile economic growth from 1980-2000 characterized by numerous periods of negative per capita income growth, countries became more resilient leading to almost 20 years of uninterrupted positive economic growth and improvements in material well-being (Figure 2.2 and Table 2.1). From 2000-2010 and from 2020-2019, only six countries in Africa suffered from negative economic growth. The rest maintained a steady upward path as shown in Figure 2.4, which plots the variation (in standard deviations) of growth rates during the prior ten-year period. Not surprisingly, the agricultural growth rate showed more variation, but both growth rates stabilized from 2000-2010 indicating a major increase in resilience.[5]

Like sustainability, resilience operates in the economic, social, and environmental domains. In

5 Although this chapter cannot substantively document this, external factors (fewer external shocks) may also have played a role by reducing the need for resilience. The period from 2008-2011 was certainly turbulent in the world economy and yet Africa showed surprising resilience.

the *economic domain*, as noted above, volatility has high costs for households, communities, and nations. Assets which must be consumed during downturns are not available for regaining an upward trajectory. Even worse, especially for households, the fear of losing assets or not being able to cope with negative shocks causes households and communities to reduce savings and not invest. This translates to lack of resilience and reduces opportunities for future welfare gains.

A distinguishing feature of poor people and countries is their high vulnerability to risk and their limited resilience. Livelihoods in poor countries are inherently risky as most people live off of what they can sell (either what they produced on their farm or at home, or what they bought and are reselling to others), resulting in a risky and uncertain income stream compared to a wage earner. Production is not very diversified so a major weather shock (reducing agricultural output and earnings) or an export price shock (reducing exporter earnings) affects national income reducing consumption and investment in both the public and private sectors. Income risk is often covariate (*e.g.*, bad weather affecting all incomes in a farming community), reducing possibilities for informal risk sharing or pooling. Investments in prevention, mitigation, or coping are difficult for people without savings or countries without access to capital to finance the investments. Recent research suggests that people with inadequate food, or even at risk of inadequate food, suffer cognitive declines making the type of planning needed to manage risks much harder (Mani *et al.*, 2013).

Addressing shocks requires learning and adaptation. Social system resilience, characterized by adequate agency, social capital, and voice and systems for collective action, is necessary to forge new solutions (including new distributions of power) while ensuring that the pain from the shock and gains from the rebound are shared equitably. If the pain and gain of loss, coping, and adaptation, are not shared in a manner perceived to be equitable, conflict can ensue. A clear example is the relationship between adverse weather conditions and localized violence and conflict (Burke et al., 2015). Resilient food systems promote overall economic and social stability.

Some of the most common shocks, for example, extreme weather events or industrial accidents, can cause extensive environmental damage. Environmental assets should be made resilient to regenerate and restore their essential functions. If they are not resilient, the risk of further, possibly irreparable, damage ensues. For example, the significant growth of urban populations along Africa's coasts has created increased vulnerability to global environment change that may lead to

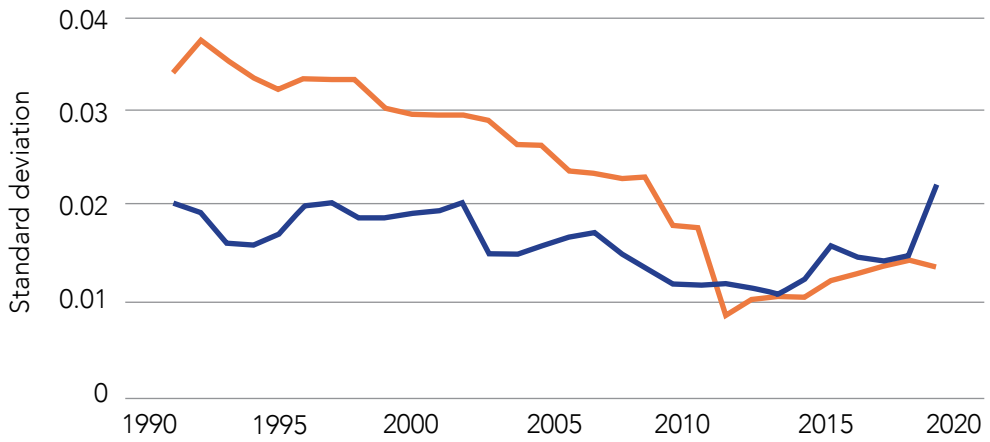

Figure 2.4: SSA Fluctuations (standard deviations) in growth rates in agricultural value added and GDP

increased coastal flooding (Parnell and Walawege, 2011), which could disrupt the continent's food systems in many ways. A resilience strategy for Africa's food systems will require anticipating where these impacts from shocks are likely to be most severe and then responding with cost-effective investments that contribute to resilience and sustainability.

Developing resilience can involve ex *ante* (preventative and mitigation) investments and *ex post* (coping) programs and projects (see Table 2.3). Examples of the latter include cash and in-kind assistance for disaster victims or farmers harmed by locust outbreak as well as projects undertaken to restore damaged wetlands. Examples of the former include agricultural R&D&E to develop drought-resistant varieties to avoid yield fluctuations, investments in grain storage to increase food security, and adapting to future climate change by hardening infrastructure to withstand extreme weather. Resilience may require *ex post* investments to adapt to "new normal" conditions. The COVID-19 global pandemic has provided important examples such investment in vaccinations to reduce the impact of the pandemic, investment in health, and safety measures taken to reassure potential tourists.

Resilience implies redundancy in all domains as they support and interact with each other to prevent, mitigate, and cope with shocks. This is a cost to households, communities, and nations; not all shocks can be prevented, mitigation is sometimes expensive, and stressors are ever-present. Resilience strategies need to balance the mix of responses to known stressors and expected shocks between prevention, mitigation, and coping according to who may be affected and the cost-effectiveness of the requisite strategies. In some cases, coping is the best response.

- In the *economic domain*, savings are needed to provide a cushion for when resources decline as well as to finance prevention and mitigation investments. Capital markets have to efficiently allocate capital to help firms adjust and adapt to shocks and stressors. Markets focused on efficiency will not deliver redundancy so public action is needed in the form of market regulation, development of insurance systems, and publicly-financed investments and reserves.
- In the *environmental domain*, potentially renewable resources cannot be used to the point that they cannot be renewed or regenerated and non-renewable resources such as biodiversity need to be maintained. This will not happen automatically. Forest reserves and conservation areas may be necessary to maintain a healthy global ecosystem and global collective action may be required to ensure that Africa is not expected to continue to bear majority of the costs associated with preserving global biodiversity and forests.
- In the *social domain*, an equitable distribution of income and good governance are keys to resiliency because the cost of risk management must be borne by all concerned in a manner perceived to be fair. Countries, communities, or households lacking in social capital may under-invest in resiliency causing higher costs later to repair system damage. Communities and regions have to cooperate and work with the national government to promote resilience and trust must be built.

Table 2.3: Typology of Risk Management Strategies

	Effect on prior shock?	Effect on future shocks?
Prevention: reduce the probability that a shock will occur	No	Yes
Mitigation: reduce the impact that a future shock might have	No	Yes
Coping: reduce the adverse effects of shock that already occurred	Yes	Possibly

State capability is needed to develop resilience strategies. While investments can be made to enhance the resilience of food systems, ultimately, such resilience entails human beings making effective decisions in response to shocks and stressors. For example, an early warning system may improve countries' capacity to anticipate an impending shock and provide more time to respond to it. However, the effectiveness and timeliness of governments' responses will determine how resilient the food system is. The state also determines whether supply shocks will be responded to via state imports, buffer stock releases, or encouraging the private sector to respond to supply/demand imbalances through market-based processes. These are all state policy decisions made on the basis of state management capacity. State capability is also needed to interact with global actors who can support national resilience to external shocks (e.g., financing for green energy, climate change adaptation investments, or vaccine production and distribution).

For social stability, resilience costs should be shared equitably across communities and social groups as well as across generations. Resilience costs can range from the cost of maintaining wetlands, the cost of dams and other infrastructure to manage rainwater, and the cost of investing in new agricultural technologies or irrigation systems, to the cost of maintaining financial reserves to preserve macroeconomic stability, hardening infrastructure to withstand extreme weather events, private insurance (a form of savings), a social safety net, which can be scaled up to cope with shocks, maintaining seed banks, or the time cost of public discussion, collective action and democracy.

Building resilience is not easy, as it involves some hard choices. It requires systems to change and evolve and choices to be made on which features to preserve and which ones to let go. In normal times, these decisions can be made incrementally. However, a shock may force a hard look at the status quo processes and outcomes. In a resilient system, adaptation will take place. New choices will be made, new trade-offs faced, and institutions strengthened in new ways and directions. State capacity will be preserved or enhanced.

African agri-food systems have resilience challenges

African AFSs are widely regarded as under-developed, with shorter and weaker connections between parts of the system (AGRA, 2019). In terms of value chains, production on the farm still accounts for a large share of value added. In eastern and southern Africa – one of the only areas in Africa where the AFS has been measured – Tschirley et al., (2015) estimate that rural households grow over 50 percent of the food that they consume, and only 30 percent (by value) of food consumed is processed. By contrast, in Asia, 60 percent of rural household food expenditures by value were for processed food reflecting a significantly larger post-harvest value addition share. In the U.S, post-harvest value addition is even larger as the US farm share of consumer food expenditures is only 5 percent. Development of off-farm value addition sectors could provide new and better jobs for Africa's growing labor force as well as produce the food demanded by African consumers at a cheaper price thus enhancing household food security and resilience.

African countries and their respective AFSs will need even more resilience in the future if a sustainable development track is to be realized. The evidence is pointing to more, not less, uncertainty in the future for Africa and the world economy with the possibility of "multiple, intersecting system shocks" caused by the continual stress of climate change (GCA, 2020, IPCC, 2021). Climate change may be Africa's biggest threat. Already, the continent has experienced major increases in dry months, extreme heat, and rainfall variability, as well as damage from heavier storms and excessive rainfall events and increased losses from plant and animal pests and disease. The best-case scenario, a two-degree Celsius rise in temperatures by 2050, is expected to reduce agricultural yields by up to 20 percent and reduce GDP growth by up to 30

percent if adaptive mitigation measures are not adopted. The potential damage is not confined to rural areas; low-lying coastal settlements, where population gains have been rapid, will also be negatively affected. Potential flooding and sea water incursion will affect whole value chains from farm to table to export. The capital investments needed to develop the downstream AFS will be more expensive owing to the need for increased resilience to extreme weather events. Urban and rural areas will compete for scarce water resources. Scenarios of higher temperatures project even more severe consequences. Meanwhile, global mobility combined with encroaching urbanization has expanded Africa's and the world's vulnerability to zoonotic diseases, raising the threat of future pandemics.

To date, African AFSs have developed by mainly relying on the expansion of cropped area but as demonstrated by rising land prices in many parts of Africa, this process has reached its limit (Jayne et al., 2021b). Another symptom of this impending threat is growing conflict between farmers and pastoralists where land and water are scarce (Chapter 3). There is a growing awareness of the need to increase the productivity of land already under cultivation and to do so in ways that are sustainable and profitable for smallholder farmers (Jayne et al., 2021b). Resilience will need to be a prominent feature of AFS development.

Weak government effectiveness hinders poor countries' capacity to develop and implement a resilience strategy. This begins with averting violence by keeping peace and protecting property. At the national level, taxes and fees must be collected and budget priorities set with resources allocated to resilience investments as part of a transformation strategy. An effective public sector response may be needed to ensure collective action and/or participation. For example, in the case of many animal or crop diseases, all farmers in an area must vaccinate their animals or spray their fields to prevent re-transmission. Mitigation investments, even if privately funded or operated, may require collective action at the community level (e.g., maintaining an irrigation or water supply system). Ensuring food security, including efficiently providing aid to victims of extreme weather events, requires an effective administrative system. Most importantly, regulatory capacity must be built so that society can trust that the measures they use to manage their own vulnerabilities will be supported by the public sector (e.g., they will not lose the savings they have in the bank, no one will be able to arbitrarily confiscate their property, and they will be able to convert their health insurance premiums into health care when needed).

In sum, African countries and their respective AFSs need resilience now more than ever to face current and potential future challenges while sustainably developing their economies, improving welfare for all. These urgent concerns are the motivation for the policy-relevant and evidence-based insights continued in this 2021 AASR. Subsequent chapters in this publication trace how resilience and sustainability can be built in the African AFS from the farm to the firm to the table. But first, the nature of the resilience challenges Africa faces and the costs of not adapting to these challenges needs to be understood. This is the focus of the next chapter.

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3 Growing impacts of shocks on Sub-Saharan Africa's agri-food system and the mitigating role of resilience

Adesoji Adelaja[1]; Justin George[1]; Marco D'errico[2]; Jennifer Hodbod[1]; Lindsey Paul Jones[3] Thomas Jayne[1]; Brian Mulenga[4]

Key Messages

1 Unless effectively addressed today, the growing incidence of conflict and climate shocks and the prevalence of health, economic and other shocks and stressors will likely slow down Africa's economic transformation and progress toward sustainable development. There is a high probability of major adverse effects of these shocks and stressors on agriculture, food security, poverty reduction, and other important economic outcome measures.

2 Strategies to build resilience can help mitigate the effects of these shocks and stressors and develop the resilience capacities of households, communities, and countries thereby contributing to the transformation agenda.

3 Policy options to build resilience include enhancing the security of supply chains, building early warning systems, developing insurance markets, protecting productive assets, and providing humanitarian relief after a natural or man-made disaster has occurred.

Background

Agriculture is a major sector in Sub-Saharan African (SSA) and is often the dominant one in many SSA economies (Jayaram et al, 2010). In 2019, agriculture alone accounted for 15 percent of the GDP of all SSA countries (World Bank, 2020) and employed 62 percent of the population (Oxford Business Group, 2021; FAO, 2020). Because a large percentage of SSA's population are farmers, most of whom are smallholders (Lowder et al., 2016), the form of economic development needed must transform agriculture to achieve higher levels of productivity, household income and value; while leveraging such success in building other economic sectors (Jayne et al., 2020), especially the agri-food value chain.

As argued in Chapter 2, this type of economic transformation is already ongoing in SSA. The remarkable progress made in key development metrics since 2000 involved simultaneous growth in agricultural production, off-farm employment and wages, non-farm industrial output, domestic and foreign investments, and overall national output (Jayne and Sanchez, 2021; Jayne et al., 2020).

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Progress in agriculture can allow skill, expertise and innovation transfer between agriculture and non-farm sectors (Jayne and Sanchez, 2021; Jayne et al., 2020). For SSA economies to enjoy long-term sustainable growth, they must continue to leverage the transformative capacity of agriculture in growing their economies.

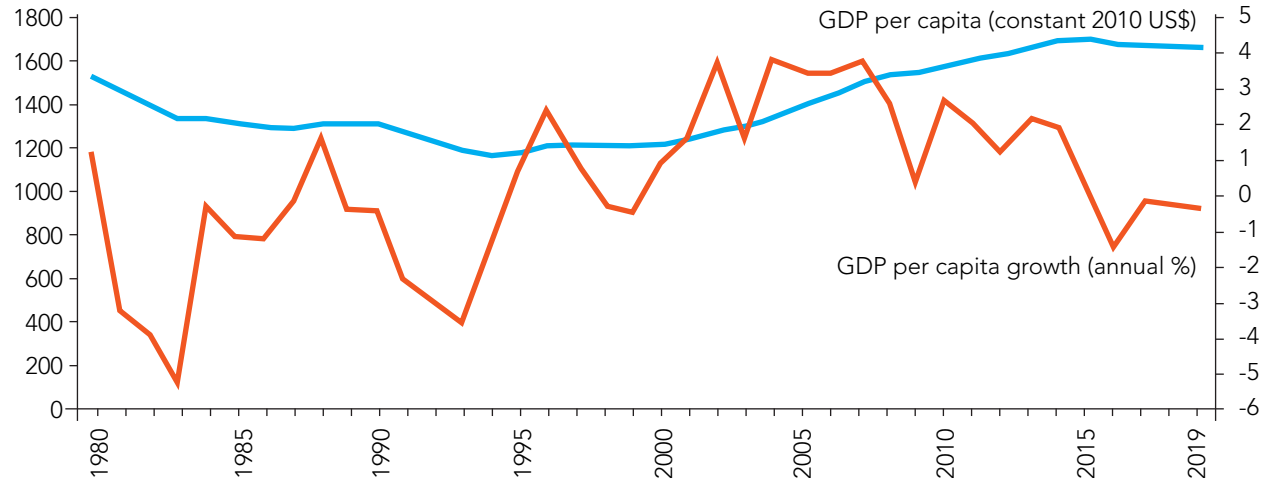
But agriculture is intrinsically linked to the broader agri-food system in the development of SSA economies (Diao, et al., 2010; Haggblade et al., 2010; Vroegindewey and Hodbod, 2018). The coherent functioning of the entire agri-food value chain is critical to the ability to transform African economies (Gómez and Ricketts, 2013; World Bank, 2013). On one hand, agriculture requires a thriving input supply sector including fertilizers, seeds, machinery, equipment, irrigation systems and farm support services, and their distribution and marketing (Webber and Labaste, 2009). But agriculture's success also requires thriving market connectivity, including simple or near-farm value addition, farm and local logistics, primary processing, secondary food processing/manufacturing, packaging and logistics, warehousing and storage, food wholesale and distribution, food retail and service, and international exports and imports. The process of economic transformation requires and involves an evolving food value chain to absorb skilled labor and benefit from efficiency gains in agriculture (Tschirley, et al., 2015). The benefits of a strong synergistic relationship between agriculture and its supply chain include improved employment, income, and nutrition (Tschirley, et al., 2015; Haggblade et al., 2010).

To be sure, we reiterate the importance of a "whole of the agri-food system" approach to economic transformation. For agriculture to be productive, progressively mature, and stable - a requirement for sustainable development – it requires a stable and reliable food value chain. On the other hand, for these food value chains to thrive and create significant employment and income for the population, they require a stable, reliable, productive, and thriving agricultural sector. Various studies predict major growth in food demand due to a growing overall population, middle class population, household incomes and urbanization (see FAO, 2018; Bjørndal et al., 2016; and Zhou and Staatz, 2016). The demand for processed foods, meats, fruits, vegetables, and similar value-added products will grow (Reardon et al., 2014), creating significant opportunities for growth in the entire value chain. With coherent strategies, the combined agri-food sector is therefore poised to drive the transformation of SSA economies.

General concerns about the sustainability of Sub-Saharan Africa growth and development

Despite the growth experiences and potential of many SSA countries, it is questionable whether such growth is sustainable. For example, the fluctuating and somewhat unstable average annual growth rate of GDP per capita (see figure 1) raises questions about future sustainability, resilience, and self-reliance. Also, recent SSA growth has involved little industrialization and somewhat more direct leap-frogging from agriculture to the service sector (Rodrik, 2015; Diao et al. 2017), raising questions about whether the broader food and agribusiness supply chains can be leveraged together to achieve growth and economic transformation in SSA. Furthermore, while many SSA countries experienced improved governance, political liberalization, fiscal/monetary policies, public expenditure on social services, domestic and foreign direct investment, and enhanced overall policy environment (Rodrik, 2014; Jayne et al, 2018), the combination of infrastructure deficits, limited institutional capacity in policy development and governance, and legacy issues from the period of colonization (Calderon and Serven, 2010) cast some doubt on whether Africa's growth could ever match that of its Asian counterparts (Collier and Gunning, 1999; Artadi and Sala i-Martin, 2003).

In addition to the above, several SSA countries face added problems resulting from their over-reliance on the oil, gas, minerals or other natural resource sectors, exposure to exchange rate fluctuations, and reliance on food exports (Erokhin and Gao,



Source: World Development Indicators, World Bank

Figure 3.1: GDP per capita vs. annual growth rate in SSA, 1980-2018 (constant USD 2010)

2020). Jayne et al. (2020) demonstrated that the pace of economic transformation in resource-rich SSA lags behind those of Lower-Middle-Income (LMI) and Upper-Middle-Income (UMI) countries. This suggests that resource wealth distracts from economic transformation.

Growing concerns about various emerging extraneous shocks and stressors

The growing incidence of various extraneous shocks and stressors (Holleman et al., 2017) since the year 2000 is an additional reason to worry about the sustainability of SSA's recent growth. These shocks and stressors emanate from a variety of sources including: climate change; natural hazards or shocks; terrorism, communal clashes, and other forms of conflict; and macro-economic and health sources. Next, we provide preliminary examples to highlight the growing importance of these shocks and stressors and the need to be proactive in avoiding them and/or mitigating their effects.

In 1990, there were 46 disaster occurrences in SSA resulting in 2,182 deaths and affecting 20.46 million people (CRED, 2021) in the region. However, by 2020, these had increased to 110 disaster occurrences resulting in 2,091 deaths and affecting 23.29 million people (CRED, 2021). Figure 2 presents graphical illustrations of the growing incidence and impacts of natural disaster occurrences alone. The relative constancy of the number of deaths due to natural disasters despite the growing number of incidents and people affected may reflect improved preparedness for natural disasters and growing resilience due to a growing number of disaster management agencies. While evidence of the economy-wide impacts of natural disasters is limited due to the geographic concentration of the affected places, these impacts cannot be totally ignored.

Figure 3.4 presents graphical illustrations of the growing incidence of armed conflicts. In 1997, there were 2,826 incidents of armed conflicts which resulted in 20,118 fatalities (ACLED, 2020; Raleigh et al, 2010). By 2020, these numbers had jumped to 23,721 incidents and 36,154 fatalities. Specifically, the incidence of violent attacks by Fulani pastoralists across SSA also increased from 1 attack in 1997 to 695 attacks in 2020 while the number of fatalities was 0 in 1997 but 2,034 in 2020 (ACLED, 2020). Farmer-herder conflicts are now major sources of angst for many agricultural communities in affected countries.

A growth trend in macro-economic shocks is not discernable for SSA. According to Rasaki and Malikane (2015), macro-economic shocks affecting SSA economies can be classified into external (foreign) and internal (domestic). Major external shocks include foreign debt exposure, exchange

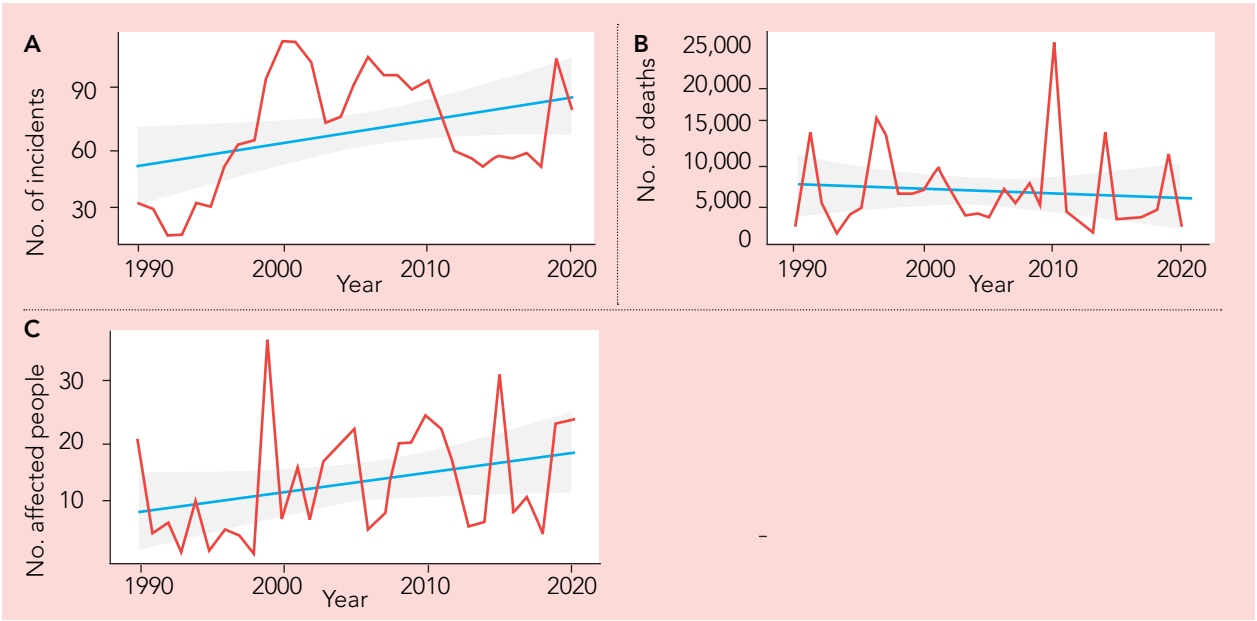
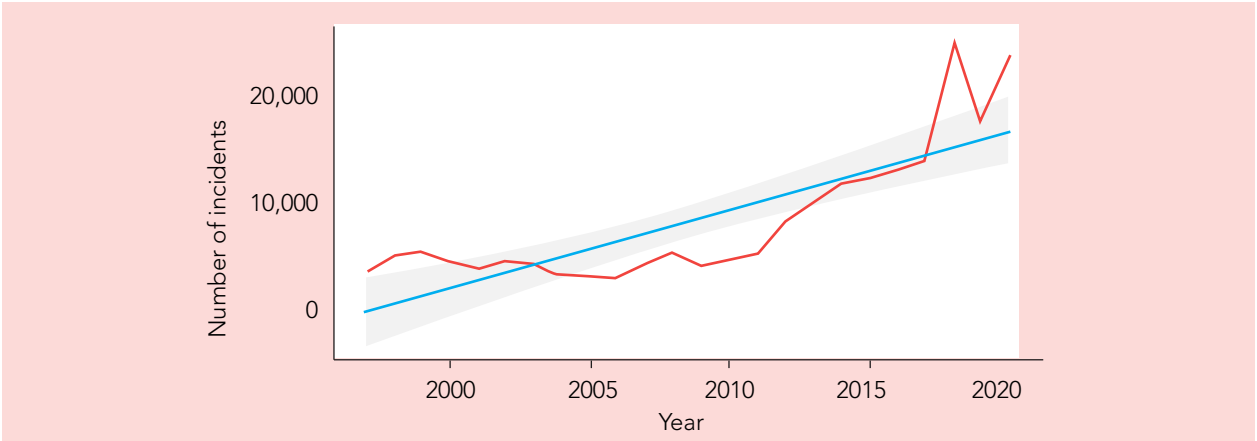


Figure 3.2: Incidence of natural disasters in SSA and their impact, 1990-2020.



Source: Armed Conflict Location and Event Database

Figure 3.3: Incidence of armed conflicts in Sub-Saharan Africa, 1997-2020.

rate fluctuations, trade shocks, foreign interest variation and major commodity prices shifts (e.g., oil and natural resources), while major internal shocks include domestic inflation and money supply shocks (Rasaki and Malikane, 2015; Houssa, Mahimont and Otrok, 2013). Evidence from Rasaki and Malikane (2015), Houssa et al., (2013), and others suggests that macro-economic shocks significantly influence not only output fluctuations in African economies, but also livelihoods, poverty, and food security.

A growth trend in health-related shocks is also not palpable. However, because health systems in SSA have been historically weak due to chronic structural, governance, and leadership problems (Gilson et al., 2017), when major health and shocks such as epidemics emerge, already-stressed systems are further perturbed. For example, in 2013, SSA experienced the onset of the Ebola virus epidemic. By May 8th, 2016, there were 28,638 confirmed cases in six countries and 11,322 deaths from Ebola in five countries (WHO, 2019) namely, Liberia (4,809 deaths), Sierra Leone (3,956 deaths), Guinea (2,543 deaths), Nigeria (8 deaths), and Mali (6 deaths). The Ebola crisis had devastating effects on many families and communities.

In short, evidence suggests that various shocks and stressors threaten the viability of households and enterprises up and down the food value chain in SSA countries (see Adelaja and George, 2019a; Adelaja and George, 2019b; George, Adelaja and Weatherspoon, 2020; George, Adelaja and Awokuse, 2020). As they destroy existing infrastructure and capacity and dislodge economies from their normal growth paths, they also have the potential to throw some economies in disarray with respect to leading economic indicators and can result in state fragility (Jayne et al., 2020). The United Nations Food and Agricultural Organization (FAO) reports that countries which did not meet their Millennium Development Goals (MDGs) are mainly those struggling with conflict, violence, and fragility (FAO et al, 2017; George, Adelaja and Weatherspoon, 2020). Similarly, the growing incidence of climate-related shocks (Hallegatte et al., 2015) exacerbates the challenges from conflict and poverty (Swinnen, 2020).

Emergence of the COVID-19 pandemic

The ongoing COVID-19 pandemic adds a whole new dimension to the growth challenges of SSA countries. As a result, many SSA economies shrank due to economic lockdown policies and resulting livelihood losses, food supply chain disruptions, and increased food insecurity (Swinnen, 2020; Thurlow, 2020; Reardon et al., 2020). McKinsey and Company, amongst others, reported major declines in agricultural export and import volumes, food retail and service operations, and associated logistics in SSA as a result of COVID-19 (Pais et al., 2020). It is too early to tell, but COVID-19 could potentially roll back some of the progress made in the last 20 years. With many national economies in stress, the capacity of governments to turn things around is constrained. Recovery will likely be long.

Growing relevance of the concept of resilience

Given the growing exposure to the shocks and stressors discussed above and their seeming unavoidability, interest in the concept of resilience in Africa's agri-food supply chain has grown in recent years. Chapter 2 above provides details on the definition, importance of and preliminary implications of resilience for the agri-food system value chain. In the context of the agri-food system, resilience implies responding to those shocks by building, a *priori*, the needed capacity to protect the viability of households and enterprises and the existing agri-food system infrastructure that they are part of. Without resilience, there is potential for the agri-food system to be severely compromised to the point where past advancements, which consumed significant resources to accomplish, are severely threatened, perhaps pushing some economies back to ground zero.

Lack of resilience translates to repeated humanitarian interventions and rebuilding. Building resilience to shocks and stressors can reduce the high human and economic costs associated with repeated humanitarian and rebuilding efforts and the associated political and public pressures. In recognition of this, agency programming around resilience has grown dramatically in the past decade. In 2018, the United States Agency for International Development (USAID) renamed the Bureau for Food Security (BFS), one of its largest bureaus, to the Bureau for Resilience and Food Security (BRFS). The importance of the concept of resilience is also growing in the design and implementation of development programs by national and international agencies.

A common guiding question in resilience discourse is 'resilience of what, to what, for whom?' (Carpenter et al., 2001; Lebel and Anderies, 2006). This approach helps bound the system under study, for example clarifying what type of food system and at what spatial, institutional, and temporal scale is of interest? It helps to determine whether one is exploring the specific resilience to a particular shock (and if so, which shock) or the general resilience to multiple shocks. It is important to acknowledge that there will be differentiated impacts of these shocks as resilience will differ for actors across the food system, and that comparison must be embedded into any analyses.

Chapter outline

The rest of this chapter is organized as follows. First, we explain the typology, incidence, geography, and political economy of specific types of shocks and stresses in SSA, including the ongoing COVID-19 pandemic. Second, we summarize the effects of these shocks and stresses on the agri-food supply chain. Third, we review evidence from extant literature on the concept of resilience and its implications for the agri-food supply chain as a shock and stress mitigator. Fourth, we briefly outline five case studies of different types of shock and ongoing efforts of governments, NGOs, and the private sector to address these shocks and restore the vibrancy of the agri-food system in the face of these shocks and stresses. We conclude by briefly highlighting some of the instruments that can be used to build resilience at various scales in the agri-food system, given that most policy instruments to deal with shocks are at the national level.

Typology, geography and the trajectory of shocks and stressors

In this section, as a prelude to reviewing the impacts of shocks and stressors on the agri-food system and the role of resilience in mitigating such impacts, we explain the nature, prevalence and geography of these shocks and stresses, as well as trends over time.

Shocks are defined as "external short-term deviations from long-term trends that have substantial negative effects on people's current state of well-being, level of assets, livelihoods and safety" (Choularton et al., 2015). Natural hazards (including floods, droughts, pests), armed conflicts, pandemics and macro-economic volatility are examples of shocks. On the other hand, stressors are "long-term trends or pressures that undermine the stability of a system and increase vulnerability within it (Zseleczky and Yosef, 2014). Climate change, land degradation, population pressure, and protracted political instabilities are examples of stressors. Some of the key elements of a resilience framework are the measurement of shocks and stressors, the estimation of their impacts, the identification of resilience factors, and the estimation of their mitigating impacts.

Shocks and stressors can be divided into 'man-made' (e.g., armed conflicts, technological disasters), 'natural' (e.g., droughts, earthquakes) and 'other' (e.g., macro-economic shocks) based on their sources (Sagara, 2018). Based on the onset and duration of the event, shocks can also be classified into acute (sudden onset, generally short duration e.g., flood, price volatility) and chronic (slow onset, generally long duration e.g., civil wars, drought) (Shimizu and Clark, 2015). Shocks and stressors can also be classified as covariate and idiosyncratic based on the number of people affected by the event. Covariate shocks directly impact a large number of people (e.g., epidemics, pest infestation), while idiosyncratic shocks affect specific individuals or households within a community (e.g., death of a family member, loss of a job) (Sagara, 2018). Shocks, which are growing in severity over time, will be the prime focus of the rest of this section of Chapter 3. The policy implications of other shocks will also be addressed.

Armed conflicts

In recent years, in terms of fatalities, injuries, and frequency, armed conflicts are the single most rapidly-growing shock in SSA. An armed conflict is defined as a contested incompatibility regarding a government and/or territory where there is use of armed force between two parties, at least one of which is the government of a state (Gleditsch et al., 2002). The number of armed conflicts has increased dramatically since the year 2000 (see Figure 3). In 2019, there were at least 15 countries facing active armed conflicts in SSA, out of which eight were low-intensity subnational armed conflicts, and seven were high-intensity armed conflicts (PRIO, 2021). Countries with ongoing high-intensity conflicts include Nigeria, Somalia, the Democratic Republic of Congo (DRC), Burkina Faso, Mali, South Sudan, and Cameroon. Ethiopia has also experienced conflicts but sufficient relevant data is not currently available.

As shown in Table 1, 184,849 armed conflict incidents in SSA between 1997 and 2020 resulted in 666,107 fatalities. The conflict dynamics and ethnic and religious tensions were often rooted in a combination of state weakness, corruption, ineffective delivery of basic services, competition over natural resources, inequality, and a sense of marginalization. For instance, previous experiences with colonial and imperial war are correlated with a greater prevalence of postcolonial conflict (Fearon and Laitlin, 2013). This is attributed to lower levels of trust, a stronger sense of ethnic identity, a weaker sense of national identity and subsequent patterns of development across countries with historical conflict (Fearon and Laitlin, 2013; Besley and Reynal-Querol, 2014).

Natural hazards

In SSA, natural hazards constitute another major source of shocks in terms of frequency, lethality, and geographical reach. As shown in Table 2, between 1991 and 2020, SSA faced 2,108 natural hazards, which killed 191,638 people and affected around 418.56 million people (CRED, 2021). The most frequent natural hazard was flood (852 incidents), followed by epidemic (722), storm (203) and drought (186). However, droughts affected the greatest number of people (324 million), while floods (63 million), storm (15 million) and epidemic (13 million). While the number of deaths from natural hazards has trended downward due to greater preparedness and the capacity to cope by emergency management agencies, the number of incidents and affected people increased dramatically since the year 2000.

The regional breakdown of the natural hazards is also interesting. From1990-2020, eastern Africa experienced the highest number of natural hazards (954), followed by western Africa (614), middle Africa (574) and southern Africa (166) (see table 2) (CRED, 2021). According to the World Risk Report 2020, an annual study published by the World Economic Forum (WEF), the African continent bears the second-highest risk of all continents in terms of vulnerability towards disasters (WEF, 2020). According to the study, a total of 11 of the 15 most vulnerable countries in the world are located in Africa. The Central African Republic (CAR) is the most vulnerable country in the world, followed by Chad, DRC, Niger, and Guinea-Bissau.

Table 3.1: Armed conflicts by type, cumulative from 1997-2020.

Conflict type	No. of incidents	No. of fatalities
Violence against civilians	57,277	185,611
Battle-No change of territory	38,606	371,563
Riots/Protests	3,2691	7,399
Battles	12,716	39,266
Protests	10,178	293
Strategic development	7,109	306
Riots	6,557	2,537
Remote violence	6,006	27,296
Strategic development	3,788	95
Explosions/Remote violence	2,844	7,834
Non-violent	2,456	2,001
Battle-Government	2,192	11,107
Battle-Non-state	1,674	10,778
Headquarters	755	21
Total	184,849	666,107

Source: Armed Conflict Location and Event Database

Macro-economic shocks

It is hard to document a growing trend in the incidence of macro-economic shocks. In contrast to conflict and climate-related shocks and stressors, macro-economic shocks tend to be more diverse in type and sources and more difficult to characterize across countries due to varying degrees of exposure, vulnerability, and capacity to avoid the shocks or mitigate their effects. These shocks are also somewhat more endogenous to national strategies, policies, and choices. Since many countries are often affected simultaneously or have experienced these shocks in the past, they seem to have greater avoidance and coping capacities vis-à-vis for other shocks. However, these shocks can still have significant and far-reaching effects (that is, can simultaneously affect more people, places, and sectors). For example, commodity-super cycles, which may affect many countries, as well as terms-of-trade shocks can have broad implications for the economy in terms of higher food prices, greater unemployment, greater poverty, greater food insecurity and increased conflicts. These impacts may further affect the whole economy, including the agri-food system (Dorosh, 2009; Headey, 2011) there is little doubt that when food prices peaked in June of 2008, they soared well above the new equilibrium price. Numerous arguments have been proposed to explain overshooting, including financial speculation, depreciation of the United States dollar (USD). Mineral-exporting countries are particularly exposed to macro-economic instability resulting from commodity price and terms-of-trade shocks.

We provide a brief explanation of the inter-connectivity of macro-economic shocks with a focus on the implication for food systems. For example, by finding that food imports play a role in mitigating food insecurity, Dorosh (2016) suggests that exchange rate volatility, food trade shocks and commodity price shocks can worsen food insecurity. Chapoto and Jayne (2009) further show that protectionist trade policies have destabilizing effects on food prices and market predictability while Porteous (2017) shows that export bans drive up food prices. Gustafson (2013) shows that food inflation impacts on food security, with impacts that vary across socioeconomic groups and countries depending on their vulnerabilities. In their study of the impact of rising prices on the poor in 11 countries in East Asia and SSA, Zezza et al. (2008) suggest that due to their high food share of household income, households headed by children, females, and the elderly are the hardest hit by

Table 3.2: Natural hazards by type, cumulative from 1991-2020.

Hazard Disaster Type	No. of incidents	No. of deaths	No. of people affected (in millions)
Flood	852	18,859	62.83
Epidemic	722	142,692	12.57
Storm	203	5,089	14.84
Drought	186	21,127	323.65
Landslide	51	2,801	0.17
Earthquake	29	494	0.34
Insect infestation	23	0	2.80
Wildfire	23	204	0.06
Volcanic activity	11	206	0.30
Extreme Temperature events	6	141	1.00
Total	2,108	191,638	418.56

Source: The International Disaster Database, CRED

price shocks and that they alter their consumption patterns, sell physical assets to buy food or forego healthcare and education services as a coping mechanism to the price shocks (Mugume and Muhumuza, 2021).

In light of the above, while the food systems implications of macro-economic shocks have not been especially well-documented, there is need to consider their roles in the performance of agri-food systems and how to build resilience to macro-volatility (macro-resilience). For one thing, as macro-volatility can cause public funds to be spent poorly and can inhibit private sector investments, macro-resilience requires greater capacity to build human capital and institutions for resilience. More details on the impacts of macro-economic shocks are presented in Section 3 of this chapter.

Health-related shocks

Like macro-economic shocks, it is difficult to discern a growing trend in health-related shocks. However, they can also have far-reaching implications. Preliminary estimates by the United Nations Economic Commission for Africa (UNECA) suggest that the incidence of Ebola stressed the economies of affected countries, public revenues and spending, and public health financing while triggering reduced domestic and international traveling and labor shortages in several sectors (UNECA, 2014). Specifically, it resulted in reduced trade and transportation and travel and tourism, decreased agricultural production and incomes, weakened agricultural value chains and markets, and decreased mining activity, among other effects (Mercy Corps, 2019).

With respect to the current COVID-19 pandemic, several studies and reports have identified a wide range of pathways through which COVID-19 has affected households, communities, and the economy (Mugume and Muhumuza, 2021; World Bank Group, 2021). These include: lost jobs due to economic lockdown policies and increased concern about the health implications of COVID-19; the closure of many businesses, especially food retail stores, resulting in income losses; the shutdown of schools and the resulting shut-in of children in poor households; reduced government revenues and expenditures; reduced mobility, logistics and trade; disconnect between urban and rural areas resulting in increased food costs in the former; and the shutdown of markets. Preliminary analyses of the impact of the pandemic in the SSA region also reveal disrupted access to agricultural inputs (including labor), extension and advisory services, and output markets for many farmers, fisherfolk and pastoralists (FAO, 2020). A range of disruptions associated with necessary pandemic and health countermeasures are also having significant - and increasing - impacts on food production and supply. Finally, the pandemic may contribute to political instability and fuel conflict between communities, for example, over natural resources like water, grazing land, or migration routes, thus further disrupting agricultural production and markets. Under certain conditions, COVID-19 may exacerbate existing drivers of conflict and undermine social and economic resilience. Conflict and violence are among the main drivers of food insecurity globally.

With respect to the impacts of the recent pandemic on the food sector, according to initial UN estimates, at a minimum, an additional 83 million people, and possibly as many as 132 million, were estimated to go hungry in 2020 as a result of the economic recession it triggered (FAO, 2020). In SSA, 14 countries are at high risk of or are already experiencing significant food security deteriorations, including rising numbers of people pushed into acute hunger (Food Security Information Network – FSIN, 2021). Declining employment and wages mean that households have less money to spend on food and household goods and that overseas workers have to send more money to their relatives in food insecure countries as remittances (FSIN, 2021). More details on the impacts of health-related shocks are also presented in Section 3 later in this chapter.

Resilience to shocks and stressors

The growing frequency of some of these shocks and the possible limited capacity of SSA countries to deal with them on their own make the resilience

framework or strategy highly relevant. We expect that systems' actors have the capacity to learn from past experiences, combine accumulated knowledge, leverage their assets, and build their capacities to deal with new shocks as they emerge. We can therefore expect resilience-building to be an endogenous capacity that can be built by individuals, communities, and states, with the aid of states. Specifically, food systems reflect the goals and preferences of their decision-makers and their learning, but also reflect any limitations of the current (economic and social) environment (Darnhofer et al., 2011), which influences institutions, governance, political stability, legacy issues, economic diversification, demographic dividend, education, health, ethnic cohesion, poverty, and wealth. Historical factors are critical in explaining the resilience/ability of systems to respond to shocks. The importance of history in explaining economic development is well-established (Dopfer, 2005; Nelson and Winter, 1982).

The literature is influenced by the concept of path dependence - the characteristics of a system or process whose outcomes evolve as a consequence of its own history (Martin and Sunley, 2006). Path dependence can mean some regional economies become locked into certain development paths and lose flexibility, while others are able to 'reinvent' themselves through successive new paths or phases of development (Martin and Sunley, 2006). As evolutionary systems, historical, and geographical context create path dependence that influences the current structure and performance of local, regional, and global food systems, often summarized through a political economy framing. As complex systems, the structure and function then influence the form of capacities of a system that support resilience (i.e., learning, social networks, assets). The concept of resilience is highly complicated and nuanced. It is important to unpack what it means for the agri-food system and how it can be developed.

There are limited examples which explicitly apply the framing of path dependence to African food systems (Bourblanc et al., 2017) but it is more common to acknowledge the importance of elements of the resulting political economy in their sustainability and resilience, particularly when discussing the introduction of European or American ideas to African food systems (Shilomboleni, 2020). The outcome of this framing is that resilience analyses require a place-based and context-specific approach based in the political economy of food systems in different locations and at different scales. This should be borne in mind as literature studying the impact of the same shock (e.g., COVID-19) is established, as preliminary analyses are already showing differentiated impacts across rural and urban food systems, on different food systems, and actors within food systems (Béné, 2020; Gillian Pais et al., 2020; Moseley and Battersby, 2020; Workie et al., 2020).

Understanding the typology of shocks and the specific characteristics of each type to then analyze how countries and systems historically dealt with them is fundamental to defining and measuring resilience. A very good example is the unique nature of resilience to armed conflicts - the single most important shock in the context of Africa's food systems. For man-made shocks such as armed conflicts, the prevention of the event itself comes under the purview of resilience. In conflict contexts, a resilient community is one that can successfully resist pressure to resort to violence as it resolves or manages long-lasting socio-economic or ethnic tensions. This suggests that humanitarian assistance missions during and post-shock are the first stage of redevelopment efforts and are crucial in preventing future shocks. Systematic coordination of both domestic and international security as well as development agencies is fundamental in conflict prevention, management, and post-conflict resettlement and rehabilitation efforts in post-conflict zones.

The impacts of shocks and stressors on agriculture and the food value chain

Understanding the macro and micro level impacts of shocks and stressors on livelihoods in affected areas is fundamental to designing and

implementing resilience building strategies and programs. Shocks and stresses, whether natural or man-made, disproportionately affect developing countries, which often lack the institutional structures and resistant mechanisms to respond to their impacts (Balassa, 1989). These countries also tend to rely primarily on agriculture as their main economic activity. In this section of Chapter 3, we focus on the impacts of shocks on agriculture and related activities in SSA and developing countries in general, drawing excerpts from extant empirical literature. We also examine the limited evidence on the impacts of macro-economic shocks on the agri-food value chain.

Natural hazards are one of the most important shocks in terms of their negative impacts on agriculture. Studies have shown that these disasters have significant direct economic consequences for affected countries, especially for low income and less-diversified economies, as they are not able to cope with negative production shocks (Cuaresma, 2010; Wouter Botzen et al., 2019). The agricultural sector bears a heavy burden in terms of exposure because of its heavy reliance on weather and climate for production and productivity. From 2008 to 2018, agriculture including crops, livestock, forestry, fisheries, and aquaculture, absorbed 26 percent of the overall impact of medium- to large-scale disasters in low- and lower-middle-income countries (FAO, 2021). This translates to approximately USD 108.5 billion in economic losses related to agriculture, with USD 30 billion for Africa alone. Although the numbers seem meager, they represent a significant share of overall potential production, reaching up to 39 percent in Niger and 41 percent in Ethiopia and Mali (FAO, 2021). Drought remains by far the most harmful disaster for livestock, causing 86 percent of total damage and loss in the sector. The largest impact over the past decade is attributed to the 2008–2011 drought in Kenya and in the overall Horn of Africa region (Demombynes and Kiringai, 2011).

Shocks due to armed conflicts and political instability also negatively impact economic activities in affected countries. In countries affected by high-intensity conflicts, GDP decreased by 8.4 percentage points per year on average, while the decline averaged 1.2 percentage points in countries with less intense conflicts (FAO et al., 2017; Holleman et al., 2017). In SSA, annual economic growth in countries experiencing conflicts is about 3 percentage points lower, and the cumulative impact on per capita GDP increases over time (Fang et al., 2020). The impacts on agriculture and food security are also palpable.

Micro-level impacts of shocks are also well documented in the literature. At household and farm levels, the post-shock impacts of natural hazards on rural livelihoods include the depletion of farm income and consumption (Mottaleb et al., 2013), reduction in food and nutritional security (Ainehvand et al., 2019; Doocy et al., 2013) and destruction of local agricultural input markets (Goeldner Byrne et al., 2013; Longley et al., 2002). Natural hazards also inflict significant damage and losses to croplands, physical infrastructure, polyhouses, livestock shelters, agricultural tools, equipment, and machinery (Chapagain and Raizada, 2017; FAO, 2006; Israel et al., 2012; Rapsomanikis, 2015).

Shocks due to armed conflicts and political instability also negatively impact agriculture and food security at the micro level. Empirical evidence from affected countries also suggests that armed conflicts adversely impact on agricultural production (Adelaja and George, 2019a), outputs of specific crops (Adelaja and George, 2019a), land use choices (Adelaja and George, 2019b), cropping practices (Bozzoli and Brück, 2009), food security (George et al., 2019), nutritional status of children (Akresh et al., 2011, 2012; Minoiu and Shemyakina, 2014), calorie intake (D'Souza and Jolliffe, 2013), labor market outcomes (Kondylis, 2010) and farmers' investments choices (Arias et al., 2018). In areas where armed conflicts are persistent, livelihoods, food systems, and resilience are significantly undermined creating a vicious cycle which results in extended and severe crises. For example, in 2016, over 2 billion of the world's population lived in countries affected by conflict, fragility and protracted crises (FAO et al.

2017) with the prevalence of undernourishment in the 46 low and middle-income countries affected by conflict is, on average, between 1.4 and 4.4 percentage points higher than all other countries in the same income categories (Holleman et al. 2017). These numbers, coupled with the fact that 11 out of 19 countries with a protracted crisis situation are located in Africa, show that present and future challenges to the region's agriculture sector cannot be addressed without focusing on threats posed by social and political unrest.

The indirect impacts of shocks via forced displacement cannot be underestimated. Shocks which threaten human survival also provide strong motivations for migration, both voluntary and forced. Such shocks can emanate from unrest (e.g., civil wars, coup d'état and terrorism), climate change (e.g., drought, desertification, and drying of critical water resources), natural hazards (e.g., floods, earthquakes, and tornados) and severe economic downturn (e.g., commodity price shocks, recessions, loss of critical industries, and currency devaluations). As of 2019, there were a total of 50.73 million internally displaced persons (IDPs) worldwide, twice the number for 2009 and eight times the number for 2005 (IDMC, 2020). In 2019, of the 33.41 million new IDPs, 24.85 million (74 percent) were displaced due to natural hazards while 8.55 million (26 percent) were displaced due to armed conflicts. SSA continues to be the region most affected by conflict-related displacements with the leading countries being DRC, Nigeria, Somalia, and Sudan (UNHCR, 2020). Forced migration has been found to have significant effects on employment (Esen and Binatli, 2017; Ruiz and Silva, 2015), wages (Calderón-Mejía and Ibáñez, 2016; Foged and Peri, 2016), and household income, consumption, and other measures of wellbeing (Kreibaum, 2016; Maystadt and Duranton, 2019) in both origin and destination communities. Forced displacement has also been found to have significant effects on commodity and land prices (Alix-Garcia et al., 2018; Balkan and Tumen, 2016; Depetris-Chauvin and Santos, 2018).

Aggregate statistics from 1990 to 2020 suggest that health-related shocks have significant impacts. During that period, a total of 12.56 million people were affected by epidemics in SSA. This resulted in 142,000 deaths and 612,000 injuries and disabilities (CRED, 2020). The top five countries in terms of the affected population were countries in East and Southern Africa namely Kenya, Burundi, DRC, Zimbabwe, and Mozambique, in that order. The top five in terms of deaths were Nigeria, DRC, Burkina Faso, Niger, and Tanzania, in that order. In terms of distribution by disease, the top five health shocks by cause of death were Cholera, Ebola, Meningococcal disease, Measles, and Cerebral Spinal Disease.

As mentioned above, macro-economic shocks can also have significant and far-reaching effects. For example, the food price hike of 2007-2008 has been alleged to have created some impetus for the Arab Spring, which led to the dismantling of several resource-rich Middle East and North African (MENA) governments, which were previously thought to be somewhat resilient to political instability (see, for example, Eltony, 2014). On the food security side, evidence suggests that rising cereal prices in Ethiopia were associated with a decline in the number of meals per day for households (Julia et al, 2015) and that high food prices exacerbate food insecurity in developing countries (Rosen and Shapouri, 2008). With respect to political stability, evidence further suggests that rising food prices contribute to riots (Bellemare, 2015), fluctuations in food prices affect the incidence of domestic terrorism (Piazza, 2013), and reduced food access is associated with greater incidence of terrorism (Adelaja et al, 2018). Given the central role of the food value chain in the connection between agriculture and overall economic performance, adverse effects of macro-economic shocks on the overall agri-food system can be expected.

Agri-food system impacts

The impact of shocks on the broader food value chain depends on the nature of the value chain and its susceptibility to the particular shock. In the case of conflict-related shocks, the direct impacts are often in rural areas and broader value chain impacts tend to arise from relative imbalances between

supply and demand. By creating disruptions in production, forcing the migration of farmers and consuming households, affecting critical infrastructure for agriculture and food logistics, and destroying the market for agricultural and food products, conflicts such as the Boko Haram (BH) insurgency and farmer-herder conflicts tend to result in higher food prices, low disposable income, reduced demand for farm inputs, greater unemployment within the food value chain, and the closure of some post-harvest enterprises. On the other hand, the influx of humanitarian support can increase the patronage of suppliers of relief materials. As pointed out by George and Adelaja (2021), the impacts on the overall food value chain may depend on the extent to which humanitarian agencies source relief materials locally. This also applies to most forms of natural hazards.

COVID-19 impacts

Globally, the recent emergence of the COVID-19 pandemic has negatively impacted all sectors of the economy, including agriculture. While agriculture remains one of the more resilient sectors, negative impacts on output, distribution, and associated food security outcomes in many parts of SSA, which were already struggling with the effects of other shocks, cannot be ignored. For example, countries in SSA have reported COVID-19-related disruptions to access to agricultural inputs (seeds, fertilizer, etc.), which will have lagged effects on agricultural production in the region (Foh et al., 2020). COVID-related restrictions have also made it difficult to access agriculture extension and advisory services (FAO, 2021). There are also reports that livestock-rearing has been negatively impacted by movement restrictions, which have limited access to grazing areas and water sources (Nchanji et al., 2021). Travel restrictions and local lockdowns also limit the supply of labor, thereby negatively impacting production and processing of food, especially for labor-intensive agricultural products. Containment measures, especially restrictions to intra- and inter-country travel, have also led to lower household incomes which, combined with reduced remittances, reduce individual and household food purchasing power (FAO, 2021). Moreover, border restrictions have reduced food trade, increasing food insecurity in food-deficit countries (Nchanji and Lutomia, 2021). Countries that depend on imported supplies, such as Burundi, Djibouti, and Eritrea, and landlocked countries, including South Sudan and Uganda, are most affected (FAO, 2021).

Gender-specific impacts

Understanding the gender-specific impacts of shocks is important as men and women may experience and be able to respond to shocks differently due to a combination of biological, economic, and cultural factors. For example, women may be forced to take on a more active economic role during conflicts, primarily driven by casualties to bread-winning family members (Justino, Leone, and Salardi, 2015; Menon and Rodgers, 2011) and an increased dependency rates in the household (Justino, Cardona, Mitchell, and Müller, 2012)1. In active conflict zones, challenges associated with restricted travel and movement of affected populations might also drive gender differentials. While direct exposure to violence, checkpoints and closures, frequent curfews, and dysfunctional public transportation systems might impact men and women equally, certain factors including the incidence of sexual and gender-based violence (SGBV), disintegration of traditional family and community support systems, and other temporary conflict-specific social and cultural constraints disproportionately affect women (Justino et al., 2015, 2018). The relative incidence of such general as well as gender-specific challenges in each shock environment could thus lead to differential impacts on welfare outcomes for women.

Evidence on the gender-differentiated effects of COVID-19 pandemic are slowly emerging. Studies show that female-headed households are significantly more likely to lose income from remittances while male-headed households are significantly more likely to lose income from other sources such as savings, pensions, and investments (Josephson et al., 2021). Economic downturn due to the pandemic has led to the loss of both formal and informal sector jobs, especially

for women in developing countries, who are often considered secondary wage earners within households (O'Donnell et al., 2021). Although the agricultural sector is relatively less affected vis-à-vis manufacturing and service sectors, women are disproportionately affected compared with men (O'Donnell et al., 2021). The loss of income for wage workers, entrepreneurs, and those in the agricultural sector could also increase household poverty and food insecurity (Hirvonen et al., 2021). Since the global pandemic began, women-headed households have significantly higher prevalence of moderate and/or severe food insecurity than households headed by men (Josephson et al., 2021). Finally, in SSA where a significant proportion of women depend on agriculture for employment, women's ability to make independent choices is also at risk as a result of the pandemic.

Roles of resilience factors in mitigating adverse shock effects

In the past two decades, the issue of resilience has risen to prominence in academia and development practice alike. Resilience is considered a vital concept in helping to understand the nature of food system dynamics and capacities needed to safeguard food security in the face of shocks and stresses. It also serves as an important guiding framework – one that development practitioners can use as an impetus for (and indicator of) promoting sustainable food systems. The concept has prompted UN agencies, international organizations, donors, and governments to invest heavily in resilience-building interventions.

The emergence of the COVID-19 global pandemic underlines the reality that despite considerable international policy attention focused on resilience-building, developed and developing countries still face considerable challenges in safeguarding living standards in the aftermath of large shock events. Indeed, while a wealth of empirical evidence now exists on the relationships between resilience, food systems and disturbances, important research questions remain. For example: (1) do given characteristics and elements predominantly determine a household's (or system's) resilience; (2) what types of shocks reduce a household's resilience capacities the most; and (3) what strategies are most successful in averting the impacts of shock events on livelihood outcomes? Using insights from recent academic and grey literature, this section highlights the current state of knowledge on resilience dynamics in food systems and their implications for policy and practice.

Owing to its varied use across a range of different disciplines, there is limited consensus on the definition of resilience (Alexander 2013). However, resilience can broadly be described as the capacities needed to ensure that adverse shocks and stressors do not have long-lasting adverse development consequences (Constas, Hoddinott, Frankenberger, 2014). Much empirical literature on resilience as applied to food and nutrition security has focused on household-level dynamics. This is true of both early (Alinovi et al., 2008, 2010) and more recent (Cisse and Barrett, 2018; d'Errico and Pietrelli, 2018; Knippenberg and Hoddinott, 2017; Knippenberg et al., 2019; Smith and Frankenberger, 2018) empirical work. While a commitment to protecting and improving the lives of beneficiaries justifies household-level analysis, the fact that shocks and stressors affect larger aggregates and disturb higher-level functions demands an exploration of dynamics related to broader food system resilience. Understanding the overlap between food systems and resilience across scales and sectors has considerable theoretical and practical benefits.

Resilience factors

This section unpacks factors commonly associated with resilience drawing heavily on insights from an aggregated dataset of more than 50,000 households collated by D'errico et al (2021). The resilience of agri-dependent and pastoral households is driven by a range of factors including access to basic services (such as schools, health centers, water, electricity, and nearby markets) as well as the accumulation and availability of household assets. In particular, productive assets such as livestock, land, and agricultural tools and machinery play a key role in mediating the impacts of shock events.

Resilience is also mediated by institutional factors that determine access and entitlement. For example, access to land and other key assets is typically lower among women and women-headed households in many SSA countries. Findings in D'errico et al. (2021) highlight this showing that a sample of household units with higher proportions of women are associated with smaller increases in resilience capacity over time. These households also pay higher tolls in the aftermath of shock events. Koolwal et al (2019) show that a sample of Ugandan women – in particular, older and widowed women – were more likely to live in consumption-poor households. At the household level, their descriptive analysis reveals that women-headed households are more likely to experience food insecurity while a regression analysis shows that widowed and younger women household heads are more likely to suffer persistent shocks and losses compared to other women heads of household. D'errico et al. (2021) show that the primary coping strategy amongst women-headed households is the sale of assets, which is normally counterbalanced by greater access to social protection and otherwise fails to counterbalance the contraction of resilience capacity as result of larger disruption of assets and adaptive capacity.

Education is another key driver. The Uganda case study shows that women's education plays a larger role in mitigating persistent exposure to and losses from shocks compared to men's education. Women with access to quality education and entry into the labor market can use knowledge acquired to expand the portfolio of options available as income-generating activities. In recent years, many development organizations have advocated for interventions to encourage access to formal education for all, especially for girls, as a key resilience-building tool. Smith and Frankenberger (2020) find suggestive evidence in Bangladesh that the following capacities reduced the negative impact of flooding on household food security: social capital, human capital, exposure to information, asset holdings, livelihood diversity, safety nets, access to markets and services, women's empowerment, governance, and psycho-social capabilities such as aspirations and confidence to adapt.

Savings, whether at the household, community, or national level, can be critical in building resilience in the aftermath of extreme shocks. At the household level, evidence suggests that members of savings groups were able to survive extended periods of shocks without requiring access to monetary loans from microfinance institutions (Murphy et al. 2019). At the community level, intangible assets created through savings groups, such as social networks can also contribute to building resilience (Sandri et al., 2021; Weingärtner & Pichon, 2017). National savings also play an important role in resilience building. Often, foreign aid is inadequate in covering the adverse impacts of shocks. Moreover, most donor countries allocate aid based on self-interest and political motives and not necessarily recipient merit. However, in the aftermath of large recurring shocks, the effectiveness of savings may be small. In many cases, savings groups may not have enough credit to satisfy the monetary demand, largely due to members skipping payments as they could not contribute to the group during the shocks.

A key element in designing resilience-building interventions is understanding how households cope in the aftermath of shocks and stresses. While responses are largely context-specific and vary depending on the type of threat, there is a range of commonalities that can be drawn. For example, across the 50,000-household sample[5] used in D'errico et al. (2021), most resorted to reducing the quantity and/or quality of food consumed subsequent to shock events (60 percent of households). Seeking an extra job and/or increasing the time spent at work is another frequent coping strategy (37 percent) as is the sale of productive and/or non-productive assets (34 percent). In addition, a large proportion of households seek help from friends and relatives, for example by borrowing food (32 percent) and many households opt to take credit, especially to buy food (30 percent) in times of difficulties. Across all shocks – natural hazards, livelihood-related, and health

5 80% of which from Africa

shocks – reducing food consumption is the most frequently-adopted strategy used by households to cope. Furthermore, D'errico et al. (2021) observe that many households elect to increase their labor supply when natural hazards occur and are more likely to take credit in the face of health shocks – results consistent with the literature. Asking for help from friends and relatives is one of the most frequent coping strategies for all shocks analyzed, while the sale of productive and/or non-productive assets is more frequent in the face of natural hazards and health shocks.

Case study evidence from Guatemala also offers lessons for the African context about the impacts of shocks on livelihoods and resilience capacities at the household level. Namely, that (1) the occurrence of an exogenous shock such as a plant disease can have large negative effects on income; (2) those who have greater social inclusion, diversified livelihoods, and better production technology, are more capable of handling leaf rust risks; and (3) the combined effect of resilience-enhancing initiatives with genetic and agroecological interventions, are more effective in smoothing or reducing negative effects on income and well-being. Since there are two forms of capacity to adapt to shocks – those associated with fundamental human development goals (generic capacity) and those necessary for managing and reducing specific climatic threats (Eakin, Lemos and Nelson, 2014), it is crucial that African policymakers design resilience-building interventions that are context-specific and tailored to the profiles of localized shock events (Serfilippi et al 2021).

Understanding how to design interventions that effectively promote resilience is a key priority for development practitioners working across SSA and elsewhere. In most cases, interventions that serve to protect and restore sustainable livelihoods are essential to resilience-building efforts, particularly in societies that depend on farming, livestock, fishing, forests, and other natural resources. Given that agriculture remains a primary source of food and income in most African countries, especially in contexts caught up in protracted crises (FAO et al. 2017), efforts to strengthen the restoration of local food production and invest in building and strengthening resilience are critical to tackling food insecurity.

There is also growing evidence of the need to promote better integration of development assistance (such as coordinated efforts between development partners) versus isolated actions (Malik et al 2020). Data from Dolow District of South-Central Somalia covering the period between 2014 and 2017, shows that most households experienced a severe drought, which destroyed crops and affected livestock. However, the financial implications were significantly reduced as a result of the restoring packages provided by an intervention. Integrated assistance provided by WFP, UNICEF, and FAO, included greater emphasis on the reduction and management of risks (rather than singular reliance on crisis response) and enhanced investments in building productive human, natural and financial resources in households and communities. The Joint Resilience Strategy focused on providing a predictable level of assistance to those suffering from long-term destitution as well as to households that are seasonally at risk on a recurrent basis. This assistance translated into supporting people to smooth the negative effects of shocks. The JRS managed to relax the debt burden and increase the share of transfers received. This enabled households to secure their basic daily needs and to be confident that, in the event of a shock, their survival is assured. The case study also highlights how social protection (SP) mechanisms such as transfers can play an important role in contributing to household resilience.

Conflict-affected environments face particularly significant challenges in providing support for resilience. Evidence from the Gaza Strip in Palestine (Brück et al 2020) highlights two important issues with regards to the importance of health and social sectors for resilience-building in conflict-affected economies. Firstly, from medical services and education to potable water access and sanitation, the recovery and resumption of basic services is critical for household resilience capacity. This

applies both to households directly and indirectly affected by conflict. Secondly, findings from Gaza showcase the importance of labor markets in strengthening household resilience capacity. In particular, labor markets were unable to provide the income streams households needed to maintain their livelihoods. While every conflict is very context-specific, we value the validity of these findings vis-a-vis the need to support the prompt restoration of basic services and resilience capacity in general. Evidence from DRC also shows that less resilient households which report having experienced drought and associated losses are more likely to be supportive of the use of political violence. However, Uexkull et al. (2020) suggest that there is no general association between reporting drought exposure and support for violence. Together, these results highlight the importance of understanding how humanitarian response in conflict-affected areas contributes to household resilience (both in the short and long-term). This calls for closer alignment between development and humanitarian responses to conflict – fields of practice that are often viewed and coordinated separately.

Toward a resilience policy agenda for Sub-Saharan Africa countries

In addition to the myriad unique institutional and other challenges which threaten continued transformation of SSA economies, many countries have had to deal with the growing incidence of various types of shocks and stressors. Evidence suggests that these shocks and stresses have the potential to not only throw more households and communities into poverty, but to slow down the pace of economic transformation or derail it altogether in some countries. Productivity-led growth and development in agriculture is critical to continued economic transformation in Africa. The entire agri-food system is needed to ensure food security and much-needed economic transformation. The unprecedented onslaught of shocks and stressors calls for bolder strategies to protect the gains that several SSA countries have made in the past two decades. The strategy for protecting SSA countries must go beyond stepping up humanitarian assistance to policy makers considering more comprehensive strategies.

The resilience framework, which has become prominent in development policy and practice, offers opportunities to safeguard SSA's progress thus far. More specifically, nations must invest in building anticipatory, absorptive, adaptive, and transformative capacities to avoid being derailed from the positive treadmill of sustainable economic development and transformation. Strengthening the capacity of agriculture to deal with shocks and stressors is central to economic resilience-building since agriculture has proven to be a major engine of economic transformation and employs a large percentage of Africans.

Agriculture, the food value chain, and resilience-building

While evidence is still mounting on what works and what does not work in building resilience capacity, given the nature of SSA economies, raising the productivity of agriculture and leveraging its transformational capacity seems central to resilience-building. Agricultural development can expand the assets of a good percentage of the population while strengthening the resilience of the entire food value chain thereby protecting the ability to transfer wealth, skills, and entrepreneurship to other economic sectors. Agricultural development will also allow greater wealth, skills, and entrepreneurship transfer from non-agricultural sectors to agriculture. In addition, to smoothen the negative effects of shocks, countries need to expand their social protection programs and help develop the absorptive and adaptive capacities of players in the agri-food supply chain.

In our review of the evidence on the role of resilience in agriculture and food value chains, we identify some strategies for building resilience. It is noteworthy that each strategy cannot be applied to every situation. However, it is also worth noting that continued progress towards economic development in and of itself is a critical resilience strategy because it provides general adaptive capacity and allows households and communities

to build wealth, incomes, and markets that better insulate them from the range of shocks and stressors. In this respect, improving basic services such as schools, health centers, water systems, electricity assets, and local markets is an important element of a resilience-building strategy.

Other key elements of a resilience agenda

Other key elements of a resilience agenda include:

1) Enhancing the depth and breadth of productive assets such as agriculture, livestock, and land through machinery and modern inputs.

2) Expanding women's and girls' access to basic services, including education.

3) Expanding the range of employment opportunities and associated training for farmers and those in rural areas in general to allow them to have more livelihood options in the face of a shock.

4) Encouraging the development of local markets and access to price information for agricultural and rural assets during periods of significant shocks.

5) Strengthening asset protection programs and land tenure systems.

6) Advancing policies to build social capital in rural areas so as to enhance the potential for households to rely on their social networks during times of economic hardship.

7) Improving financial intermediation to allow people to cope by investing in systems that will aid their transformation during times of shocks and stressors.

8) Promote better integration of development assistance including humanitarian assistance.

9) Promote national capacities to develop and implement early warning systems that can allow countries to better anticipate and prepare for shocks and stressors.

10) Provide public education on shocks and associated coping strategies.

11) Make assistance to highly impacted people and communities more consistent and predictable.

12) Promote an environment where budgetary provisions and processes support a resilience agenda and approach rather than excessive focus on emergency assistance.

13) Increase policy attention to transformative programs in host communities of people displaced by shocks and stressors to enhance their ability to bounce back.

14) Promote the concept of building back better (BBB) where appropriate to reduce future demand for humanitarian assistance.

The impacts of shocks and stressors on the structural composition of economies in SSA countries is an understudied aspect. While agriculture is also negatively affected by most shocks, the relative impacts compared to other sectors is sometimes small. For instance, evidence suggests that armed conflicts have a higher impact on the manufacturing and service sectors than that on agriculture (Depetris Chauvin and Rohner, 2009; Vothknecht and Sumarto, 2012). The recent COVID-19 crisis has significantly accelerated inter-sectoral labor movements. In the context of SSA, evidence suggests that smallholder agriculture continues to be the main source of livelihood for households, with the proportion of households involved in agriculture increasing since the start of the pandemic (Amankwah and Gourlay, 2021). The study also suggests a rural-urban divide in the movement with more urban households transitioning to agriculture compared to their rural counterparts. This seems to suggest that the agricultural sector is more resilient to the COVID-19 pandemic than other sectors and that it offers people displaced from other sectors good opportunities to mitigate the impacts of shocks and stresses.

In the absence of specific existing studies on what works with respect to specific stressors and shocks, Table 3 summarizes major shocks and stressors to key agri-food system components, the sources of vulnerability, and possible policy options for a more granular context. As indicated in Table 3, agricultural inputs

sectors seem particularly and directly vulnerable to conflict and climate shocks. This is partly because these shocks lead to the dislocation of people in the form of IDPs, significant infrastructure damage, increased cost of transportation, and reduced government support. The redistribution of farmers across the landscape and the separation of many of them from their land, homes, and traditional markets leads to discontinuations in agriculture, idle agricultural assets, and distortions in market and production signals, which make planning, logistics, supply, and demand for inputs difficult. Also, violent non-state actors have been shown to usurp agricultural inputs in support of their operations (e.g., fertilizers as explosives and tractors as attack equipment) while floods are known to damage various forms of farm inputs. The provision of critical assets protection services to input suppliers, security support for transportation and key supply chain infrastructure, and temporary input subsidies for input suppliers and farmers seems promising as part of mitigative resilience-building strategies.

As discussed earlier, agriculture is often the primary source of income in most places affected by conflict and climate-related shocks. These shocks have significant implications for land use and, by extension, agriculture, which is typically a land-intensive sector. This therefore also negatively impacts rural areas where agriculture is often the predominant sector. Armed conflicts often result in territory capture, fatalities, injuries and IDP migration, thereby eroding the efficiencies of agricultural places. Climate-related shocks tend to render productive agricultural places less productive and less efficient for long periods of time. Locations to which IDPs relocate to do not typically readily provide vocation replacement opportunities for farm households (George & Adelaja, 2021). As shown in Table 3, resilience-building and mitigating strategies for agricultural production locations may include early warning systems for farmers and agencies providing support services, security support in rural areas that are important targets of violent non-state actors, deradicalization and counter-radicalization programs in rural places, research and development (R&D) on resilient crops and production methods, farmer relocation and resettlement assistance, timely humanitarian support to agricultural families, provision of hazard insurance, and post-crisis market redevelopment support.

Food processing and manufacturing activities in rural and urban areas require a steady flow of agricultural raw materials, connective logistics to farmers and markets for value-added products, skilled labor, and markets predictability. By dislocating farmers and players in the agri-food supply chain, conflict and climate shocks can weaken access to raw materials and markets, create imbalances in labor supply and demand, and put upward pressures on input costs. Food and raw material input costs have been shown to be higher in areas facing conflict (Awodola & Oboshi, 2015). In essence, primary food processing, especially in rural areas, is vulnerable to conflict and climate shocks as well as commodity price shocks. Commodity price shocks can create input shortages for processors and increase input costs especially for secondary processors. As shown in Table 3, resilience building strategies for food manufacturers and processors may include early warning systems for processors, early detection programs for changes in consumption patterns, protection of productive assets by the security sector, R&D on appropriate shelf-life extension, refurbishment support for facilities that have been attacked or destroyed, policies to promote the adoption of hazard insurance, and policies to improve external trade arrangements.

In addition to conflict and climate shocks, food wholesalers and distributors may also be exposed to commodity price and terms of trade shocks. For them, conflict and climate-related shocks can compromise distribution infrastructure, increase transportation costs, create imbalances in supply and demand, adversely affect communications capabilities, and create logistical challenges. Commodity price shocks can increase production costs and reduce consumer demand while terms of trade shocks can create supply limitations and labor shortages. Resilience-building strategies for food wholesalers and distributors may include:

Table 3.3: System implications of shocks and stressors by major components of the agricultural and food system: selected policy options

Key agricultural and food system component	Key shocks or stressors	Key reasons for vulnerability	Sample policy options
Agricultural Inputs	a. Conflict/ climate	a. Human dislocation (IDPs), infrastructure damage, ↑cost of transportation, ↓ government support, etc.	a. Critical assets protection, security support for transportation and input supply chain, and temporary input subsidies.
Agricultural production	a. Conflict/ climate	a. Territory capture, fatalities, injuries, and IDP migration.	a. Early warning systems, security support for rural areas, R&D on resilient crops and production methods, resettlement support, humanitarian support, hazard insurance, prost-crisis market redevelopment, etc.
Primary food/ other processing and packaging	a. Conflict/ climate b. Commodity price	a. Labor market disparities, ↑ input cost, market disruptions. B. Input shortages, diseconomies of scale, viability issues, etc.	a. Early warning systems, early detection of changes in consumption patterns, security support for rural areas, protection of productive assets, R&D on shelf-life extension, refurbishment support, hazard insurance, etc. b. Improved external trade arrangements, early warning systems, etc.
Wholesale and distribution	a. Conflict/ climate b. Commodity price c. Terms of trade	a. Infrastructure deficiencies, ↑ transportation costs, supply/demand match, ↓ communication, logistical challenges, etc. a. ↑ production cost and ↓ consumer demand. a. Supply limitations	a. Early warning systems, security support in rural areas, protection of distribution assets, etc. b. Early warning systems, economic stimulus, promotion of local food systems, etc. c. Promotion of domestic food systems reliance, industry-specific trade shocks resilience programs, etc.
Food retail and service	a. Conflict/ climate b. Pandemic/ health c. Terms of trade	a. Safety concerns and limited customer mobility. b. Safety concerns and enterprise shutdowns c. Supply limitations and labor shortages	a. Integration of food retail and service into relief efforts, etc. b. Integration of food retail and service into relief efforts, economic stimulus, etc. c. Industry-specific trade shock resilience programs.

early warning systems; security support in rural areas; protecting distribution assets for conflict and climate shocks; early warning systems; economic stimulus and promoting local food systems to mitigate commodity price shocks; and promoting domestic food systems reliance and industry-specific trade shocks resilience programs to mitigate against terms-of-trade shocks.

Food retail and service operations are more threatened by the combination of conflict and climate shocks, pandemics, epidemics, and other health shocks, and terms-of-trade shocks. Conflict and climate shocks can create safety concerns and limited customer mobility in affected areas while health shocks such as the recent Ebola and COVID-19 pandemic crises can create mass safety concerns and enterprise shut-downs, terms-of-trade shocks can create limitations in labor supply and shortages for food retail and service operations. Resilience-building strategies for food retail and service operations may include better integration of food retail and service into relief efforts and economic stimulus programs and industry-specific trade shock resilience-building programs.

Case Studies

Case Study A: Conflict in the Democratic Republic of Congo (DRC)

Drought is by far the most frequently reported shock in our survey with 45 percent reporting exposure for themselves or household members in the past twelve months in stark contrast, for example, with only 2 percent reporting exposure to floods. Using novel household survey data from two conflict-affected regions in Eastern DRC, we studied variation in the support for violence related to reported exposure to drought and resilience metrics (Uexkull et al, 2020). Using comprehensive multifaceted objective and subjective indicators of resilience, the study finds that less resilient respondents who report having experienced drought and associated losses are more likely to be supportive of the use of political violence. In contrast, the findings suggest that there is no general association between reporting drought exposure and support for violence. The findings of this article suggest that objectively, more resilient households are less likely to support political violence and thus potentially participate in violence in this context. The reported experience of a drought is associated with support for political violence for the least resilient individuals. Yet, objective resilience and, to some degree, subjective resilience dampen the estimated security effects of reporting drought shocks. The study also shows that the explanatory power of resilience goes beyond conventional measures which rely on assets or income. These findings are in line with qualitative evidence on the role of violence in North Kivu, portrayed as an opportunity for social mobility, a new identity, and livelihood in a situation of social and economic crisis.

Notwithstanding limitations (which are duly acknowledged in the paper), these findings are relevant to assessing the security implications of climate change. There is a great need to identify pathways through which climate affects conflict risks (cf. Mach et al. 2019). This study provides a nuanced and granular analysis of the effect of climate-related shocks in one of the most fragile regions globally and shows how reported natural hazard impacts are moderated by resilience. The study findings are also important for development and humanitarian policy makers supporting more resilient individuals and communities. As relates to the design of policies and programs, a key finding of this study is that a member of a resilient household is less likely to support the use of political violence. This provides encouragement for investments in enhancing resilience of rural populations by both the international community and national governments, particularly in protracted crises, with the caveat that findings from this context cannot automatically be transposed to other situations.

Case Study B: The Boko Haram (BH) Insurgency in Nigeria

In recent years, there has been a significant increase in the number of armed conflicts in Africa primarily driven by organized non-state actors. Among such actors, one of the most lethal groups is BH, a transnational terrorist organization, which ideologically places itself as a force of resistance

against Western-based cultural intrusion among Muslims in northeastern Nigeria. From 2009-2019, Boko Haram carried out more than 4,000 attacks in Africa, with human fatalities extending over 38,000. During the same period, about 70 percent of the attacks and 80 percent of casualties were in Nigeria, making it the epicenter of BH insurgency. At the height of the insurgency, the group had significant territorial control in northeastern Nigeria, where it established a parallel state by replacing traditional governance structures and law enforcement bodies. (Cooke, Sanderson, Johnson, and Hubner, 2016).

A significant majority of the area occupied by BH comprised rural areas where agriculture is the predominant industry. Although BH's stated objectives do not include the destruction of the agricultural sector and food security, their attacks directly and indirectly affected agriculture, rural households, and their livelihood activities. In the affected areas, casualties, disabilities, and injuries inflicted on farmers resulted in reduced labor supply in the agricultural sector. For people who were not directly exposed to the attacks, fears about possible exposure to future attacks and associated travelling risks discouraged movement away from home. This led to reduced application of labor in planting, weeding, harvesting, marketing, and sales and resulted in unrealized production or the idling of land. In areas where attacks were frequent and persistent, farmers were forced to flee their communities and fields leading to significant population displacement and abandonment of farms. BH insurgency has also negatively impacted fisherman and livestock producers via output shocks, inability to access markets, and increases in transportation costs. The presence of support systems, including micro-financial institutions and crop insurance agencies, which were already minimal in the northeastern region, worsened post-conflict.

Given the persistence of the BH insurgency, surviving farmers have formed their own coping strategies over time. A growing interest in sheep production is one such strategy as sheep can be grazed within the household's premises and nearby areas. Similarly, limiting agricultural activities to times of the day when the probability of BH attacks is low has also helped. Crop diversification strategies are also being implemented with the help of resilience-building programs adopted by development partners and national governments. Programs to integrate peacebuilding into assistance programs, increase access to finance, strengthen food market systems, and improve information-sharing among the local farmers have also been implemented.

That said, challenges remain in the resilience-building efforts in conflict-affected parts of Nigeria. First and foremost, Boko Haram's attacks are still ongoing making the implementation of development programs extremely difficult. Identifying and mitigating the drivers of such attacks should be a priority as part of mitigating endogenous shocks such as armed conflicts. Second, optimal use of limited available resources requires understanding that different locations within the same conflict zones may be very different with respect to their degree of exposure to the shock, and hence require more decentralized rebuilding efforts. Finally, with respect to IDPs, agricultural development programs in both host communities and post-conflict zones should be based on the characteristics and preferences of farmers who choose to stay and return respectively.

Case Study C: Locusts in East Africa

From 2019-2021, desert locusts triggered by a cyclone in the Arabian Peninsula spread south affecting food systems across East Africa (see Figure 3.4). Locust swarms directly affect food systems by destroying crops and grazing fodder thus negatively affecting the availability of food for human populations and indirectly influencing food security by escalating competition for pasture, space, and water. For context, a small ($1km^2$) size swarm (approx. 40 million locusts) can consume the equivalent amount of food that 35,000 people would eat in a day (Cressman et al., 2016). Individual farms have had their total crop destroyed in less than 24 hours; during the 2003-2005 locust outbreak in West Africa, the region recorded 100,

Figure 3.4. Locust extent in 2019-2020 (DW, 2020).

90 and 85 percent losses on cereals, legumes and pastures respectively adversely affecting more than 8 million people (UN-SPIDER, 2021). Locust outbreaks have historically created intense shocks for national and global food systems, decreasing food availability while requiring additional financial capital for pesticides, equipment, and labor. Further, recovering from the destructive impact of locust attacks puts a huge economic burden on the affected farmers and countries (Cressman et al., 2016).

During the recent crisis, it was estimated that swarms affected 5.3 million hectares with the worst impacts in five countries: Ethiopia, Kenya, Somalia, Sudan, and Yemen. A total of 35 million people were affected across these countries 20.2 million of whom in East Africa were already food insecure. The outbreak was the worst in 70 years in Kenya and the worst in 25 years in Ethiopia, Somalia, and India (ReliefWeb, 2020). Without broad-scale control, conservative estimates in 2019-2020 for the locust-related losses (including for staple crops, livestock production, and asset damages) were estimated at US$8.5 billion for countries in the wider East Africa region, Djibouti, and Yemen (ReliefWeb, 2020). In response, FAO requested $351 million for rapid response and anticipatory action, of which it received 95 percent, and was able to lead an effective response program from forecasting to responding and from short-term coordinating to preparing for the medium and longer term. Treatment involves pesticide application on the ground and from the air, with environmental trade-offs. With this funding, more than 2 million hectares of land have been treated since January 2020, saving the livelihoods and protecting the food security of 36.9 million people across the ten countries and three main livelihoods in the region namely, farming, agropastoralism, and pastoralism (FAO, 2021a).

Early response allowed rural communities to avert the loss of 4.1 million tons of cereal crops and 806.6 million liters of milk with a combined commercial value of $1.57 billion. While some marginalized groups in the region remained vulnerable and next-generation swarms are emerging in 2021, so far, the system has demonstrated resilience to this shock (FAO, 2021b).

Case Study D: Drought in Uganda

The region of Karamoja, located in the northeast of Uganda, is recognized as the least socially and economically developed part of the country. Majority of the population remains below the poverty line. It comprises seven districts: Kaabong, Abim, Kotido, Moroto, Napak, Nakapiripirit and Amudat. Historically, Karamoja has been a pastoral area, suited for livestock husbandry. Although Karamoja bears similarities to other pastoral regions in East Africa, few of its households are self-sufficient in terms of food and most rely on barter trading for much of their staple foods. The region suffers from severe environmental degradation,

poor infrastructure, lack of social services, and limited opportunities to sell agricultural products. In recent years, the region has been subject to recurrent droughts and sporadic floods possibly resulting in the erosion of the local people's resilience and coping capacities. This has led to an increased focus on the need to better understand the importance of livelihood strategies and resilience here.

Considering rainfall anomalies and self-reported drought, climatic conditions are relevant factors that affect both household resilience capacity and food security in the region. The greater amount of rainfall during the rainy season of 2016, compared to the long-run average, is positively associated with resilience capacity and food security indicators (both food consumption and Household Dietary Diversity Score (HDDS)). On the contrary, the shock of drought (again is self-reported), has a negative effect. Almost all households located in Karamoja report being affected by drought. To cope with drought, households adopt strategies with negative implications for food security and for income-generating activities in the long term. For example, one common trend across all districts in the Karamoja region is that households reduce meal sizes and quality when coping with drought. On their part, Amudat households sell more animals than usual to cope with drought while in Kotido, the consumption of wild food and seeking relief assistance are the most frequently adopted strategies. On the other hand, in Moroto, the most frequent coping strategy often entails engaging in prohibited activities such as the sale of charcoal or illegal brewing of alcohol for sale to provide an income.

The key drivers of resilience capacity - diversification of crop production, diversification of income sources, coping strategies adopted in the case of a food shortage, and education - are all part of the Adaptive Capacity (AC) pillar of resilience measured within RIMA-II (FAO 2016). Non-productive assets and agricultural assets, including land (access to land and natural resource management), also significantly contribute to the resilience capacity of households. In comparison to Abim, the most resilient district of the region, all the other districts (especially Amudat) report lower proximity to main services (specifically schools and hospitals), low stability of the main water source, and low access to improved sanitation and water. Households in Abim District show a high contribution to resilience capacity from formal transfers such as cash-for-work programmes. On the other hand, households in Amudat, Moroto and Nakapiripirit show poor access to credit services.

In terms of district heterogeneity, the drought shock had a more significant negative effect on resilience capacity in Nakapiripirit, followed by Napak, Abim and Kaabong. On the contrary, the shock does not affect resilience capacity in Amudat, Kotido and Moroto districts (see Table 3). Women-headed households located in Kaabong, Kotido, Moroto, Nakapiripirit and Napak districts are less resilient than households headed by men because they have a lower amount of assets (both productive and non-productive) compared to households headed by men.

Case Study E: Farmer-Herder Conflicts in Nigeria

For centuries, pastoralism (or transhumance) has been an important livelihood activity across Africa. Due to seasonal drought conditions and variations in grazing resource availability, nomadic herdsmen historically grazed their animals at locations far from their domains, even across national boundaries, with little resistance. Pastoral clashes have become more prevalent in recent years due to more persistent drought conditions (Butler and Gates, 2012, Maystadt and Ecker, 2014), changing weather and rainfall patterns (Lybbert et al., 2006; Maystadt and Ecker, 2014), climate change (Adano et. al., 2012), and increased desertification (George, Adelaja and Awokuse, 2020). In the case of Nigeria, growing desertification in Lake Chad, poverty in the north, and security concerns from the BH insurgency have exacerbated the pressure on Fulani herdsmen to graze further from their northern primary grazing areas into the Middlebelt and southern states for longer periods of time (George, et al., 2020). These destinations often have established agriculture, land tenure practices, and economies (George et al, 2019).

A palpable recent result of these dynamics is increased farmer-herder conflicts and more deadly violence by pastoralists. According to the Armed Conflict Location and Events Database (ACLED), the number of violent incidents increased by 2000 percent (from 74 to 1,613) between 2009 and 2018. Since 2010, eight more African countries have experienced their first episode of violence by pastoralists (ACLED, 2020). This rise in violence can be attributed to increased property rights problems (e.g., Butler and Gates, 2012), poor institutional arrangements (e.g., Adano et. al., 2012), and growing incidents of conflicts (George, Adelaja & Awokuse, 2020). With 54 percent of the incidents in Africa and 60 percent of the fatalities in 2019, Nigeria is now the epicenter of violence perpetrated by pastoralists and their associated organizations. Between 1997 and 2018, 7,983 casualties resulted from 1,082 pastoralist attack incidents in Nigeria alone. In 2018, fatalities from Fulani herdsmen attacks outnumbered those from BH. Most Fulani herdsmen are Muslims, but their victims are mostly northern and southern Nigerian Christians. With the rise of violence by the Fulani Ethnic Militia in support of its herdsmen kindred, the farmer-herder problem in Nigeria has taken on a serious religious undertone, with questions now being raised by some minority groups about the sovereignty of the nation.

In addition to growing casualties from violence by pastoralists, adverse impacts on agriculture and the food supply change have been documented in extant literature. George, Adelaja and Awokuse (2020) showed that in affected areas, agricultural production is curtailed, livestock holdings are reduced, and cattle thefts have increased as farmers flee, also resulting in a reduction in crops planted and harvested. Reprisals from Middlebelt and southern communities and greater rejection of beef raised by pastoralists have also disrupted the cattle beef supply chain thereby raising the level of angst among herdsmen. The Nigerian government's proposed cattle settlement policy has also been rejected by many states in the Middlebelt and southern Nigeria. Proposals by some southern and Middlebelt states to promote animal husbandry will likely create more discontent among Fulani herdsmen and the Fulani Ethnic Militia.

The complex farmer-herder conflict has now become a major national security threat in Nigeria. The resolution of this problem will simultaneously advance food security, agricultural development, national security, ethnic and religious harmony, and economic development while fostering greater resilience to future shocks. Given the complexity of the problem and the large number of people killed to date, the foundation of any permanent solution must be peace-building.

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4 Opportunities for Building Resilience of African Farming Systems

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Key messages

1. Continued reliance on area expansion and encroaching onto forest land and marginal lands as the main strategies for agricultural growth in Africa is neither environmentally nor socially sustainable

2. Building African farming systems' resilience to shocks and stressors for sustainable food and nutrition security and economic growth and transformation requires shifting from extensification to intensification. This should be driven by integrated management practices on farms.

3. Components for building resilience and sustainability into Africa's agricultural production systems include: efficient use of nutrients and water; improved soil health; use of high-yielding, climate stress-tolerant seeds adapted to local climate change; crop diversification; and investments in risk mitigation and management strategies.

4. Practical actions for African governments, development partners, and other stakeholders to build resilience and sustainability into Africa's agricultural production systems include:
   - provide incentives for farmers to increase adoption of management practices that increase soil nutrient and water use efficiency;
   - provide incentives that boost farmer demand for inorganic fertilizers and increase availability and uptake of organic inputs;
   - create conducive policy and regulatory environments for fertilizer businesses;
   - support fertilizer trade financing via credit guarantees and supplier credit;
   - increase funding to agricultural R&D&E;
   - create incentives for and invest in irrigation; and
   - prioritize policy actions that enhance synergies and avoid policy collisions.

Introduction

Increasing agricultural production to feed the growing world population is a key sustainability challenge and one that is most crucial for SSA where most of the expected rise in world population by 2050 will occur and where demand for cereals is projected to triple (Canning et al., 2015; van Ittersum et al. 2016). It is estimated that agricultural production will need to rise by between 60 percent and 80 percent to meet the projected rise in food demand (van Ittersum et al., 2016).

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Rising food demand in Africa can be met by any combination of the following pathways: (1) increased importation of food; (2) increased agricultural output due to expansion of area under food production; (3) reducing food waste and loss, which currently accounts for about 30 percent of agricultural output; and/or (4) producing a greater quantity of agricultural output on existing farmland, i.e., a productivity-led approach to agricultural growth. SSA achieved the highest rate of growth in agricultural production value of any region in the world since 2000, expanding by 4.3 percent per year in inflation-adjusted US dollars between 2000 and 2018, roughly double that of the prior three decades (Jayne and Sanchez, 2021). The world average over the same period was 2.7 percent per year. However, roughly 75 percent of SSA´s crop production growth came from the expansion of area under cultivation and only 25 percent from improvements in crop yield (Jayne and Sanchez, 2021). The region´s average cereal grain yield at the start of the 21st Century was about 1 t/ha (tonne per hectare), while yields averaged 3 t/ha in Latin America and South and Southeast Asia, 5 t/ha in China, and more than 10 t/ha in North America, Europe, and Japan (Sanchez, 2019). The main biophysical reason for SSA being at the bottom was the depletion of soil fertility on smallholder farms because they could not replenish the nutrients removed by harvest with enough mineral fertilizers and organic inputs (Sanchez 2002). Empirical evidence from on-farm experiments suggests that cereal yields in SSA can increase to 3 t/ha using current widely-available technologies (Sanchez, 2010: Sanchez, 2015). By 2019, SSA´s average cereal yields increased to about 1.5 t/ha, halfway to that of Latin America and South and Southeast Asia, indicating that there is scope for significant further improvements in yields.

Due to environmental concerns including biodiversity conservation and destruction of natural vegetation, continued reliance on area expansion as the main source of agricultural growth is not a viable option (FAO, 2017). In some communities, all potential farmland is already under cultivation, meaning an increasing population will further limit access to quality land for the youth, potentially triggering social conflicts (See Chapter 3, Table 1). Cropland expansion is a major cause of deforestation, which engenders climate variability by raising temperatures (Vargas Zeppetello et al., 2020). For example, in Zambia, smallholder cropland expansion accounts for about 60 percent of the 250,000 hectares of forest lost annually (Ngoma et al., 2021). Curtis et al., (2018) estimates that 92 percent of forest cover lost in Africa between 2001 and 2015 was due to agricultural expansion by smallholder farmers, compared to about 51 percent loss in forest cover at the global level during that period. With this trajectory and relative to 2010 baseline, Tilman et al (2017) estimate that an additional 430 million hectares will be cleared for food production in SSA by 2060 with dire environmental and biodiversity costs. Tilman et al. (2017) estimate that agriculture-led habitat loss is responsible for 80 percent of all threatened terrestrial birds and mammals. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) estimates that 25 percent of plants and animals assessed, or about one-million species, are threatened with extinction and that agriculture expansion is the most common form of land use change (IPBES, 2019).

Much of the agricultural system in SSA is characterized by low-input and low-technology production, rainfed production, many small and declining farm sizes, and underdeveloped infrastructure and markets (Haggblade et al., 2010; Otsuka and Larson, 2013), which interact in many ways to hamper significant yield improvement. This trend must be reversed to build resilience. The goals of feeding Africa's growing population and conserving the planet's natural resources and diverse ecosystems and the services they provide will be more effectively achieved through productivity improvements on existing farmland (Jayne and Sanchez, 2021).

Building the resilience of African farming systems (i.e., agricultural production systems) is closely associated with shifting from extensification to intensification mainly by increasing crop yields including on previously-fallowed land. Now that there is increasing land pressure and that, despite

some challenges, mineral fertilizers and credit are increasingly available, smallholder farmers are planting areas they had previously abandoned because of extremely high fertility depletion, weed infestation by *Striga* sp., and other factors. Farmers who have expanded into new high-potential areas such as much of Tanzania´s Southern Highlands must increase and maintain their crop yields.

This chapter identifies interventions that can harness opportunities for building African farming systems' resilience to shocks and stressors towards sustainably achieving food and nutrition security and economic growth and transformation. The chapter thus has two objectives: (1) to highlight the main resilience and sustainability challenges facing African farming systems, i.e., the main shocks and stressors that affect African agricultural production systems; (2) to identify opportunities for building resilience to these shocks and stressors. The materials presented in the chapter are based on review of literature and other ongoing research by the authors. Section 4.2 provides a brief discussion of the main challenges to the resilience of African farming systems, while Section 4.3, the main part of the chapter, discusses opportunities for building the resilience of African farming systems. The chapter concludes with recommendations in Section 4.4.

Challenges to sustainable and resilient African farming systems

The resilience and sustainability of African farming systems is limited by several factors. The main ones, many of which are related to farmer behaviour, include: acute land scarcity and diminishing farm sizes; the degradation of land and soils on many African farms; increasingly variable weather conditions; and persisting challenges in creating an enabling policy environment that encourages private investment in food systems. These issues are discussed in turn.

Increasing rural population and diminishing farmland sizes

Africa's rural population is projected to increase by 305 million to reach 810 million by 2050 (Headey and Jayne, 2014). A decade ago, the population density on the continent averaged 117 persons/km^2 of cropland (i.e., arable land and land under permanent crops according to FAOSTAT definition), with the average much higher at 172 persons/km^2 in areas of high density (Headey and Jayne, 2014). Approximately 74 percent of the rural population in SSA is clustered in densely populated areas operating on 20 percent of arable land that receives good rainfall (Chamberlin et al., 2014).

The projected increase in rural population poses two important challenges to agricultural and food systems on the continent. First, it implies mounting pressure on cropland and increasing land fragmentation. Second, given the land pressures, agricultural growth will have to rely on intensification as the long-term sustainable path. Yet, evidence indicates that at very high levels of population density, the positive relationship of agricultural growth with Boserupian land intensification breaks down (Josephson et al., 2014; Muyanga and Jayne, 2014). This implies that yield improvements on existing land will need to be based on sustainable intensification practices for agricultural growth.

Land degradation and poor soil health

Land degradation constitutes the loss of production capacity due to reduction in soil fertility and the loss of biodiversity (FAO, 2002). It is estimated that Africa is the second most affected by land degradation after Asia, with some 73 percent of land (or 10.5 million km^2) in dry areas degraded (Barman et al., 2013). Barbier and Hochard (2016) estimated that about 157.2 million people (or 38 percent of rural population) in SSA were living off degraded agricultural land by 2010, up from 32 percent in 2000. With rising land pressures on the continent, there is risk of accelerated degradation of existing arable agricultural land and population encroachment onto degraded lands that are unsuitable for agricultural production.

Loss of soil fertility is a major source of land degradation that has significantly affected crop yields and agricultural production in SSA. Soils in SSA have undergone nutrient depletion over the years, rendering them less fertile for agricultural

production (FAO, 2016; Morgan et al., 2019; Vanlauwe et al., 2015) and thus jeopardizing the region's food security and farm incomes. The challenge of low crop productivity was identified as a key hindrance to agricultural development and food security at the Africa Fertilizer Summit held in Abuja, Nigeria in June 2006 under the auspices of the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The key outcome of the Summit was the Abuja Declaration on Fertilizer for an African Green Revolution, to which African leaders unanimously assented. The declaration resolved to increase fertilizer use among farmers in Africa by over six-fold from about 8 kg/ha of nutrients then to a minimum of 50 kg/ha by 2015, using various interventions including subsidies (FAO, 2016; Minot and Benson, 2009; Wanzala, 2011). However, that target has largely not been achieved and it is increasingly recognized that while necessary, promoting the use of inorganic fertilizers alone is insufficient for realizing the needed sustainable agricultural productivity growth on the continent. Roughly 10 to 40 percent of smallholder fields in a wide range of countries and conditions across Africa were found to be non-responsive to inorganic fertilizer applications (Roobroeck et al., 2021). Mounting evidence indicates that smallholder resource constraints and soil fertility deficiencies need to be addressed holistically for smallholders to achieve a higher yield response to inorganic fertilizers and to increase the profitability and demand for fertilizers (Marenya and Barrett, 2009; Lal, 2006; Tittonell and Giller, 2013; Vanlauwe et al., 2015; Burke et al., 2017; Sanchez, 2019, Roobroeck et al. 2021). A more holistic approach to increasing soil fertility that includes increased mineral fertilizer use as well as other organic nutrient resources will thus result in increased efficiencies and profitability of fertilizer use in SSA. Brooks et al. (2013) contend that agriculture that can attract the youth has to be profitable, competitive, and dynamic, which are characteristics needed for agriculture to deliver growth and preserve a fragile natural resource base.

Climate change

Climate change is one of the most important challenges to the resilience of agricultural and food systems globally. This is more so in developing countries that have limited resources to mitigate the effects of climate shocks. In Africa, rising

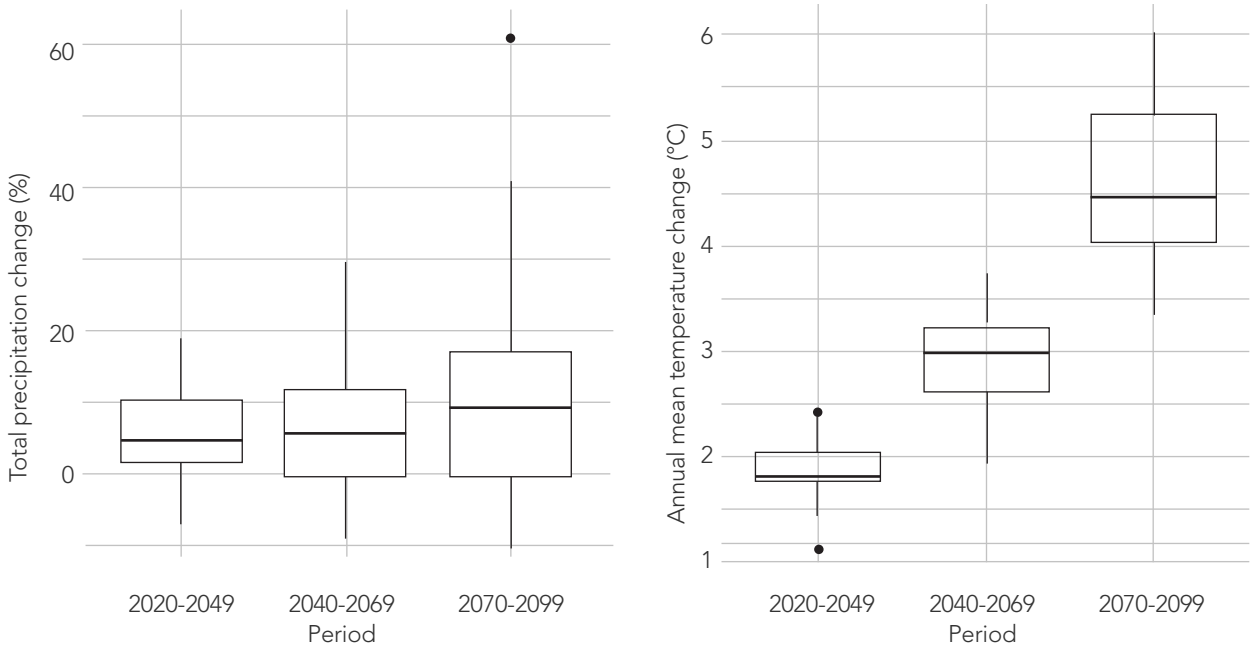

Figure 4.1: Projected changes in total annual precipitation (in percentage) and annual mean temperature (°C) for Africa
Source (Girvetz et al., 2018)

temperatures and increased rainfall variability have been observed in the past and predicted into the future with negative implications for agricultural production. Under the current emissions' trajectory, mean temperatures on the continent are expected to rise by 1.7 °C and 2.7 °C by the year 2030 and 2050, respectively (Figure 4.1). While average total annual rainfall is also projected to increase, parts of southern, western, and northern Africa are predicted to experience a decrease in rainfall by 2050 (Girvetz et al., 2018).

Changing climatic conditions will necessitate a change in cropping patterns across the continent (Girvetz et al., 2019). It is estimated that by 2050, SSA will experience a decrease in the yield of a range of staple crops, specifically for maize (22 percent); millet (17 percent); sorghum (17 percent); groundnuts (18 percent); and cassava (8 percent) (Schlenker and Lobell, 2010). These predictions paint a picture of high-level vulnerability for a large section of SSA's smallholder farmers who are dependent on rainfed agricultural production with low levels of inputs and limited access to basic services such as improved infrastructure and information (Girvetz et al., 2019).

Human and crop health pandemics – the current COVID-19 and fall armyworm

The recent outbreak of COVID-19 puts a further strain on Africa's agricultural sector, which is already under pressure from a range of other challenges. Given that about 70 percent of the African population is engaged in agriculture, the outbreak of this pandemic threatens production systems that are predominantly labor-intensive (Obayelu et al., 2021; Nchanji et al., 2021). While many smallholder farms are dependent on family labor, the enforcement of strict health directives, particularly the movement restrictions and lockdowns to curb the spread of the virus, may constrain labor mobility and availability for medium-scale farms that depend on hired external labor. The number of such farms (5 -100 hectares) is growing rapidly in some African countries, accounting for a rising share of total farmland (Jayne et al. 2016). Cropped area and yields may reduce as a consequence of a reduced workforce for agricultural production due to lockdowns and movement restrictions (Ilesanmi, 2021). Restrictions on movement have also contributed to increased food waste and losses for highly perishable agricultural products (Ilesanmi, 2021; Nchanji et al., 2021; Mulenga et al., 2020) and the situation is worsened by limited investments in cold chain systems and value addition. Other effects of COVID-19 containment measures such as transport restrictions have resulted in logistical challenges including scaling down of international shipments, which have impacted supply chains of farm inputs such as seed, pesticides, fertilizer, and other agrochemicals (Nchanji et al., 2021; Willy et al., 2020; Brenton and Chemutai, 2020). This has driven up the prices of inputs especially in countries that depend on imports (Ayanlade and Radeny, 2020).

Fall armyworm (FAW) is a polyphagous, transboundary pest that has spread across more than 100 countries in less than four years beyond its native territory in the tropical and subtropical Americas (FAO, 2020). FAW devastates crops and reduces crop yields considerably if it is not well controlled. It thus presents a significant threat to food security and the livelihoods of millions of farmers in SSA. Some of the actions taken by governments to control the spread of COVID-19 inadvertently affected the implementation of some FAW control measures. The devastating effects of COVID-19 and FAW have revealed the limited capacity of African farming systems to cope with pandemics and associated economic shocks. This suggests a need for building resilience to such shocks at the primary level of the food systems.

The context of heterogenous and changing economic and bio-physical conditions that are location-specific needs to be considered in efforts to address increasing population and diminishing farm sizes, land degradation and poor soil health, climate change, and the human and crop health pandemics affecting African agriculture. In the next section, this chapter identifies opportunities for building African farming systems' resilience to shocks and stressors towards achieving sustainable food and nutrition security and economic growth and transformation.

Building resilience of African farming systems

Improved farming practices that help restore and maintain soil heath and raise productivity are necessary for building the resilience of African farming systems. Although the exact mix of practices will differ spatially, climate-smart agriculture (CSA) – broadly defined to include all farming practices that aim to raise productivity and household income, build adaptation capacity and resilience to climate change, and reduce greenhouse gas – is considered an integral component (IPCC, 2014; Thierfelder et al., 2017). Some proven technical components of building resilience to shocks and stressors into agricultural production systems are suggested here in no order of priority: soil health, high yielding seeds adapted to the local climate change, and crop diversification. Conservation agriculture (CA) is presented as a controversial practice for smallholder farmers. Two other important ones, digital information and an enabling policy environment, are covered in other chapters.

Soil health

The health of soils on smallholder farms in SSA can be restored or, if already good, maintained by keeping a vegetative cover over the soil throughout the year, appropriate and timely use of mineral fertilizers and organic inputs, returning crop residues to the soil, and use of conservation practices.

Year-round soil cover

Soil cover protects the soil from highly erosive rains thereby minimizing runoff and erosion. Planting agroforestry-improved fallows or cover crops intercropped with the main crop during the rainy season provides cover to protect soils, recycle nutrients from the subsoil as the root system grows deep, and, if they are legumes, they can fix a considerable amount of nitrogen during the dry season, which is utilized by the subsequent rainy season crop (Buckles et al.,1998; Kwesiga et al., 2003; Sileshi et al, 2008; Akinnifesi et al, 2007). Agroforestry-based investments produce long-term effects (Sanchez, 2019). As such, financial incentives such as subsidies for their use in combination with mineral fertilizers and clear and secure property rights would facilitate this type of investment. Long season shrubby grain legumes such as pigeon pea that are in the field for three quarters of each year to maturity and with capacity for vegetative regrowth after cutting near ground level (ratooning) are especially useful for preventing water erosion during the rainy season as well as wind erosion during the dry season.

Mineral fertilizers

Achieving sustainable intensification requires a stable and reliable supply of quality fertilizers at prices that farmers can afford, are available at the right time, and are suitable for the soil and crop nutrient needs of farms. In 2006, farmers in SSA used 8 kg of mineral fertilizers per hectare, whereas Asian farmers used 15 times more. Although fertilizer use per hectare in SSA has since more than doubled to 17.9 kg per hectare in 2018 (FAO, 2021), this is still far short of what is needed to produce large crop yields. For example, a 1t/ha maize crop takes up about 22 kg of nitrogen from the soil (15 kg in grain and 7 kg in stover). On very poor soils, the 17.9 kg/ha fertilizer use would barely support this low productivity level. While some countries in SSA have significantly increased fertilizer application rates over time, others have not seen much improvement. For example, average application rates in Ethiopia and Tanzania have exhibited an upward trend while Malawi has experienced a decline in the past decade (Figure 4.2). The application rate in Niger was below 3.5 kg/ha while in Uganda it was below 2 kg/ha. These statistics indicate significant heterogeneity in fertilizer use rates across SSA countries.

Fertilizer markets in SSA were liberalized in the late 1990s/early 2000s with the private sector largely providing the supply and distribution of fertilizers. The private sector is the pivotal partner at all levels of the value chain from soil testing, fertilizer importation, manufacturing and blending to marketing and distribution of fertilizers. Private investment requirements at the various levels of the value chain differ. At the supplier level (importation, manufacturing, blending) funds are needed for substantive capital investments to establish a fertilizer manufacturing

plant or to import fertilizers either to be used directly or as raw materials by blending plants. A new fertilizer manufacturing plant costs about USD 1.3 billion; a steam granulation plant costs approximately USD 80 million, while blending plant construction requires a much lower investment - approximately USD 20 million (UNECA and AFFM, 2018). Funds are also needed for trade finance at all levels of the value chain (by importers, distributors, and retailers) and for the construction of storage facilities.

Figure 4.2: Trends in national average fertilizer application rate (kg/ha) in various countries

Source: Authors' computation from Living Standards Measurement Survey (LSMS) datasets by the World Bank.

Private fertilizer companies and financial institutions are investing at all levels of the fertilizer value chain in SSA. In a number of countries in Africa, the private sector is already involved in the production and blending of fertilizer. For example, in southern Africa, International Raw Materials Limited (IRM) is producing ammonium sulphate in Madagascar; two blending companies in Malawi – Malawi Fertilizer Company and Optichem – are producing mineral fertilizer blends; and Mozambique has three blending plants (Mozambique Fertilizer Company, Export Trading Group, and Omnia Fertilizers) also producing mineral fertilizer blends. In East Africa, MEA Ltd in Kenya and Minjingu Fertilizer in Tanzania are producing fertilizer blends. In West Africa, Indorama Eleme Fertilizers & Chemicals Ltd in Nigeria is one of only two plants producing urea in SSA. Further downstream in the value chain, development organizations and foundations are partnering with financial institutions as well as fertilizer suppliers to mitigate the high cost of business finance.

Commercial banks are the most traditional sources of funds for any business venture. However, the share of agricultural lending from commercial banks is low due to both the perceived and actual risks of investing in this sector. For many countries in SSA, the share of commercial bank lending to the sector is less than 10 percent (UNECA and AFFM, 2018). An innovative way being used by some governments to increase agricultural loans by commercial banks is by partnering via risk-sharing and credit guarantee schemes. The Nigeria Incentive-Based Risk-Sharing System for Agricultural Lending (NIRSAL) is one such example and is a promising initiative. Established in 2011, the objective of NIRSAL is to use risk mitigation, financing, trading, strategic initiatives, and technical assistance to promote lending by commercial banks to agriculture sector actors. The Central Bank of Nigeria (CBN) provided start-up capital of N75 billion through a partnership with the Alliance for a Green Revolution in Africa (AGRA). Loans are available to stakeholders at all levels of the agricultural value chain including those in the fertilizer sub-sector. The guarantee is for up to 75 percent of bank loans made to sector players, including farmers. To date, more than 454 agricultural projects have received credit guarantees valued at N61.61 billion through NIRSAL and more than 112,000 farmers have received training in business management and good agricultural practices through its technical assistance program. NIRSAL's 10-year goal is to increase agricultural loans to 7 percent of Nigeria's total bank lending (from the current level of 1.4 percent) (UNECA and AFFM, 2018).

Despite the promising example provided by NIRSAL, as noted earlier, the proportion of lending to agriculture by the commercial banking sector is low. Development organizations and foundations are introducing initiatives to fill this vacuum. AGRA is working with financial institutions to make low-interest loans available to key agrodealers, fertilizer wholesalers, and seed companies (UNECA and AFFM, 2018). The African Fertilizer and Agribusiness Partnership (AFAP) is partnering with the AFFM to provide trade finance for Hub-agrodealers through supplier credit guarantees, which are proving to be viable alternatives to costly bank loans. There is also private sector investment to enhance consumption among smallholder farmers, e.g., Bayer and Yara in Malawi, Mozambique, and Zambia. Furthermore, private input supply companies routinely hold farmer field days to demonstrate the benefits of and correct ways of using fertilizers, improved seeds, and agrochemicals to smallholder farmers.

Private sector investment in production and distribution driven by policy decisions has also been observed. In Tanzania, the Government contracted Minjingu Fertilizers Ltd. (the only fertilizer company in the country) to produce fertilizers for the government subsidy program. Similarly, in Nigeria, under the Presidential Fertilizer Initiative (PFI), private sector firms are not allowed to import fertilizers. The Nigeria Sovereign Investment Authority (NSIA) is the only official importer of raw materials for fertilizer blends. Until recently the NSIA could only sell to selected blending companies. In a recent policy change, while the NSIA remains the sole importer of raw materials for blends, it now sells freely to all parties (raw material off-takers and blenders); it is

no longer making allocations to selected blending companies. In addition, CBN and Nigeria's Ministry of Finance (MoF) have been tasked with developing a finance structure that is not expensive to support individual blenders and agrodealers). Furthermore, MoF and the Federal Ministry of Agriculture and Rural Development have been tasked with putting in place a structure to allow targeted farmers to be given subsidies without distorting the market pricing. This new policy empowers the private sector (blenders) to be innovative. Blenders now make production and marketing decisions on a commercial basis, not simply because they have received an allocation from the NSIA.

Despite the successes noted above, private investment is still below its potential as there are several factors constraining increased investment. First, the fertilizer business is capital intensive. For example, in the average fertilizer market in SSA today, a fertilizer wholesaler would need approximately USD 300,000 to buy 1,000 tons of fertilizer, no mean feat. Access to affordable capital for investment is, therefore, a critical challenge faced by actors at all levels of the supply chain. A second obstacle to increased investment is low demand because most fertilizer markets in SSA are small, less than 100,000 tonnes, which is not economically viable for a private investor who is interested in establishing a fertilizer plant. Government fertilizer subsidy programs do not have guaranteed long-term funding and so subsidy-based fertilizer markets cannot be used as a basis for private sector investment.

A third obstacle is the policy and regulatory environment. While many governments are reviewing, updating and, in many cases, putting in place a policy and legal framework to govern the sector, there is a lingering distrust of the private sector and hence many governments believe that there is a need for these frameworks to have a more controlling and punitive approach than a facilitative approach. The result is overly-restrictive regulatory environments, which stifle private sector investment. For example, many countries still require three seasons of testing for imported fertilizers even if these fertilizers are being used by neighbouring countries and are comprised of active ingredients that have been approved for use in the country.

Increased investment by the private sector in fertilizer businesses in SSA is critical, particularly given the high cost of finance from commercial banks. However, to attract private investment, governments in Africa will need to create more policy and regulatory environments conducive to fertilizer businesses. Governments will also have to invest in both hard and soft infrastructures to boost farmer demand and make these investments economically viable. Hard infrastructures include roads, rail, and port facilities, while soft infrastructures include soil maps, extension services, financial services, and regulatory reforms. Third, governments should look for opportunities to partner with development organizations and foundations to provide trade finance via credit guarantees and supplier credit.

Organic inputs

Large addition of organic matter is a necessary condition for achieving resilient agricultural systems in most areas of Africa (Sanchez, 2019). Soils that are high in organic matter retain moisture for longer periods and help plants cope with dry spells. Because mineral fertilizers contain no carbon, organic inputs must be part of the equation for soil health. There is plenty of evidence from SSA that organic inputs must be applied along with mineral fertilizers (Sanchez 2019).

Although cattle manures are used all over Africa as organic inputs, and while those produced from dairy farms are generally of high nutrient quality, most manures used by smallholder farmers are often of low nutrient quality because cattle graze on low-quality grasses grown on nutrient-depleted soils. Crop residues such as cereal stover are mainly fed to cattle but when cereal crop yields more than double, as commonly happens with mineral fertilizers and improved germplasm, crop residues also double. This provides an opportunity to satisfy feeding cattle while returning substantial quantities of crop residues containing 45 percent carbon to the soil.

Very few countries have some form of functional organic inputs markets, partly due to the resource being bulky. As a result, farmers have limited options for sourcing organic nutrient inputs, as they generally use compost or livestock manure that is generated on their farms.

Other alternative options that are readily accessible, cheap and of good quality to support soil fertility are needed. The use of insects such as black soldier fly (BSF) larvae (Hermetia illucens L.) to recycle organic waste into low-cost nutrient-rich biomass for animal feeds and frass fertilizer (FF) for improved soil health and crop yields has rapidly attracted attention globally (Beesigamukama et al. 2021; Menino et al. 2021; Quilliam et al., 2020). The International Centre for Insect Physiology and Ecology (ICIPE) has demonstrated that BSF larvae takes five weeks to produce mature and stable FF compared to 8–24 weeks for conventional composting (Beesigamukama et al. 2021). On-farm soil amendment with FF showed significant increase in beneficial bacteria and fungi, reduced soil acidity, and increased phosphorus (two-folds) and magnesium (two to four-fold) release than commercial fertilizers. Soil treated with FF had higher nitrogen mineralization and better synchrony for plant uptake thus leading to increased yields (Anyega et al., 2021; Mugwe et al., 2009; Beesigamukama et al., 2020).

High-yielding germplasm adapted to the local soils and changing climate

An additional condition for resilience is to have the correct crop varieties or hybrids that can take advantage of healthy soils and variable rainfall. Many such cultivars have been developed by national agriculture research services (NARS), the Consultative Group on International Agriculture Research (CGIAR) centers, and private companies throughout SSA including genetically modified organisms (GMOs) that protect maize plants from insects like the fall armyworm and provide deep rooting that alleviates water stress. Several African countries (e.g., South Africa, Egypt, Burkina Faso, Sudan, and Kenya) have approved GMO cultivars for several crops. These cultivars are also linked to improved resilience in non-acidic soils. Using nationwide data from Zambia, Pelletier et al., (2020) find that the use of improved maize hybrid seed in non-acidic soils (pH ≥ 5.5) is associated with reduced deforestation. Cultivars developed for hotter or drier climates can also be used in areas that have been rendered hotter or drier by climate change. In addition, improved cultivars on healthy soils cover the ground faster and more thoroughly, decreasing soil water evaporation and increasing plant transpiration, thus increasing water use efficiency.

However, improved cultivars require effective generation and delivery systems. In many cases, regulatory reforms that remove barriers on seed trade and allow for greater private investment in seed development and distribution are needed to make improved seed more accessible to African farmers (Fuglie et al., 2020). For example, early generation seed production (breeder seed and foundation seed) has been a frequent bottleneck in the production and supply of certified seed, delaying farmers' access to improved seed. Most African governments formerly held a monopoly on seed production but now many have allowed private companies to begin producing (Devries, 2019). There are now more than 100 African-owned seed companies that sell improved seeds that can attain high yields when fertilized.

Figure 4.3 shows the impact of high-yielding cultivars when combined with fertilizer applications and good agronomy. Today, the countries benefiting from sustained support to access high-yielding seed and fertilizers achieve 80 percent higher yields (Devries, 2019). Improved germplasm without improving soil health is a nonstarter.

Diversifying cropping systems

Rainfall variability exacerbates challenges associated with poor soil fertility in maize-based cropping systems of sub-Saharan Africa. Even with high fertilizer investment, the risk of crop failure remains high because of low and erratic rainfall. Enhanced yield stability and the efficient use of nutrients and water are therefore at the foundation of resilience-building. To this end, functional crop diversity that integrates legumes at scale is a clear

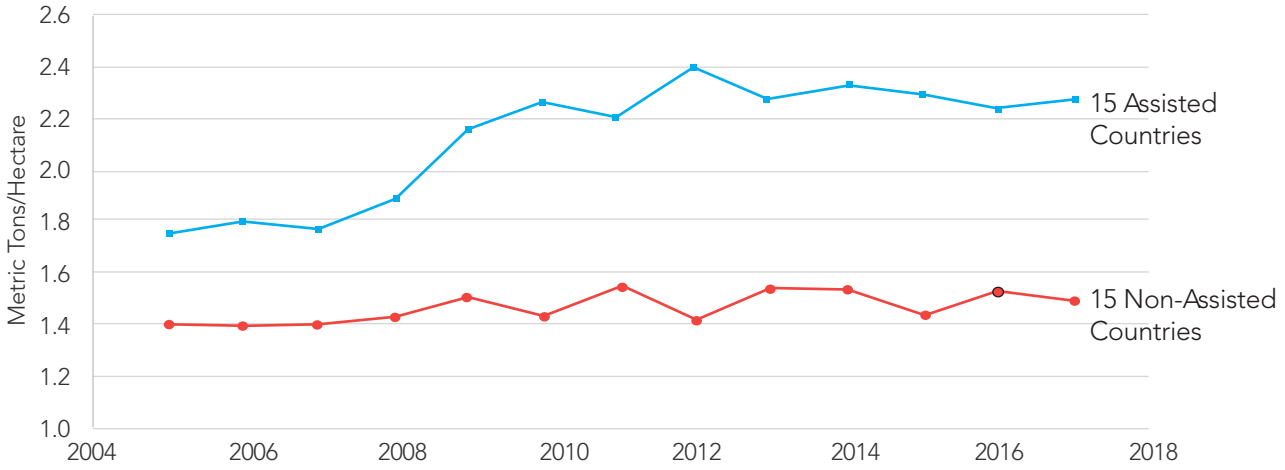

Figure 4.3: National average cereal grain yields (maize and rice) of 15 African countries that received assistance on high-yielding seed and mineral fertilizers compared with 15 countries that did not (Devries, 2019).

way to enhance nutrient cycling and efficient soil water utilization.

Many people's diets are heavily dependent on maize which is produced inefficiently with little fertilizer, resulting in yields below 1 t/ha. Maize is also lacking in essential nutrients, thus putting farming households at risk of nutrient-deficiencies. Unfortunately, grain legumes that are nutrient-dense (high-protein content, key macronutrients) are disproportionately grown on small fields on farms. This is despite the fact that grain legumes biologically fix atmospheric Nitrogen (N_2) gas and accumulate it in the plant via biological nitrogen fixation, which takes place in the nodules on their roots (Figure 4.4). By fixing atmospheric nitrogen, grain legumes make it available to the host plant thus providing nitrogen to the next crops through residues left on the soil or incorporated (Giller, 2001). In the medium to long term, the high-quality legume residues and residues from cereal crops gradually build up soil organic carbon thereby improving crop response to fertilizers and supporting more resilient crop production. Addressing the twin problems of malnutrition and poor soils requires diversification of maize-dominated cropping systems to include a substantial component of grain legumes. Some grain legumes are also of interest as low-risk options for intensification of cropping systems as they are adapted to drought stress (Franke et al., 2017; Ojiem et al., 2014). Enhanced productivity and nitrogen cycling is of particular interest to smallholder farmers, who generally struggle to afford external nutrient inputs (Tittonell and Giller, 2013). For smallholders with poor access to mineral nitrogen fertilizers, the enhanced fertilizer use efficiency is a hugely positive benefit of rotational systems. More details on the ecology and benefits of integrating grain legumes in cropping systems are in Box 4.1

Figure 4.4: Nodules on the roots of a soybean plant. Specific soybean varieties require inoculation for these 'urea factories' to form successfully.
Photo: Regis Chikowo/MSU

Box 4.1: Doubled-up legume technology and land productivity, nutrition, and the environment

Grain legumes are bred to accumulate nitrogen in the grain component, giving a high nitrogen harvest index. The magnitude of the benefits of growing legumes to soil fertility largely depend on how the legume residues are used. When crop residues are taken off the field or burnt (as is often the case on smallholder farms as part of land preparation), the nitrogen input from the grain legume is nominal, or even negative. Thus, for both soil organic carbon and nitrogen, it is necessary to retain the legume stover (plant leaves and stalks) in the field. In general, grain legumes are less efficient than cereals at recovering soil inorganic nitrogen (Jensen and Hauggaard-Nielsen, 2003). This results in greater levels of soil inorganic nitrogen in the soil after a legume crop than after cereals, especially at deep layers. This is generally referred to as the 'nitrogen-sparing' or 'nitrogen-conserving' effect in legume–cereal rotation systems.

Extensive experimentation is key to evaluation of biologically complex technologies for yield stability as part of cropping system resilience assessment. Evidence from multi-year on-farm experiments conducted in central Malawi point to increased yields and yield stability of cereals when grown in systematic legume-cereal sequences over several seasons (Chimonyo et al. 2019; Figure 4.5). The doubled-up legume technology (DUL rotation) is a special type of intercropping in which two grain legumes (e.g., groundnut and pigeonpea) with different growth habits are successfully grown together, resulting in increased land productivity, human nutrition, and environmental benefits. After three cropping cycles, maize sequenced with legumes (soyabean, groundnut, DUL rotation) and fertilized at 50 percent NP rate had yields similar to continuous maize with full NP fertilizer rate. Rotating maize with legumes increased nutrient use efficiency by 56 percent and protein contribution by 65 percent relative to fully-fertilized maize (Chimonyo et al. 2019). When crop residues are properly retained in the field following a good grain legume crop as in Figure 4.6, the rotational benefits accrue, irrespective of legume type used. Thus, farmers located in different agroe-cologies with specific niches for different legume crops will all benefit from legume integration. The DUL rotation is a lifeline for continued diversified legume production when land access becomes a serious constraint as land allocation is often prioritized for cereals for food security.

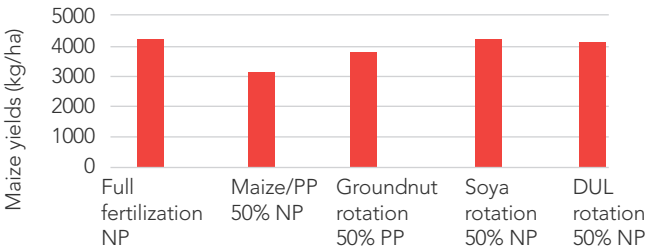

Figure 4.5: Maize productivity with continuous NP fertilization or after three cycles of cropping legumes in sequence (Chimonyo et al. 2019)[Maize/PP =continuous maize/pigeonpea intercropping; Gnut rotation = groundnut-maize rotation system; soya rotation = soyabean-maize rotation system; DUL rotation = groundnut/pigeonpea intercropping system rotated with maize as described above).

Figure 4.6: Integrating soyabean at scale on a smallholder farm in Malawi as part of ecological intensification. Photo: Regis Chikowo/MSU.

Adapting farming practices to climate change

Smallholder farming in most of SSA is rainfed and thus exposed to the increasing rainfall variability caused by climate change. Annual rainfall is projected to decline in southern and western Africa, while it is projected to increase in East Africa, with opposite negative effects such as drought and flooding. While there is little opportunity for irrigation for most farmers, there are adaptation measures through which agricultural production systems in SSA can build resilience to climate shocks. In addition to adoption of improved crop varieties adapted to the local climate conditions and sustainable intensification practices involving simultaneous application of inorganic fertilizers and organic inputs discussed earlier, other adaptation measures include: a flexible nitrogen fertilization strategy responsive to rainfall variability; weather-based index insurance; enhancing financial security; and CA. We discuss these in turn.

A flexible nitrogen fertilizer management strategy responsive to rainfall variability

The erratic and uneven distribution of rainfall makes the use of fertilizers by smallholder farmers risky. Farmers may therefore be reluctant to apply full rates of appropriate fertilizers in good rainfall seasons because of the risk of crop failure, and they may apply more fertilizer than is justified by crop returns in drought years. Most nitrogen (N) top-dressing recommendations provided to farmers are rigid and do not recognize the importance of soil–water interactions regarding N fertilizer use efficiency. Practical methods of applying proportioned doses of appropriate fertilizer are therefore dependent on the prevailing rainfall required to optimize fertilizer use efficiency.

Piha (1993) devised and successfully tested a flexible system of fertilization in which theoretically optimum rates of the nutrients phosphorus (P), potassium (K), and sulfur (S) are applied based on yield potential in an average rainfall season, while N is applied as a series of portioned applications adjusted during the season according to the degree of water stress observed especially when nitrate-based fertilizers are used as N sources (Box 4.2). This fertilizer management strategy optimizes resource use efficiency during good rainfall seasons while ensuring minimum wastage in case of drought due to reduced fertilizer inputs. Adoption of this practice will certainly require more effective extension systems.

Weather-based index insurance

There is need to promote weather-based index insurance to help reduce the negative impact of climate-related shocks on agricultural production. Weather-based index insurance is less costly to administer for a large group of farmers because compensation in cases of loss is based on verifiable rainfall threshold within a defined area covering the farm. There is also evidence that weather-based index insurance induces farmers to increase investment on the farm through increased adoption of productive agricultural inputs (Karlan et al. 2014). However, the often-low uptake of index insurance at commercially viable prices is a major challenge that needs to be addressed (Carter et al. 2017; Ahmed et al. 2020). Supporting and encouraging uptake of weather-based index insurance will require sustained efforts at training and educating private sector insurance providers and farmers alike on the benefits and costs of index insurance. Farmers who have low economic power and are in weather risk-prone areas need the cost of index insurance subsidized. In an experimental study in Kenya, Butle et al. (2020) found that bundling subsidized insurance with certified seeds led to greater adoption of both. However, the study also found that farmers were willing to pay for insurance but that their valuation of the insurance product was way below the market price. This implies that the emerging market for index insurance in SSA will require subsidization to support farmers and establish a steady market.

Enhancing financial security

Building farmers' financial security by promoting savings and access to credit can help buffer against the negative impacts of climate shocks at the primary level of the food systems. This is particularly

Box 4.2: Fexible nitrogen fertilization strategy responsive to rainfall variability

Piha (1993) compared two nutrient management strategies, in two contrasting agro-ecologies, that involved either:

- A fixed N application rate for specific agro-ecologies, in line with recommendations normally given to farmers by the extension system, or
- Rainfall-varied N top-dressing that was a function of general agro-ecology as well as current rainfall season quality.

This flexible system of fertilization resulted in more efficient maize production especially for high agro-ecological potential sites (Figure 4.6). Trials on farmers' fields over a five-year period resulted in 25–42 percent greater yield and 21–41 percent more profit than a model based on existing fertilizer recommendations. These results are significant as they confirm that productive and profitable agriculture is possible on poor soils and in semi-arid conditions with the judicious and strategic use of inorganic fertilizers. This adaptive fertilization strategy optimizes N use efficiency during good rainfall seasons while ensuring minimum losses in case of drought as further N topdressings are withheld under sub-optimal soil moisture conditions. Results are more positive when in-field water conservation measures such as tied-ridging are used.

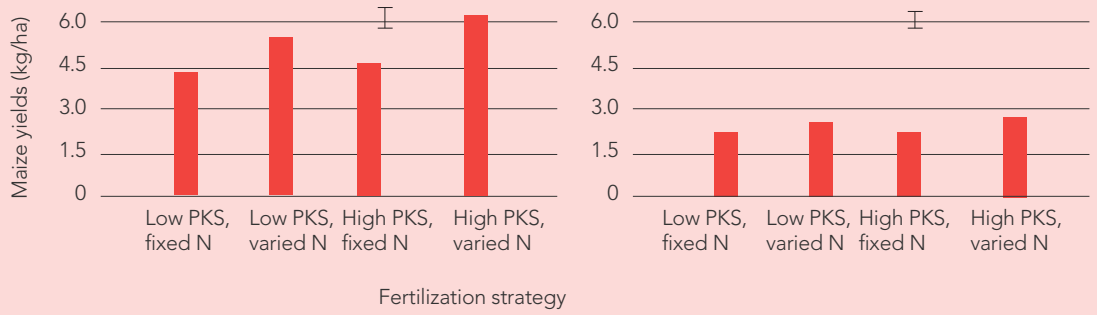

Figure 4.7: Effects of N, P, K and S fertilization strategy on maize productivity for (a) a high agro-potential site and (b) low agro-potential site in central Zimbabwe (adapted from Piha, 1993)

important for full-time farming households, which earn income from crop harvests once or twice a year but must consume throughout the year and use that very income to purchase inputs for production in the subsequent year. There is evidence that timely access to credit allows farmers to postpone selling their produce and store during harvest when prices are low and sell in the lean season when prices are high thereby increasing farm revenue (Bulte et al. 2019; Channa et al. 2021). Access to better storage technologies has similar effects (Chengere et al. 2021; Omotilewa et al. 2018; Aggarwal et al. 2018).

Conservation agriculture?

CA is a controversial technology that governments and development partners have promoted widely in SSA as a possible solution to soil erosion and degradation on smallholder fields largely attributed to conventional tillage (Bayala et al. 2012; Haggblade and Tembo 2003; Marongwe et al. 2011; Umar et al. 2011). While FAO identifies CA as consisting of three components - reduced tillage, crop residue retention, and crop rotation or diversification, the practice is often equated to reduced tillage, ignoring the two other

components. Reduced tillage is by far the most adopted component by the largest number of smallholder farmers (Nyamangara et al. 2013). Maintenance of at least 30 percent year-round cover with crop residues is the least adopted component due to a combination of low crop yields (less than 1 t/ha) and competing claims to residue use on farms, primarily for livestock feed (Giller et al. 2009) and fuel. In-field crop residue retention is the most critical component because it provides new carbon for the soil as well as year-round soil cover while the effects of crop rotation are more often related to weed, pest, and disease control.

Reduced tillage typically results in substantially higher weed pressure and manual weeding labor requirements, making herbicides use a critical requirement under the practice (Haggblade et a. 2017; Nyamangara et al., 2013). While herbicides are often promoted to enable CA adoption in Africa (Giller et al., 2015; Lotter, 2015), their use is extremely limited. For example, evidence indicates that only of 1 percent of farmers in Malawi and just over 25 percent in Ethiopia and Ghana use herbicides (Gianessi, 2009; Haggblade et al., 2017). The few households that adopt herbicides use are often the more well-off and who are also a source of community safety net as they provide casual labor opportunities for manual weeding to their poor neighbors. Bouwman et al. (2021) suggests that new technologies that displace labor may inadvertently assist the more well-off at the expense of the poor, thereby aggravating food insecurity and inequality.

CA has had dramatic effects on reducing soil erosion and runoff but inconsistent effects on crop yields largely due to inherent or declining soil fertility. Ndlovu et al. (2013) reported 39 percent more maize grain yield under CA compared to conventional tillage in Zimbabwe but noted that high labor and fertilizer demands present adoption problems for CA among resource-constrained farmers. In a compilation of 23 reports, Wall et al. (2013) reported over 10 percent higher crop yields under CA compared with conventional tillage but the role of fertilization was not clearly defined.

Giller et al. (2009) noted that empirical evidence of the contribution of CA to yield gains is not clear while Nyagumbo (1999) reported that the performance of CA relative to existing technologies is highly variable and dependent on site and farmer characteristics. The main constraint is probably the need for powerful farm machinery to drag the reduced tillage implements (Sanchez, 2019).

Appropriate use of fertilizer has been suggested as a fourth principle of CA in order to increase the likelihood of benefits for smallholder farmers (Vanlauwe et al. 2014). A meta-analysis of major long-term CA trials conducted worldwide indicated that grain yield was positive when mineral N fertilizer was applied at rates greater than 100 kg N ha (Rusinamhodzi et al. 2011). The performance of CA under semi-arid conditions is enhanced by the addition of small amounts of N fertilizer and cattle manure—often referred to as micro-dosing. These studies illustrate the pivotal role of optimal application of nutrients in enhancing crop yield under CA as opposed to interpreting CA as a silver bullet on its own.

The advantages and limitations of CA, particularly as a tool to sequester carbon and mitigate climate change, have been debated in scientific literature (Lal 1989; Giller et al. 2009; 2011; Palm et al. 2014; Powlson et al. 2014; Pittelkow et al. 2015) as well as in policy-oriented publications by FAO and the World Bank. Several analyses suggest that CA does not always provide the benefits that are widely publicized. A meta-analysis found that when only the reduced tillage component is applied, crop yields were 11 percent lower than with CA. When reduced tillage was combined with crop residue return, the CA yield penalty was reduced to about 5 percent, and when all components were applied, the difference was reduced to practically nothing (Pittelkow et al. 2015).

CA works well in many large-scale mechanized farms but it is generally difficult to implement in smallholder farms that lack sufficient crop residue return, do not use herbicides, and often use tied furrows. Nevertheless, there are successful CA systems practiced in small farms of Central America and in southern Zambia.

Box 4.3: Conservation agriculture and carbon sequestration

Increased carbon sequestration under CA is considered one of the main pillars of CSA. Due to considerable variation in carbon sequestration in the top 40 cm as a result of differences in texture, mineralogy, initial soil organic carbon content, amount of crop residues added, and the crop rotation schemes, the data, does not provide a clear trend (Palm et al. 2014). Data on nitrous and methane emissions do not show a clear trend either. Therefore, the carbon sequestration function of CA cannot be taken for granted. Soil organic carbon (SOC) increases in the top 10 cm of the soil after 5 to 10 years of continuous zero tillage, particularly if it is accompanied by crop residue return. The increase in SOC under CA results in higher biological activity, including that of macrofauna such as earthworms and termites and improved nutrient cycling. Plow pans are eventually eliminated by root and macrofauna activity. However, heavy no-till planters sometimes cause soil compaction. Occasional deep tillage is often needed to eliminate compacted layers.

Conclusion and way forward

Building agricultural production systems' resilience to shocks and stressors is critical for Africa to sustainably achieve food and nutrition security and economic growth and transformation. Expansion of cropland into natural old-growth forests and biodiversity-rich habitats, which has been the primary factor of agricultural productivity growth on the continent is untenable. Going forward, concerted efforts are needed to sustainably intensify production and increase yields on existing agricultural land to meet increasing food demands and environmental sustainability requirements. Variability in yield response of crops to fertilizers due to degraded soils and variable climate increase the vulnerability of smallholder farmers. Rapid population growth, rising average incomes, and demographic changes have affected changes in relative costs of land, labor, cash inputs, and demands for food. These demographic and economic changes are influencing the trajectories and opportunities for sustainable agricultural intensification and productivity growth in ways that are highly location-specific. Addressing these issues for the different farming contexts to attract and keep farmers, and increase productivity and profitability are essential to building resilience and putting farmers on a trajectory of sustainable intensification.

In different sections, this chapter has described approaches that can be used to build resilience of African farms to climate shocks and other stressors. Building resilience will require increased yields and enhanced yield stability; efficient use of nutrients and water; improved soil health; use of high yielding, climate stress-tolerant seeds adapted to the local climate change; crop diversification; and investments in risk mitigation and management strategies. These call for integrated approaches on farms. While the capacity to fully implement integrated practices often differ across farms, empirical evidence from experiments suggests that any degree/intensity of combined utilization of biological nutrient cycling through legume integration at scale, utilization of different types of organic nutrient resources generated on farms (i.e., livestock manure, crop residues, and compost from household waste), and judicious application of mineral fertilizers will be more beneficial. When coupled with appropriate germplasm selection, crop management techniques and water management, integrated nutrient management optimizes the benefits from all possible sources of plant nutrients in a manner that sustains agricultural production and protects the environment. Highlights of how African governments, donors and other stakeholders can actualize these proposals to increase resilience and sustainable productivity growth on African farms are given below.

Proposed actions by governments, donors, and other stakeholders for increasing resilience in Africa's farming systems

1. **Improving soil health** will require approaches that encourage farmers' adoption of appropriate technologies, innovations and management practices that improve and maintain soil fertility. Options to do so include:

    - *Covering the soil surface to protect it throughout the year* (e.g., improved tree fallows and cover cropping). Market-based and economic incentives such as payments for ecosystem services and production standards are required for farmers to increase adoption as these practices increase labor and land requirements.

    - Increasing the use of *mineral fertilizers* to replenish nutrients that have been depleted for decades. Achieving this will require actions that increase availability of and access to appropriate fertilizers for a broad base of farmers in SSA. Increased investment throughout the fertilizer value chain is needed. To attract private investment, governments in Africa will need to create more conducive policy and regulatory environments for fertilizer businesses along the entire supply chain - boosting farmer demand to make these investments economically viable and looking for opportunities to provide trade finance via credit guarantees and supplier credit. Such investments would improve fertilizers supply chains and reduce the cost of fertilizers making it more accessible and affordable to many smallholder farmers who do not use fertilizers mainly due to current prohibitive costs.

    - Encouraging the use of *organic inputs combined with mineral fertilizers.* The efficiency of mineral fertilizer use increases when combined with organic inputs (e.g., manures, composts, mulches, cover crops, and improved fallows). The associated increased soil organic matter also builds the resilience of the production system through better soil water retention. There is need for incentive programs to increase the availability of organic inputs and their uptake by smallholder farmers. Bundling farmer input subsidies available in most countries with organic input use would be an advisable approach. In addition, enhanced extension efforts to educate farmers on the need for and benefits of combined use of mineral fertilizers and organic inputs will be necessary.

2. **Higher accessibility to improved crop varieties and/or hybrid adapted to local soils and climate change** in SSA will require several transformative measures. These include regulatory reforms that remove barriers on seed trade, allowing for harmonisation of seed trade regulations, and allowing for greater private investment in seed development and distribution. National and international research systems have developed numerous crop varieties/hybrids that are adapted to local conditions including hotter and drier conditions. Yields have doubled or tripled in countries where these improved seeds have been widely distributed and used with mineral fertilizer. Given the ever-evolving conditions of African agriculture, more investments in adapting and developing new crop cultivars and animal breeds that are tolerant to climate-induced stresses are needed. National governments and partners should facilitate the transfer (scaling-out, scaling-up, and scaling deep) of improved cultivars and animal breeds and other proven farm management practices to farmers by strengthening and financing effective extension delivery systems. In addition to providing education on husbandry practices, extension systems need to take advantage of the available digital tools to help address the rising crop and animal disease burden facing African agriculture.

3. **Diversifying the cropping system** with legumes integrated at the field and farm at scale as a clear way to enhance nutrient cycling and efficient soil water utilization and increase diet diversity. Research with grain legumes and cover crops has provided many successful examples, where nitrogen fixed by legumes can reduce the amount of costly mineral fertilizer that is required, and residues of legumes replenish degraded soils by increasing soil organic matter and nitrogen availability. For example, long-term trials on diverse systematic legume-maize sequences in Malawi have shown the increased resilience of this cropping system. Wider adoption of these integrated legume systems will require local adaption and more effective extension systems.

4. **Investments in risk mitigation, management, and pooling strategies.** Options here include weather-indexed insurance, targeted social cash transfers, savings groups, and improving access to credit and other financial resources. Educating farmers on how such instruments work and on innovative digital platforms for timely delivery of climate information services should be an important complementary element. Weather index insurance will require subsidization to support farmers and establish a steady index insurance market.

5. **Support to research and development and strengthening extension systems.** Adapting to climate change through use of locally-relevant seasonal forecasts and extension messages will be critical to reduce risks and increase success and adoption of the key components of resilient agricultural production systems. Promotion of 'improved practices' that provide resilience in agricultural production systems must be based on evidence that applies to local conditions. Universal promotion of practices that have been shown to work in some places but have also been shown not to work in others or under many smallholder farming conditions in SSA is highly discouraged. It is therefore vital to increase funding to R&D to equivalent of at least one percent of agricultural GDP, which is the target under CAADP (African Union, 2018). SSA's current spending on R&D is equivalent to 0.38 percent of agricultural GDP (Fuglie et al. 2020), which is way below the CAADP target, and most countries devote less than 10 percent of agricultural expenditures to R&D (Jayne et al. 2020).. Equally critical is strengthening extension systems on the continent through increased funding to and effective management of the extension functions (Jayne and Sanchez, 2021).

6. **African governments need to reconcile policy actions to enhance synergies and avoid policy collisions**. For example, agricultural policies that aim to increase food production and increase area under cultivation conflict with environmental and biodiversity policies, which aim to reduce forest and biodiversity loss in most countries.

7. **Create incentives for and invest in irrigation**. Scope for increasing irrigation in SSA to cope with drought-related shocks and stresses exists as only about 4 percent of land in the region is under irrigation (World Bank, 2008). African governments need to invest in infrastructure for and proper management of public irrigation schemes and support the development and adoption of small-scale irrigation technologies. While promoting irrigation agriculture, it is important to ensure that irrigation is managed in a way that avoids the negative consequences of waterlogging and salinization as has been observed in parts of Asia (The Montpellier Panel 2013).

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5 Achieving Resilience in Downstream Agri-Food Systems

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"Mayibuye[11] is simply a plea to all Africans to come together, share their problems, try to solve them in a manner and fashion that our great forefathers and kings… would be proud of…" - Miriam Makeba

Key messages

1 Over the coming decade, Africa's food demand will rise, making it one of world's largest sources of additional demand.

2 Value addition post-farm in Africa is low by international standards. To meet growing demand, Africa will benefit from upgrading value chains in the food system. This is best achieved through policies that support agricultural transformation more generally and incentives that encourage private investment in food systems.

3 Africa's agri-food system offers growth potential to large-scale, multinational agribusinesses. Over the past five years, some of the world's largest grain traders, food processors, and wholesalers/retailers have expanded their investments on the continent. This has positive implications for private investment by small- and medium-scale agribusiness firms as well, and for the economic, social, and environmental sustainability of African food systems.

4 Africa will become more resilient as it 'upgrades' value chains in the food system which will involve shifting production and employment from informal microenterprises to formal firms offering wage employment with income security and health benefits for employees and their families, and improvements in food safety.

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2 Agricultural Business Chamber of South Africa (AgBiz)
3 Cornell University
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5 Holger Matthew's institutional affiliation should be listed as: Food and Agriculture Organization of the United Nations (FAO).
6 African Development Bank (AfDB)
7 Tegemeo Institute of Agricultural Policy & Development, Egerton University and ReNAPRI
8 Sokoine University of Agriculture, and ReNAPRI
9 Eastern Africa Grain Council
10 The Rockefeller Foundation
11 Mayibuye iAfrika was the concluding response at the 1958 Accra Conference of peoples from all over Africa. The literal translation is "Come back Africa!"

5 The prospect of a single market with more than a billion consumers and a combined GDP of more than U$2.5 trillion presents vast opportunities for agribusiness in Africa. The expanded markets create unprecedented opportunities to capitalize on economies of scale. To realize this potential, African countries should effectively implement AfCFTA. The additional state revenues from greater intra-Africa food trade can help finance public investments to make Africa's food systems more resilient and sustainable.

6 SSA remains a challenging place to do business. Bureaucratic obstacles to entry and growth result in high transaction cost for potential agripreneurs. Public investment in transport (rail, road, and port) and energy infrastructure would significantly lower the cost of trade and create many indirect benefits that support both resilient and sustainable food systems.

Introduction

The agri-food system is best viewed as a complex adaptive system consisting of related activities and institutions. Achieving the growth and transformational targets of Agenda 2063 and the SDGs will depend on the ability of the system to self-organize in response to tipping-points and ever-changing landscapes[12] (Barder, 2012, Mitleton-Kelly, 2003, Ramalingam, 2008). Welfare-improving co-evolution and adaptation will require game-changing, innovative, and pragmatic actions that build a sustainable and resilient[13] downstream agri-food system over the next decade.

This chapter examines the capacity of the downstream agri-food system to meet the needs of current and future generations and the degree to which the emerging system can absorb, recover, and adapt to external shocks and/or stressors. The downstream agri-food system is defined as actors engaged in post-farm value addition, e.g., assembly, trading, wholesaling, storage, processing, retailing, preparation of food for sale outside the home, beverage manufacturing, etc.

Using a Strength, Weakness, Opportunities, and Threats (SWOT) framework, Section 2 identifies the key internal strengths and weaknesses of the off-farm food system that may ensure or erode economic, social, and/or environmental sustainability. Section 3 examines external political, economic, social, and technological (PEST) factors that are either opportunities or threats to the resilience of the downstream agri-food system. We conclude in Section 4 by translating the SWOT and PEST analysis into actionable strategies and concrete plans to achieve a sustainable and resilient agro-food processing system in Africa. In short, we identify the "sweet-spot" actions that promote both sustainability and resilience.

Internal factors shaping sustainability in downstream agri-food systems in Africa

The ability of the downstream agri-food system to meet the current and future needs of African consumers will require achieving sustainability along three dimensions namely economic, social, and environmental (Elkington, 1994). Acknowledging the heterogeneity across Africa, this section focuses on the strengths and weaknesses internal to the food system that affect the sustainability of the downstream agri-food system. Table 5.1 below summarizes the key characteristics which either provide a relative advantage or disadvantage to achieving economic, social, and environmental sustainability in Africa's downstream agri-food system.

12 See Chapter 3 on the growing impacts of shocks on African agri-food systems

13 See Chapter 2 for the conceptual framework of sustainability and resilience.

Table 5.1: Key internal strengths and weaknesses shaping the sustainability of Africa's downstream agri-food system

Internal factors	Strengths	Weaknesses
Upstream[14]	• Primary agriculture has the ability to meet rising food demand as evidenced by growing output between 2000 and 2018.	• Agricultural growth driven mainly by expansion erodes environmental and social sustainability: root cause is chronically low public investment in agricultural R&D&E which, in turn, leads to low productivity.
Consumer demand	• Rapidly increasing demand for food driven by population growth has implications for economic sustainability.	• Slow, post-COVID economic recovery will constrain income growth which, in turn, will slow the pace of dietary diversification in most regions. This has implications on the health and well-being of consumers.
Typology of downstream markets	• Growth potential of Africa's agri-food system attracts investments of multinational agribusinesses (elephants[15]) and small and medium enterprises (gazelles) at the trading, processing, and retailing level. These investments not only have implications for employment but through these companies' corporate social responsibility programs, social and environmental sustainability are core values.	• Persistent informality perpetuated by fast-growing labor supply results in low-productivity and limited economies of scale. • Self-employed *survival entrepreneurs* are generally seasonal operations in the informal sector with no benefits.

Upstream

Rapidly-rising demand for food translates to increasing demand for primary agricultural products. Between 2000 and 2018, crop and livestock production values in SSA grew annually by 4.3 percent in real terms (Jayne and Sanchez, 2021). Over the coming decade, the net value-added for agricultural and fishery products in SSA could grow by as much as 23 percent, while meat production for the continent is expected to increase by 26 percent (Figure 5.1) (OECD-FAO, 2021).

The projected growth in meat production is driven both by increasing the number of animals and their productivity (i.e., transition to more intensive production systems using improved breeds, more intense feeding, advanced herd/flock management, resulting in higher off-take rates). The projected intensification of production systems varies by meat type. Small ruminants' production will likely continue to use mostly extensive production systems. By contrast, poultry production has been undergoing structural changes in recent years and the projections assume that this will continue in the coming decade, often supported by policy initiatives. For example, poultry production in Morocco has benefitted from the Government's agricultural development blueprint "Green Morocco Plan".

Despite these gains, the output growth has been largely driven by extensification. Between 2000 and 2018, only 25 percent of crop production

14 Refers to farm-level of the agri-food value chain

15 Borrowing from Birch et. al.'s (1995) animal analogy in classifying firms, Elephants refer to large-scale, multinational firms while gazelles refer to fast growing small and medium enterprises (SMEs).

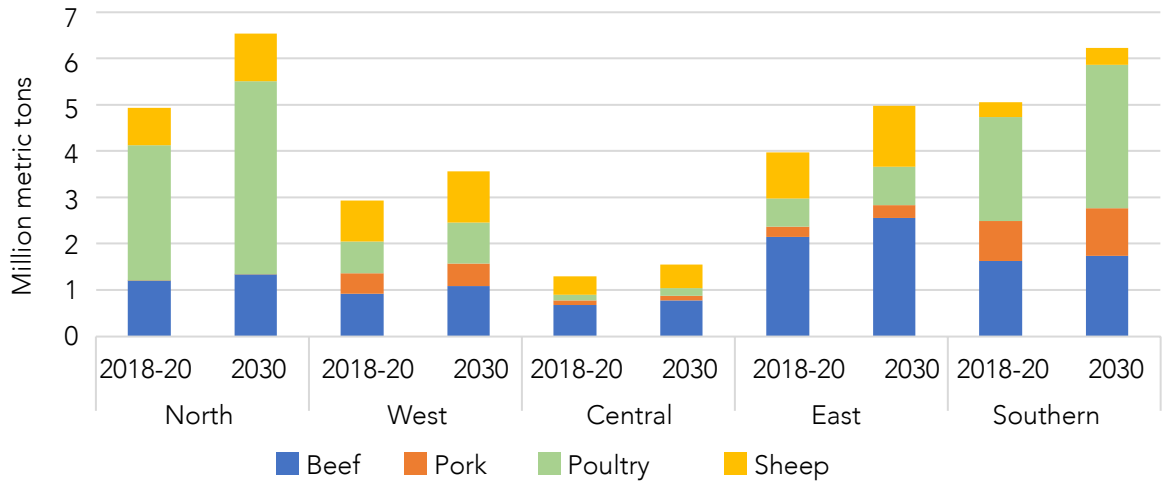


Figure 5.1: Meat production in Africa

Source: OECD-FAO, 2021

growth was attributed to improvements in yields (Jayne and Sanchez, 2021). Going forward, growth driven by expansion is both environmentally and socially unsustainable. Rising land fragmentation, deforestation and loss of biodiversity are a few of the challenges that arise with continued reliance on area expansion as a driver of growth.

Reversing this trend will require increased investment in agricultural R&D&E. While agricultural R&D spending has risen over the years in SSA, most public investments amount to less than 1 percent of agricultural GDP[16] (Fuglie, et. al., 2020). This level of public spending on agricultural R&D is not meeting the Khartoum target of 1 percent of Agriculture GDP spent on R&D (Pernechele, et. al., 2021; Traub, Jayne, Sihlobo, 2021). This type of public investment will be a catalyst for increased productivity in Africa's agriculture and, as such, provide a sustainable pathway to meet the continent's future food demand.

Consumer demand

While income recovery could slow due to the COVID-19 pandemic shock, rapid population growth will underpin the regions' food demand, making it one of the largest sources of additional demand globally over the next 10-years (OECD-FAO, 2021). Moreover, the Sub-regional projections of per-capita calorie consumption[17] indicate that for all regions, except for central and southern Africa, total per capita calorie consumption will likely increase by 2030 (Figure 5.2).

In North Africa, total calorie consumption is roughly 3,300 kcal/day in the base period (2018-2020) and could increase slightly by 2030. Driven by income growth, the region's average diet might become more diverse over the coming decade. Consumption of staples, mostly wheat, will likely fall, while consumption of all other food groups may increase. Most of the additional calories are expected to come from animal sources (meat, dairy, eggs, and fish), followed by other foods and fats. Sweetener use, sugar, and high fructose corn syrup (HFCS) stays relatively constant.

Diets of West African consumers are also predominantly based on staples, which currently provide about 70 percent of calories. Poor income prospects preclude a transition to more diversified and protein-rich diets in the region. Staple foods are expected to remain the main source of dietary energy during the coming decade, while the

16 For the latest available year, only Botswana, Cabo Verde, Mauritius, Namibia, South Africa, and Zimbabwe's investment in agricultural R&D was valued at more than 1 percent of agricultural GDP (ASTI, 2021).

17 Consumption refers to food availability to consumers in a national accounting framework. It does not represent food intake, because losses and waste are not deducted.

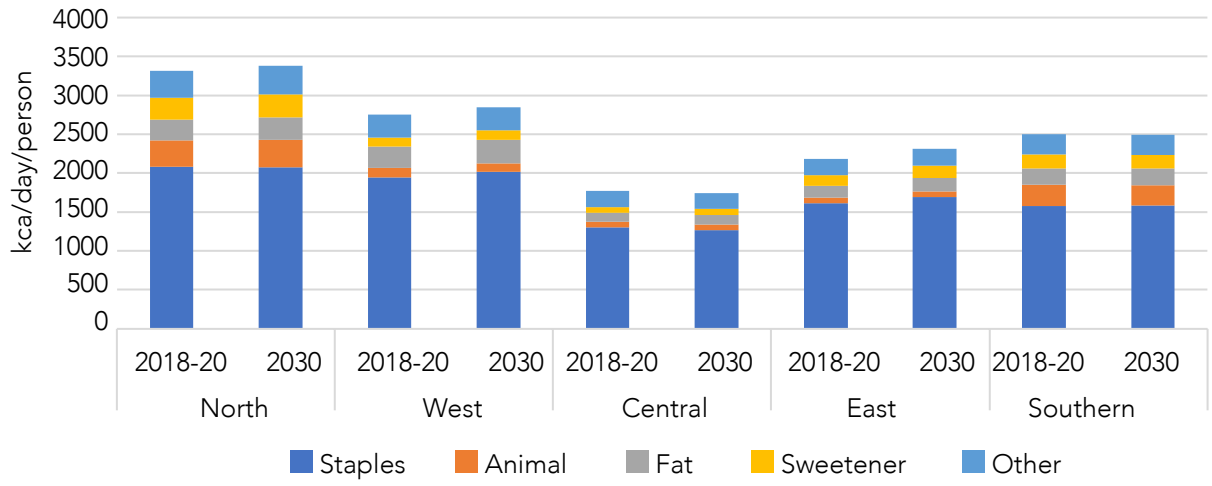


Figure 5.2: Average calorie consumption
Source: OECD-FAO, 2021

consumption of animal products is expected to remain very limited. The projected increase in the use of sugar and fats is mainly attributed to rapid population increase in urban areas where processed foods are more common.

Diets in Central Africa are dominated by staples, which currently contribute 73 percent of calories. Other foods, including plantains, account for about 12 percent, followed by fats with roughly 7 percent. Poor income prospects and an ongoing shift in consumption habits due to urbanization result in a projected increase in the consumption of fats and sweeteners, while the consumption of staples, animal, and other foods may decrease slightly. However, these changes are happening very slowly and diets will continue to consist primarily of staples for both calories and protein.

In East Africa, the average consumption per person/day is estimated at 2,180 kcal in the base period (2018-2020). This is projected to increase by 134 kcal/person/day (6 percent) in 2030, predominantly based on staples. Fast growth is expected in fats (20 percent) and sweeteners (13 percent), which gradually increases their shares in the diet indicating a growing consumption of convenient and fast-food products in the region. By contrast, animal product consumption will decrease by about 4.5 percent in the projection period, reducing its share in the average regional diet slightly to 2.9 percent, suggesting no significant improvement in dietary quality.

Total calorie consumption in Southern Africa is currently estimated at 2,500 kcal/person/day, the majority coming from staples (63 percent), followed by animal products (11 percent), fats (8 percent) and sweeteners (7 percent). Due to income constraints, per capita food consumption in Southern Africa is expected to remain nearly constant, with minimal changes in the shares of individual food groups. An increase in fat consumption is projected to compensate reductions in animal food and sweetener use.

Typology of the downstream market: elephants and gazelles

The projected value of Africa's food system is USD 1 trillion by 2030 and the food import bill is expected to increase to USD 90 billion (African Common Position, 2021). As such, Africa's agri-food system offers large scale, multinational agribusiness companies (elephants) growth opportunities. Over the past five years, some of the world's largest multinational agribusinesses have expanded their African footprint (Business Day TV, 2019). For example, in February 2021 the Distell Group, a South African spirits producer, reported a 20.3 percent growth in sales in their target African markets outside South Africa, for the six-month

period ending on December 2020 (BusinessTech, 2021). Sales volumes on their digital Business-to-Business (B2B) platform during this period, grew faster than the non-platform sales (BusinessTech, 2021). Such growth has attracted the attention of Heineken, the world's second-largest brewery, and talks are underway for a possible merger.

Large-scale multinational acquisitions are not just occurring in the beverage sector. In March 2020, South Africa's Competition Commission approved PepsiCo Inc.'s USD 1.7 billion acquisition of South African-based Pioneer Food Group Limited (Pioneer Foods, 2020). This move enables PepsiCo to immediately scale their business and product offerings within SSA by building on known brands focusing particularly on staple food products (Pioneer Foods, 2019). Over the next five years, the merger is expected to create 500 direct and 2,500 indirect jobs. The company is committed to sourcing locally and sustainably through its Food Innovation Valleys concept (Pioneer Foods, 2020).

Investment in Africa's agri-food system is no longer simply a story of multinational companies. African-owned enterprises (gazelles) are expanding their footprint. Table 5.2 lists only five of the Food Business Africa Top 100™ companies in 2020[18] (Food Business Africa, 2020). When one examines the list, majority of firms only joined the food industry at the turn of the century, while others expanded and diversified their operations. For example, BIDCORO Africa Limited. BIDCO was established in 1985 and by 1998 had diversified into seed crushing. Between 2000 and 2005 it expanded their East African footprint by establishing

18 This is a first-of-its-kind listing. Criteria for inclusion on this biennial top 100 listing includes innovation and industry leadership as well as demonstrated commitment to environmental sustainability and social upliftment.

Table 5.2: Five of the top 100 food, beverage, and milling companies in Africa

Company name	Country	Estab-lished	Ownership structure	Sector	No. of employees	Local procurement
Africa Improved Foods	Rwanda	2016	Public-Private Partnership (PPP)	Grain processing	208	2020: 15K MT of maize sourced from 45K farmers
Astral Foods Limited	South Africa, Eswatini, Mozambique, Zambia	-	Publicly traded on JSE	Poultry and animal Feed	9,067 permanent + 2394 contracts	2020: Largely local with import substitution
Beloxxi Industries Limited	Nigeria	1994	Private limited liability	Grains, milling and pastry	2300	-
BIDCORO Africa Limited	Kenya, Tanzania, Uganda,	1985	Joint venture with Co-Ro Food in Denmark and Land O' Lakes (US)	Consumer goods, animal feed	2,000 (+)	2020: Sources from 30K Soya bean and Sunflower farmers
Dangote Group	Nigeria	1978	Diversified and fully integrated conglomerate	Sugar, salt and seasoning, Tomato and rice farming, fertilizer	10,500 (+)	2020: 60% locally sourced rice, while vertically integrating into rice farming

Source: Food Business Africa, 2020 and company websites.

operations in Tanzania and Uganda. By 2009 the company had further diversified into animal feed production. Its products are currently available in 17 countries in Africa.

Going forward, the ability of local startups and medium-scale family-owned food processing companies to expand is predicated on the availability of financing. From a regional perspective, access to credit is woefully inadequate in SSA. Between 2000 and 2016, domestic credit to the private sector as a share of GDP declined from 57 percent to 45 percent (Figure 5.3).

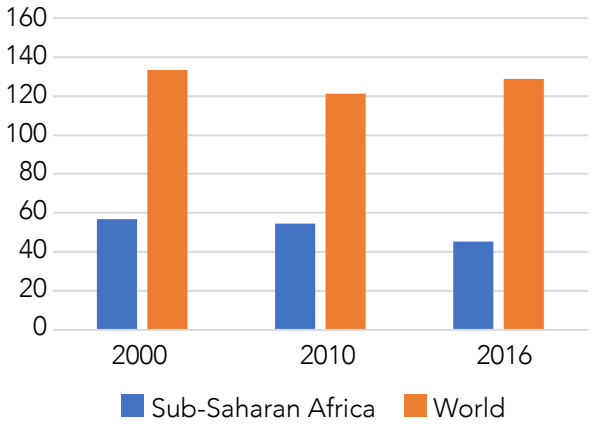


Figure 5.3: Domestic Credit to Private Sector (% of GDP)

Source: World Bank Jobs Database

At the retail level, the COVID-19 health and safety crisis further accelerated the growing demand for supermarket-style retailing, e-commerce, and food delivery by households in middle-income countries (Reardon & Vos, 2020). Africa was no exception. Between 2015 and 2020, the top three leading retail outlets in South Africa expanded their African footprint by increasing the number of outlets across the continent as indicated in Table 5.2 (MassMart, 2015 & 2020; Pick n Pay, 2015 & 2020; Shoprite Checkers, 2015 & 2020).

This expansion of the African footprint of formalized agribusiness enterprises can, to a degree, mitigate the economic precarity linked to largely informal labor markets found on the continent (Fox, et. al., 2020). These companies offer stable wage and salary employment with benefits[19], equity[20], as well as human capacity development opportunities[21].

While this has positive implications, one would need to think carefully about the "how" when it comes to these firms entering the African space. African national and multinational competition authorities and

19 87.8 percent of MassMart associates received health benefits in 2020

20 In 2020, 65 percent of Shoprite Checkers employees were female

21 Shoprite Checkers invested approximately USD 32 million towards employee training in 2020

Table 5.3: Expansion of African Footprint for the top three South African Retailers: 2015-2020

No. of Stores	MassMart*		Pick n Pay**		Shoprite Checkers***	
	2015	2020	2015	2020	2015	2020
South Africa	365	404	1126	1771	1644	2048
Rest of Africa	38	41	116	154	289	330
Total Stores	**403**	**445**	**1,242**	**1,925**	**1,933**	**2,378**
Total Employees	**48,035**	**45,776**	**48,700**	**53,600**	**132,942**	**141,452**

Source: MassMart, 2015 & 2020; Pick n Pay, 2020 & 2015; Shoprite Checkers, 2015 & 2020

Notes:

* Stores operating in Botswana, Eswatini, Ghana, Kenya, Lesotho, Namibia, Nigeria, Tanzania, Uganda, Zambia

** Stores operating in Botswana, Eswatini, Lesotho, Namibia, Zambia and Zimbabwe, with planned expansion into Nigeria

*** Stores operating in Botswana, Eswatini, Lesotho, Mozambique, Namibia, Zambia, Madagascar, Uganda, Ghana, Nigeria, Malawi, and DRC

networks such as the African Competition Forum (ACF) play a critical role. These organizations can contribute solutions to national challenges by strategically and effectively enforcing competition and merger regulations on foreign direct investments. Such enforcements could support the development of national markets and food supply chains through local procurement requirements and provide social protection through community upliftment programs and/or minimum wage requirements.

Typology of the downstream market: survivalist entrepreneurs

Most marketed food output e.g., grains, tubers, pulses, etc. in Africa goes through under-capitalized informal markets. The vast majority of those employed in these food systems are living near or below the poverty line. This applies to the majority of smallholder farmers as well as those employed in off-farm stages of the food system as illustrated in Figure 5.4. Across all regions except Southern Africa, informal employment as a percentage of total employment in the agricultural and non-agricultural sector was above the global average of 64.7 percent (represented by the green line) for the economies of emerging and developing markets.

In fact, the vast majority of those employed in off-farm stages of the food system are self-employed *survival entrepreneurs* involved in small-scale trading or transporting; their businesses are generally seasonal operations in the informal sector with no benefits. They must self-insure themselves and their families. Their low returns to labor are related to low entry barriers into trading, creating great localized competition and hence low trading margins.

Informality has implications for economic sustainability. Limited access to credit, low human capital and physical infrastructure accumulation, and little to no livelihood and job stability are a few of the challenges (World Bank, 2021). As a consequence, productivity remains low (LaPorta and Schleifer, 2014) and perpetuates the current fragmentations of Africa's food value chains.

A major policy priority is how to grow the economy to transition most people currently informally employed in food systems to wage earners in formal sector firms (either small-, medium-, or large-scale) in agribusiness-related activities or in the non-farm sector. African governments and development partners should focus on increasing and attracting investments into network/infrastructure industries such as roads, rail, water and electricity (see Case

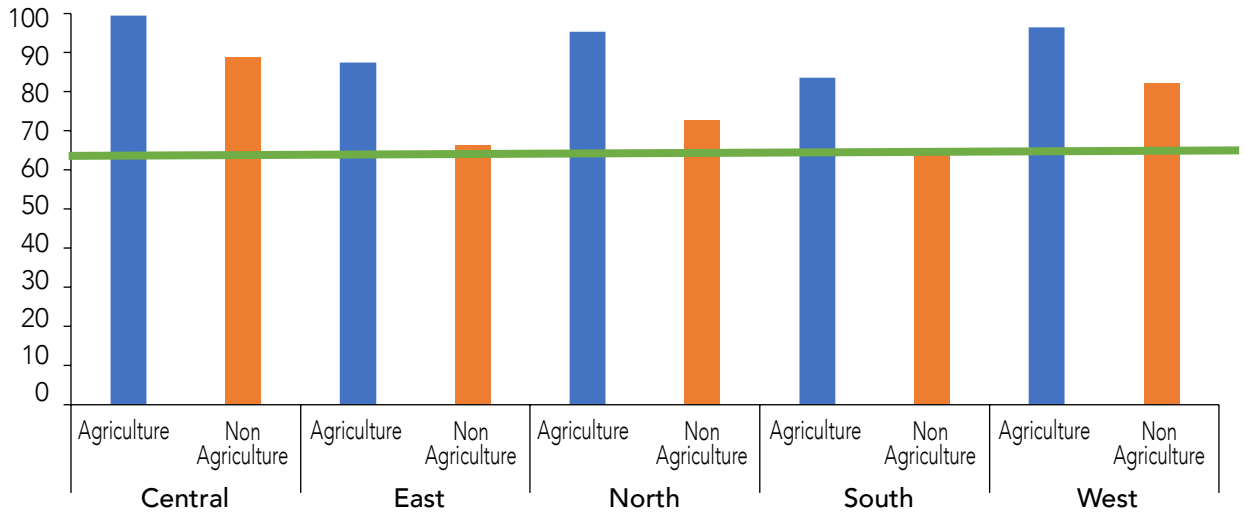


Figure 5.4: Regional Informal Rate of Employment by Sector (%)
Source: Own calculation. International Labour Organization, harmonized series; World Bank (2021)

Study Box 1). Such basic infrastructure would, in turn, serve as a catalyst for more formalized agri-food enterprises from SMEs to major agribusiness. The incentive for governments is that formalized businesses can easily be registered with the revenue authorities of the respective countries and through taxation, boost the fiscus in order to strengthen public service provision as well as social protection programs[22] (World Bank, 2021).

The ability of the downstream agri-food system to meet the current and future needs of African consumers depends on the capacity of elephants, gazelles, and survivalist entrepreneurs to leverage the strengths and mitigate the weaknesses inherent in the system. In a world of growing uncertainty and constantly shifting landscapes, building resilience will require understanding the key opportunities and potential threats to the system's resilience. These insights can be translated into actionable strategies to ensure a sustainable and resilient African food system.

External factors shaping resilience in downstream agri-food systems in Africa

By definition, resilient agri-food value chains can absorb shocks, adapt to their effects, and transform themselves to "build back better" systems that deliver affordable and nutritious food to consumers (Stone & Rahimifard, 2018). This section explores external opportunities and threats that are shaping Africa's downstream agri-food systems. These external factors are summarized in Table 5.4 using a PEST framework. Given the magnitude and heterogeneity of the African continent, it is impossible to exhaustively analyze these external factors. This section therefore focuses on a narrow set of external factors that will likely have broad and enduring effects across much of the continent. It is important to acknowledge that the impact of these factors on downstream agri-food systems will vary significantly with type of commodity value chains[23], the size and composition of market actors (i.e., proportion of elephants, gazelles, and survivalist entrepreneurs), and geography (sub-region, country, rural vs. urban). This section explores these external factors paying attention to how they can facilitate or constrain the resilience of Africa's downstream agri-food processing systems as opportunities or threats respectively.

Political factors

Government actions, or lack thereof, at the national, regional, and continental levels play a fundamental role in shaping the macro-environment in which agri-food systems operate. The latest and probably the broadest-sweeping of these government actions is the commitment by 54 of the 55 AU nations to join AfCFTA. The Agreement, which took effect at the beginning of 2021, opens the path towards creating a single market, thereby deepening economic integration on the continent (Technical Box 1 explores the broader economic potential of the AfCFTA beyond the agri-food sector). As highlighted earlier, the prospect of a single African market with more than 1 billion consumers and a combined GDP of more than U$2.5 trillion presents vast opportunities for agribusiness. For large and well-established agribusinesses – the elephants – the expanded markets create unprecedented opportunities to capitalize on economies of scale, while minimizing localized risks through geographically integrated supply chains. Some of the smaller agribusiness – the gazelles and survivalist entrepreneurs – may be squeezed out of the market as it consolidates. Still, many will continue to plug distribution gaps as consolidators and base of the pyramid retailers. Overall, the expansion of trade in agricultural markets both within and outside Africa will likely positively contribute to resilience in food systems (Badiane, Makombe, & Bahiigwa, 2013).

Despite the strong political will driving AfCFTA, non-tariff barriers (NTBs) will likely continue to stifle regional trade and integration. NTBs are defined as restrictions resulting from prohibitions, conditions, or requirements that make the importation or exportation of goods difficult and costly.

22 See Chapter 9 on the role of social protection in fostering sustainable food system transformation.
23 Value chains such as livestock, blue-economy, staple crops, horticulture, and high-value products, etc.

Table 5.4: Key external factors shaping resilience in Africa's downstream agri-food systems

External factors	Opportunities	Threats
Political	• The common market under the African Continental Free Trade Agreement will expand regional trade potential for African farmers, with associated employment growth in African food systems. • National government's growing commitment to the agricultural sector (CAADP[24], Malabo Declaration[25] and NAIPs[26])	• Non-tariff barriers to regional trade • Poor implementation of National Agriculture Investment Plans (NAIPs) • Ad hoc government policies that disrupt market forces and trade. • Conflict hotspots and political instability
Economic	• Significant progress has been made over the past decade in improving the enabling environment for agribusinesses.	• Weak enabling environments for agribusiness persist through much of the continent. • Poor infrastructure connectivity contributing to the high cost of doing business on the continent.
Social	• Demographic shifts: Growing population, youth bulge and urbanization • Positive returns to female participation in primary agricultural system.	• Gender inequality in downstream processing.
Technological/ Environmental	• The rise of digital technologies and growth in e-commerce • Rising number of patents published in field of technology with application at primary agricultural level.	• Declining number of patents published in fields of technology with greater application in off-farm level. • Increased frequency and intensity of extreme weather events due to climate change • Rapid expansion of cropped area resulting in deforestation, soil degradation, and associated losses in biodiversity and environmental resilience • Spread of pests and diseases that threaten crops and livestock • COVID-19 and other pandemics

24 Comprehensive Africa Agriculture Development Programme
25 Also known as the 2014 declaration on Accelerated Agricultural Growth and Transformation
26 National Agricultural Development Plans

These include unjustified and/or improper application of non-tariff measures such as sanitary and phytosanitary or technical measures. NTBs can also arise from official measures in laws, regulations, policies, restrictions, labelling requirements, private sector business practices, or prohibitions. Increasingly, several countries use them to protect domestic industries from foreign competition. Several studies show that NTBs and trade facilitation issues pose significant challenges to intra-African trade and integration (Karugia et al, 2009; Dupasquier and Osakwe, 2017). The success of AfCFTA will be primarily determined by the commitment to eliminate NTBs by all African countries. It is not the conclusion of formal agreements *per se* that will boost intra-African trade, but what countries are willing to do with the impediments at border posts and along trade routes that count.

Within the narrower confines of the agricultural sector, many African governments have made commitments to invest in the sector and support pro-business policies. CAADP, the 2014 declaration on Accelerated Agricultural Growth and Transformation (Malabo Declaration) along with NAIPs has brought together government, private sector, development partners and civil society actors under a shared framework to increase investments and boost productivity in the agricultural sector. Despite these formal commitments, progress in implementing targeted investments and reforms has fallen short in large part due to fiscal budgetary constraints (See Box 2 and 3 case studies on Kenya and Tanzania). The 2019 Biennial Review Report and the Africa Agriculture Transformation Scorecard (AATS) show that although African countries are making progress toward achieving the Malabo goals, the rate of progress has slowed. While 36 out of 49 reporting African countries improved their overall agricultural transformation scores compared to 2017, only four countries, namely Rwanda, Morocco, Mali, and Ghana, surpassed the 2019 benchmark (AUC, 2020). The same report shows that out of the seven commitments from the Malabo declaration, Africa as a whole is on track to meet only one commitment, namely tripling intra-African trade in agriculture. Only 11 countries are on track to meet the commitment to enhancing resilience to climate variability. The gaps between political commitment and implementation will continue to limit the growth and resilience of the agri-food sector.

In most countries, ad hoc government policies continue to disrupt market signals and trade. For example, rice trade and value chain development in West Africa have been hampered by inconsistent trade policies, different and changing tariff levels, and weak enforcement of food quality and safety standards (Tondel, D'Alessandro, Hathie, & Blancher, 2020). We see a similar situation in Zambia where maize export bans are typically imposed negatively affecting the trading companies with export commitments (ReNAPRI, 2019).

Export and import bans are a common feature in Africa, even within customs union territories. Oftentimes, countries revert to export bans and other export restrictions on raw or semi-processed commodities to promote value addition and for food security considerations. This policy stance increases the domestically available supply of raw materials, eventually leading to a fall in domestic prices. The attraction of export bans is that while domestic raw producers (e.g., farmers, loggers, and miners), middlemen, and exporters are likely to lose income, processing in the country of origin becomes more competitive vis-à-vis raw exportation and foreign processing, thereby incentivizing domestic and foreign entrepreneurs to invest in country-of-origin processing.

Another major political threat to agri-food systems in Africa stems from ongoing as well as new conflicts. According to a recent report, *Conflict Trends in Africa* (Palik, Rustad, & Methi, 2020), in 2019, state-based conflicts on the continent reached a record high 13 of which were territorial conflicts. In addition to the usual conflict hotspots, there is growing concern on the rise and expansion of the Islamic State, which accounted for conflicts in nine African countries in 2019 (Cameroon, Niger, Chad, Nigeria, Libya, Burkina Faso, Mali, Somalia, and Mozambique).

Economic factors

The agri-food system operates within the broader context of macro-economies and thus any success or failure of the system is inextricably tied to national growth and development. The emergence, performance, and resilience of downstream agribusiness firms primarily depend on the enabling environment. Such an environment is defined as a "set of policies, institutions, support services and other conditions that collectively improve or create a general business setting where businesses activities can start, develop, and thrive" (Christy et al, 2009).

While significant progress has been made over the past three decades in improving the enabling environment for agribusiness, SSA remains a challenging place to do business. According to the latest *Doing Business* report, only one African country, Rwanda, makes it to the top 50 out of a ranking of 190 countries (World Bank, 2019). The average score for Sub-Sharan Africa was 51.8 out of 100, which only improved by one point from the previous year[27]. The regions perform poorly on indicators that are vital to downstream agribusinesses, including processes for business incorporation, access to electricity, access to credit, paying taxes, engaging in international trade and contract enforcement. Weak public infrastructure, especially transport (both rail and road) and electricity, significantly increases the cost of producing, processing, storing, and delivering food, especially for high-volume, low-value products.

The *Enabling the Business of Agriculture* report, which is much more geared for upstream agri-food players (farmers and agricultural input supply), also shows high regulatory and efficiency gaps between SSA and global averages. The implications of this weak enabling environment for resilience in Africa's agri-food system are twofold. For established agribusinesses that are already working in Africa, many have already been stress-tested under unfavorable business environments, making them more adaptive to shocks. On the other hand, a weak enabling environment acts as a barrier to entry for many agribusinesses that could improve competitiveness and service delivery.

Poor infrastructure connectivity contributes to the high cost of doing business on the continent. Several studies have revealed that transport costs in Africa are still among the highest in the world. For instance, shipping a car from Japan to Tanzania (Port of Dar es Salaam) would cost about US$1,500 (including insurance); shipping the same car from Dar es Salaam to Lusaka (Zambia) would cost close to US$5,000. For a continent with the vast majority of its population living in abject poverty, this trend has to be reversed. The high cost of doing business is inadvertently passed on to the consumer, which defeats the ultimate poverty eradication and wealth creation objectives of regional integration. Closing infrastructure financing gaps should thus be a key priority for governments and development partners on the continent. The presence of physical infrastructure should stimulate trade and investment; hence more attention should be on mainstreaming soft infrastructure issues in infrastructure projects. Harmonization of transport and other infrastructure policies and regulations among member countries is essential if the continent is to benefit from regional integration.

Social factors

Demographic and socio-cultural factors both play a critical role in shaping demand for agri-food products. Africa's population stands at more than 1.3 billion people with a growth rate of about 2.5 percent per annum (Worldometers, 2020). By 2040 the continent's population will likely exceed 2 billion people accounting for nearly a quarter of the global population (Worldometers, 2020). From a demand perspective, population growth, coupled with rapid urbanization and a shifting consumer preference for value-added and processed foods, presents market potential for downstream agribusiness (see Figure 5.2 above).

From the supply side, Africa's youth bulge presents unique opportunities to increase food supply

27 For comparison, New Zealand and Singapore had the highest individual country scores at 86.8 and Singapore 86.2 respectively.

through labor markets. Recent investments by government and development partners to engage Africa's youth in agriculture as a strategy to create employment are starting to bear fruit (Yami et al, 2019). Other studies are more skeptical, concluding that youth training programs are proving to be ineffective and that most young entrepreneurs' ventures fail and are largely enterprises in the informal sector. Assuming that evidence-based policies will prevail, we predict that as more African youths explore entrepreneurship in agri-food systems, supported by capacity development and microfinancing, the continent will likely witness a surge in agri-SMEs (gazelles and transitioning survivalist entrepreneurs). This could further strengthen food value chains through increased and competitive service delivery.

African women make a significant contribution to agriculture at the farm level. Data from *Living Standards Measurement Study - Integrated Surveys on Agriculture* (LSMS-ISA) puts average female share of labor in crop production across Ethiopia, Malawi, Niger, Nigeria, Tanzania and Uganda at 40 percent (Christiaensen and Demery, 2018). Moreover, women play a central role in household food processing and meal preparation. Despite these significant contributions to on-farm activities by women, their participation in downstream formal agribusinesses is fairly limited. While women dominate localized and informal food markets, men are more involved as commercial players, especially in more lucrative value chains (AfDB, 2016). To build resilient and inclusive food value chains, Africa must close the prevailing gender gaps in: (i) access to and control over productive resources and opportunities; (ii) influence and collective capacity; and (iii) agricultural policies and investment (FAO,2018).

Technological and environmental factors

Starting from a very low baseline, Africa has great potential to enhance the productivity and efficiency of agri-food systems through technological innovation and adoption. When the number of published patents by Africans in Africa across two decades (2000-2009 and 2010-2019), in fields of technologies with greater application at the primary agricultural level are examined, the number of patents published increased between the two decades (Traub, Jayne, and Sihlobo, 2021). For example, in biotechnology and environmental technology the number of patents published increased from 133 to 200 and 197 to 212 respectively (Table 5.3). Upstream at the farm level, the prevailing yield gap can be closed by adopting and intensifying purchased technologies and innovations such as improved seed varieties, crop protection, and animal health products, fertilizers, irrigation, and mechanization.

For downstream value chain actors, new innovation in storage, processing, and logistics can significantly reduce post-harvest losses. However, in fields of technologies with greater application in downstream levels of the food system, the number of patents published in Africa by Africans tended to decline between 2000-2009 and 2010-2019. In food chemistry, this number fell from 216 to 190, while handling technologies saw a significant decline to less than half the number of patents published from 650 in 2000-2009 to 264 in 2010-2020. This decline flags the issue of African capacity[28] to develop such technologies which are relevant to the local downstream level of the agri-food system.

Recently, there is a growing recognition that digital technologies can transform the agricultural sector in Africa to build back more efficient and resilient food systems. Increased mobile phone penetration and improved access to the internet have fueled the spread of digital agricultural services. For example, mobile phone subscriptions in Africa grew from under 10 per hundred people in 2005 to more than 80 per 100 people by 2018. As measured by a number of unique subscribers, mobile phone penetration has risen by 25 percent over the past decade to 45 percent in 2019 and is projected to reach 50 percent by 2025 (GSMA, 2021). Moreover, the COVID-19 pandemic has provided a unique opportunity to accelerate the deployment of contact-free digital solutions along the food value chain.

28 See Chapter 7 which examines the issue of capacity and its impact on the agri-food system.

Table 5.5: Patent publications by technology: number of patents registered in Africa by Africans

Field of technology	Period	
	2000-2009	2010-2019
1 - Electrical machinery, apparatus, energy	380	325
3-7 - Telecommunications[29]	578	643
15 - Biotechnology	133	200
18 - Food chemistry	216	190
19 - Basic materials chemistry	305	269
24 - Environmental technology	197	212
25 - Handling[30]	650	264
28 - Textile and paper machines	94	75
32 - Transport	554	307

Source: WIPO Statistics database, Schmoch, 2008

The growing adoption of e-commerce in middle-income African countries will further accelerate and deepen digitalization. According to *The Digitalization of African Agriculture* report, the number of digital agriculture solutions serving Africa has skyrocketed from only 42 in the period before 2012 to 390 by 2018 (Tsan, Totapally, Hailu and Addom, 2019). These services reach an estimated 32.7 million smallholder farmers and downstream actors enhancing access to advisory and information services, market linkages, financial access, and value chain coordination tools. Digitalization of agri-food value chain can increase the resilience of the entire food system through better coordination between actors and increased use of big data to predict and mitigate against shocks.

Climate change poses an increasingly severe threat for African agriculture. From droughts in the horn of Africa, to flooding in East Africa, extreme weather events are occurring with increased frequency and intensity across the continent, often resulting in massive disruptions in food supply.

The rapid expansion of cropped area across the continent is resulting in deforestation and fueling the vicious cycle of climate change and environmental degradation, soil degradation, and associated losses in biodiversity and environmental resilience. The continent is considered highly vulnerable to climate change due to weak adaptive capacity, high dependence on ecosystem goods for livelihoods, and less developed agricultural production systems. While the immediate effect of climate change is felt upstream on farms[31], the effect of reduced supply of raw material often cascade to downstream actors and consumers. Africa's food supply faces increased threats from a host of pests and diseases linked to climate change. These include the FAW, desert locusts, and wheat rust, which are increasingly hard to control. Due to the transboundary nature of pests, diseases, and weather events, it is essential to establish interconnected prediction, response and mitigation strategies across agri-food system actors at local, regional, and continental levels.

29 Includes telecommunications, digital and basic communication, computer technology, and IT methods for management fields.

30 This includes technologies in cranes, elevators, and packaging.

31 It's important to note that adverse weather, such as flooding, can directly impact downstream actors and consumers by disrupting distribution channels; see https://floodlist.com/africa/kenya-floods-may-2021

Towards actionable strategies and policy conclusions

Can Africa leverage its food system to achieve the aspirations of Agenda 2063 or the 2030 SDGs? African leaders answered the Mayibuye plea ahead of the UNFSS. At the June 2021 extraordinary meeting of the African Union Specialized Technical Committee (AUSTC), ministers of agriculture outlined the African Common Position, which identified five priority action tracks in response to the UN's call for food system transformation.

Achieving the growth and transformational targets will depend on the capacity of governments to provide an enabling environment that encourages rapid investments in productivity-led agricultural growth on millions of African farms and in small-, medium- and large-scale agribusinesses whose profits and productivity are synergistically entwined with farmer production growth. It will be extremely difficult to attract young people, from which the next generation of African farmers will come, into farming or agribusiness if neither farming nor agribusiness trading is profitable.

Government actions that provide a conducive enabling environment include the following:

1. National agricultural R&D&E in crop science, good agronomy, and animal science to promote technical innovation appropriate to the highly-varied agro-ecologies of Africa.
2. National agricultural R&D in food sciences, handling, storage, and transportation innovation relevant to all stages of the food system and market conditions of Africa.
3. Effective enforcement of national and regional competition policy to enhance inclusive economic growth and transformation for all types of agri-food enterprises (gazelles, survivalists, and elephants).
4. Physical infrastructure investments including roads, rails, ports, reliable energy/power, and conventional communications, and ICT to enable digital technologies to thrive.
5. Cybersecurity policy and regulatory frameworks that develop cyber defense capabilities, promote the digital economy, strengthen digital governance, and promote public infrastructure that closes the digital divide between women and men as well as rural and urban populations.
6. Effective and transparent implementation of existing policy to ensure no unreasonable barriers to trade or investment. Aggressively move forward to implement AfCFTA.

To translate the SWOT and PEST analysis into sustainable and resilient strategies for private sector agri-food stakeholders, this section links internal characteristics aimed at achieving sustainability with external factors that facilitate resilience. The resulting actionable strategies for the private sector include:

1. Use strengths to leverage opportunities

    - *Projected food demand – technological opportunities*

      Africa has great potential to enhance the productivity and efficiency of agri-food systems through technology adoption. For downstream value chain actors, new innovation in storage, processing. and logistics can significantly reduce post-harvest losses and ensure healthy and nutritious food products. Moreover, the COVID-19 pandemic has provided a unique opportunity to accelerate the deployment of contact-free digital solutions along the food value chain. The growing adoption of e-commerce in middle-income African countries will further accelerate and deepen digitalization.

    - *Growth potential of African agri-food system – political opportunities*

      National governments' commitment to agricultural investments could position agriculture as one of the sectors that will lead the economic recovery from the COVID-19 slump. Successful

implementation of AfCFTA could expand markets and create unprecedented opportunities to capitalize on economies-of-scale for well-established agribusinesses. PPP approaches to infrastructure development could ease constraints on regional trade. A case in point is South Africa's Economic Recovery and Reconstruction Plan centered around infrastructure, with the private sector playing a prominent role. There is also a role for international development finance institutions, for example, AfDB's high-five initiative around infrastructure investments.

2. Leverage Opportunities to minimize weaknesses

   - *Limited productivity growth in primary agriculture – political and technological opportunities*

     Governments' political commitment to agricultural R&D&E investment should be leveraged to develop regenerative agroecological approaches that protect soils and ensure sustainable intensification. This will be a catalyst for increased productivity and resilience in Africa's farming sector.

   - *Persistent informality – political opportunities*

     Unlock financial capital constraints to facilitate modernization of local informal food markets. Through a blend of finance instruments, consolidate public and private funds to provide capital to transition value chains. For example, in South Africa, a blended finance instrument consists of 50-50 public and private capital. The government portion is a subsidy for de-risking the businesses so that the private sector can participate and still receive fair returns. This fund targets new participant farmers and smallholders who aim to commercialize and expand their businesses. The fund primarily targets input loans, infrastructure investments, and land acquisition (IDC, 2021).

   - *Persistent informality – social opportunities*

     Africa's youth bulge presents unique opportunities to increase food supply either through providing low-cost labor or through innovative and competitive service delivery. Public and large-scale agribusiness support of capacity development programs, microfinancing targeting, and removal of regulatory barriers that constrain the growth of agri-SMEs can be leveraged by transitioning value chains (gazelles).

Africa can achieve the aspirations of Agenda 2063 or the 2030 SDGs by leveraging the strength and opportunities inherent in the agri-food system. However, to do so effectively will require both private and public stakeholders working collaboratively to achieve the continent's transformational agenda. Mayibuye iAfrika.

Case Study 1: Smart Food Markets of the Future Project

A project implemented in Kenya by the Eastern Africa Grain Council (EAGC), with support from The Rockefeller Foundation.

Previous efforts in food security and food availability have been focused on production and increasing productivity. Despite their centrality and importance, market value chains in food systems have received minimal attention - "80 percent of the population relies on open-air markets for their source of food and nutrition. 55 percent of fruits and vegetables and 30 percent of food grains are sold through open-air markets. Investing in markets would immediately support women vendors who constitute about 55 percent of the traders" (EAGC, 2020).

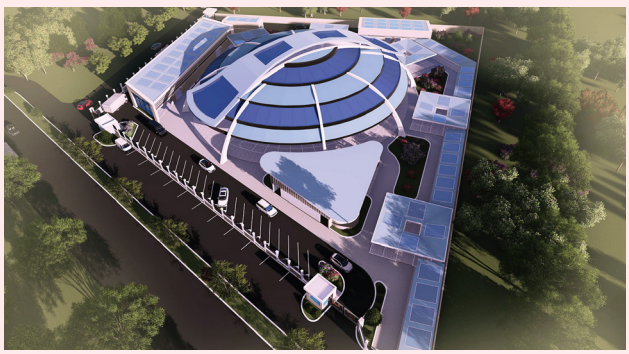
EAGC, with support from The Rockefeller Foundation, is rethinking and re-imagining open-air food markets in a project to "establish Smart Food Markets for the Future in Kenya". In response to the question of "how might we re-imagine open-air markets in Kenya to enable high standards of safety, sanitation, comfort, sustainability, and economic prosperity?" EAGC imagined a market that covers market participants' basic sanitation, safety, and comfort needs while amplifying their economic opportunities. A market that supports the traceability and safety of produce to inspire better food choices for shoppers and enables reducing, recycling, and reusing of waste while restoring natural systems. A market that better reflects and responds to the needs and aspirations of vendors, shoppers and other market actors who depend on it for their well-being (IDEO.ORG, 2020).

Solar energy has great potential to power then envisaged markets. A study established that "a solar mini-grid for smart food market has a payback period of 6 to 15 years depending on the size and battery storage options" (PowerGen, 2021). Business Analysis indicated that the smart markets were viable with a 32 percent return on investment (Dalberg Consulting, 2021).

The project is supporting the design and construction of the Naivasha Smart Fish Market in Nakuru County, Kenya, and is expected to be completed at the end of January 2022. Cladded with solar photovoltaic roof panels for a solar mini-grid, the market features modern sanitation and COVID-19 compliance facilities, an e-mobility center for battery swapping and charging electric bikes and vans for food deliveries. Additionally, a cold store, kitchen, and fish processing facility, water harvesting, and sanitation. Notably, there will be a waste management center for collecting, sorting, and evacuating waste for recycling. The organic waste will be supplied to insect-based feed farmers of Black Soldier Flies[32], an alternative and potentially lower-cost protein source for blending with cereals grains to manufacture animal feeds.

Besides the Naivasha Smart Fish Market, the project will pilot a solar-powered e-mobility smart solution at the Nakuru Top Market, Ngong Market in Kajiado County, and City Park Market in Nairobi County where a waste management solution will also be piloted.

To scale up, replicate and mainstream the Smart Food Markets Concept, a new National Markets Policy is under development in partnership with the State Department for Housing and Urban Development in Kenya.



The Proposed Naivasha Smart Fish Market in Nakuru County, Kenya; Design by School of Architecture & Building Sciences, Jomo Kenya University of Agriculture & Technology.

32 https://en.wikipedia.org/wiki/Hermetia_illucens

Box 1: AfCFTA: Trade creation and trade diversion potential from proposed tariff reduction

Africa's share of global trade and production has been declining over the years and the continent continues to engage at the periphery of the global economy. Most African countries predominantly export commodities in a limited range of products and largely import finished goods from outside the continent. In this context, most African businesses operate mainly in small domestic markets with low purchasing power and limited competition to drive productivity and efficiency. This stifles economic diversification and growth in most African countries. Of the 32 landlocked less-developed countries (LLDCs) in the world, 16 are in Africa and are poorly connected to sea ports and other African countries. The potential advantages of regional integration to the private sector include increasing economies of scale and access to cheaper raw materials and intermediate inputs, better conditions for the development of regional value chains, and integration into global value chains. AfCFTA therefore, presents an opportunity to develop trade in manufactured and final products.

Unlike other regions, Africa trades less with itself; intra-African trade is currently estimated at between 15 and 17 percent, which is quite low compared to Europe (69 percent), Asia (59 percent) and North America (31 percent). According to the World Bank, with the start of trading under AfCFTA launched on 1st January 2021, it is expected that the Agreement could boost regional trade and regional income by 7 percent or US$450 billion by 2035. It is also anticipated that trade will be a key driver of growth in Africa in the next couple of decades.

According to estimates by the Economic Commission for Africa (ECA), AfCFTA could substantially increase the value of intra-African exports. Just by removing tariffs on goods, AfCFTA is expected to increase the value of intra-African trade by up to 25 percent (or $70 billion) in 2040, depending on liberalization efforts. The removal of non-tariff barriers could potentially double intra-African trade by the same period.

Trade diversification of exports is important as it allows countries to build resilience to shifts in demand due to economic downturns in importing countries as well as price dips. In the case of commodity-exporting countries, it supports a shift from over-dependence on commodities to higher-value-added products and services. Figure 5.5 illustrates the 15 to 17 percent trade occurring among African countries; the top ten products traded are largely industrial.

Manufactured goods make up a much higher proportion of regional exports than those leaving the continent—41.9 percent compared to 14.8 percent according to recent estimates. Cement, ship and light vehicles, and sugar have consistently been the top three exports among African countries over the last ten years (2010-2019). However, the real test of AfCFTA will be how quickly African countries can accelerate export diversification and product sophistication and make trade more inclusive. It is, therefore, important that the Boosting Intra-African Trade (BIAT) Action Plan endorsed by African heads of state and government in 2012 is implemented to promote industrialization on the continent. This will allow for the inclusion of small- and medium-sized enterprises and help encourage innovation as more markets open.

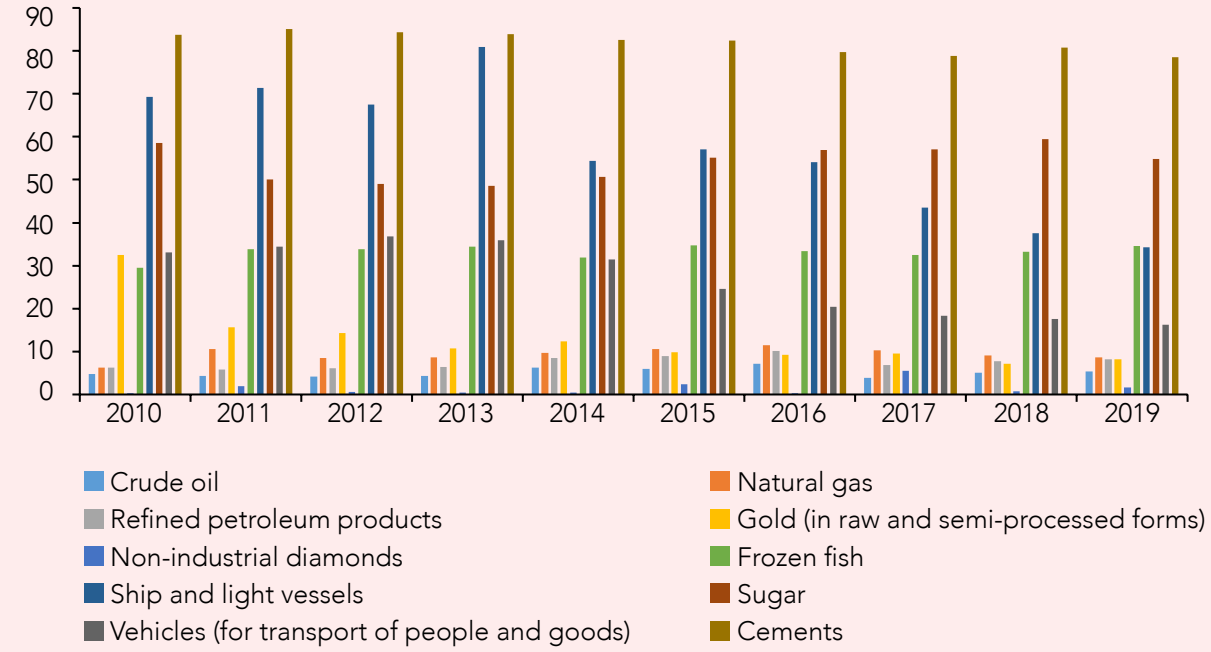


Figure 5.5: Top 10 Intra-African Export (%) Products 2010-2019

Source: UNCTADstat

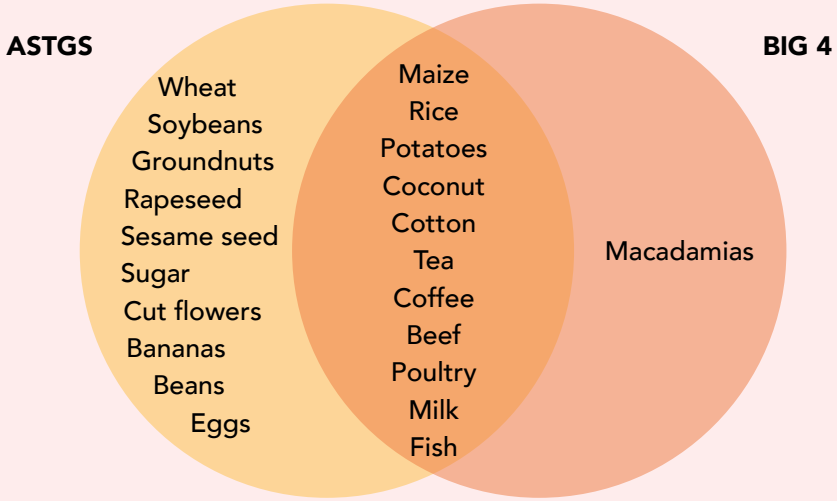
Box 2: Prioritizing the National Agriculture Investment Plan in Kenya and Tanzania: A method of determining policy/regulatory reform impacts to allow policy makers options

Kenya's NAIP for 2019-2024 is a five-year investment plan accompanying the country's 10-year Agriculture Sector Transformation and Growth Strategy (ASTGS). The goal is to achieve a vibrant, commercial, modern, and equitable agricultural sector that sustainably supports economic development. The process of preparing the NAIP was highly consultative and iterative and nine flagship projects were identified through a rigorous process of prioritization for feasibility, impact and value-chain fit given the agroecological zones in which the flagships would be implemented (GoK, 2019).

Kenya's identification of priority value chains (VCs) considered the following: production value; regional import demand; competitive advantage; potential yield increase; agro-processing potential; percent of total value chain output from smallholders; nutritional value; and calorific value. As a result, 21 and 12 VCs were prioritized under the ASTGS and the Big Four Presidential Agenda[33], respectively, as shown below[34].

33 Kenya's President Uhuru Kenyatta's development blueprint, The Big 4 Agenda, comprises of food security, affordable housing, manufacturing, and affordable healthcare.

34 This section draws heavily from o-going work in Kenya under the PPVC project (Meyer et. al., 2019)



The identification of key VCs for driving inclusive agricultural transformation was a crucial first step towards policy prioritization. However, given budgetary constraints that policymakers typically face, the next step was to identify and prioritize actionable and affordable policies and public investments that can drive market-led inclusive agricultural transformation in Kenya. This requires: in-depth analysis of market dynamics and price competitiveness; technology and profitability analysis at each stage of the supply chain; and, economy-wide analysis of development outcomes and policy trade-offs. Although the tools required for these analyses exist in many countries, they are rarely used together to provide comprehensive assessments of policy options. As a result, governments lack crucial information needed to design actionable and cost-effective policies that can drive market-led inclusive agricultural transformation (Ferdi et. al, 2019).

To address this gap, the Bill & Melinda Gates Foundation (BMGF)-supported Policy Prioritization through Value Chain Analysis (PPVC) initiative aims to support governments to identify prioritized value chains and assess the economic costs and benefits of specific policy and investment interventions using a market-led approach.

In Tanzania, the PPVC approach, which uses multi-market and economy-wide models, complements Tanzania's ongoing national agricultural investment planning by providing new analytical tools to help the Government evaluate the policy and investment needs of priority VCs.

The approach ranked the 15 prioritized commodities in Tanzania's Agricultural Sector Development Programme Phase II (ASDP II) using quantitative and qualitative analysis. The prioritized VCs were selected based on their market potential and effectiveness in contributing to development outcomes (i.e., economic growth, jobs, poverty reduction, and dietary diversity). The indicators considered in the quantitative VC scans were: (i) market-led - consisting of multiple indicators showing the VC upgrade potential and competitiveness i.e., intensification, domestic consumption growth, regional export potential, input cost efficiency ratio and relative trade advantage; (ii) social inclusiveness i.e., poverty employment; and, (iii) agricultural transformation i.e., agricultural food system growth and dietary change. Outputs

from the Partial Equilibrium (PE) and Computable General Equilibrium (CGE) models and VC scans informed the selection criteria/indicators, which were combined into a "portfolio and ranking" approach to facilitate prioritization and selection of three VCs for deep-dive analyses, one of which was the sunflower value-chain.

The detailed analysis identified a list of value-chain-specific policies and public and private sector investments that were required to drive inclusive growth and transformation in the sunflower oilseed sector. Implementation of the recommended prioritized policies could help ensure that the cooking oil supply in the country was resilient to external shocks such as the COVID-19 pandemic.

Like many African countries, Tanzania imports large volumes of palm oil from Indonesia and Malaysia with smaller volumes also coming in from other global exporting countries. Palm oil in Tanzania is the single largest agricultural product import (by value) and is the second-largest overall product import by value behind petroleum oils (ITC, 2018)[35]. At the same time, sunflower as an oil crop can be grown in almost all regions in the country given the favourable soil and prevailing climatic conditions. The over-reliance of the domestic edible oils sector on imported palm oil is a thus clear case for import substitution. While SMEs are the predominant sunflower oil processors in Tanzania, they underperform with an average extraction rate of 25 percent and capacity utilization running between 30 and 40 percent. Outdated technology and low levels of investment are among the key challenges.

The challenge of low investment among SMEs sunflower seed crushers can be addressed through policy incentives such as the removal of value-added tax (VAT) on the importation of solvent extraction technology and domestic sales between SMEs and commercial crushers. The results of the study indicated that with a yield gain, implementation of palm import tariff rate, VAT exemption, and feed policy reform, the net gain to Tanzania's agri-food system could be USD 2,051 million in GDP, 181,000 jobs created, and reduction of approximately 363,000 people in the rural poor (see Figure 5.6).

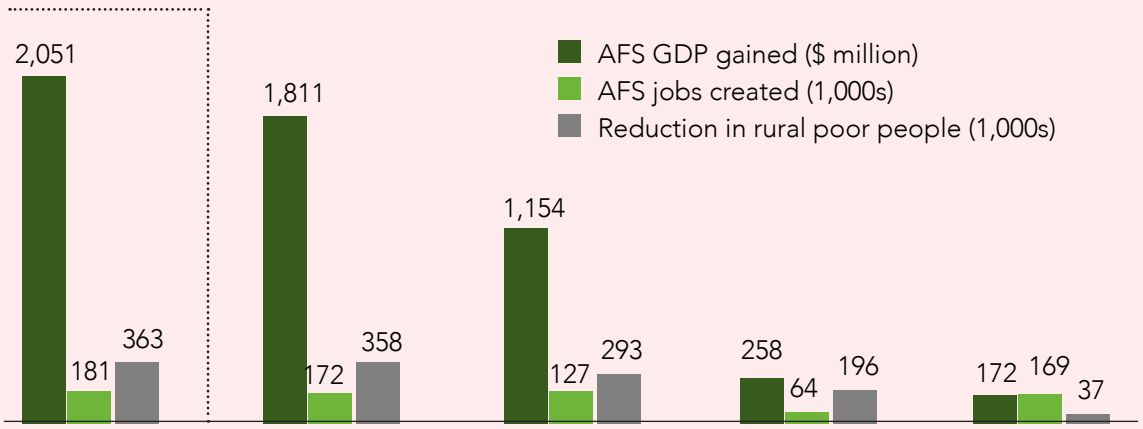


Figure 5.6. Economy-wide Gain through Sunflower Value Chain Upgrading

Source: BFAP, SUA (ReNAPRI) & IFPRI, 2018 Presentation on Sunflower PPVC Approach in Tanzania

35 Based on HS 4 level trade data obtained from ITC Trade Map. www.trademap.org, 2018

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6 The Codependence between Nutrition, Resilience and Sustainable Food Systems

Makaiko Khonje[1], Martin Fregene[2], Atsuko Toda[2] and William Burke[1]

Key messages

1. Although Africa has high levels of malnutrition, child stunting reduced from 38 percent in 2000 to 30 percent in 2018. However, Africa still has the highest prevalence rates of stunting, anemia, and hungry people.

2. Key barriers include overreliance on subsistence farming and correspondingly insufficient specialization, low investment in agricultural R&D&E services, low use (and low efficiency in the use) of modern agricultural technologies and sustainable farming practices.

3. African governments can invest more in agricultural R&D to develop pro-nutrition seed varieties that are appropriate for local conditions and consumer preferences and sustainably raise productivity in staple and micronutrient-dense crops and livestock production.

4. African governments can promote sustainable production practices through increased investment in agricultural R&D&E to sustainably raise productivity of staple and micronutrient-dense crops and livestock.

3. Developing livestock and fisheries sectors, especially small-scale livestock and fish production systems, with breeds that are resilient to extreme heat and diseases would reduce these value chains' vulnerability to climate shocks and increase farm revenues and consumption of animal-sourced foods.

4. Governments can use public health campaigns and subsidies to incentivize consumers to purchase healthy foods; resulting changes in consumer demand can drive new investments by the private sector to respond to the increasing demand for healthy foods

Introduction

Hunger and malnutrition remain widespread in Africa especially where access to staple and nutrient-dense foods is highly constrained. While many African countries are making progress to reduce malnutrition (e.g., child stunting has reduced from 38 percent in 2000 to 30 percent in 2018), the progress is too slow to meet global targets[3]. This chapter outlines how African governments and pan-African organizations could make staple and nutritious food value chains more resilient and sustainable for food security and improved nutrition. Meta-analysis suggests that key barriers to attain food and nutrition security include

1 MwAPATA Institute
2 African Development Bank Group
3 Achieving Sustainable Development Goal (SDG) 2 to eliminate hunger and all forms of malnutrition and SDG 3 to ensure healthy lives and promote well-being for all at all ages by 2030.

overreliance on subsistence farming and correspondingly insufficient specialization, low investment in agricultural research and development, low use (and low efficiency in the use) of modern agricultural technologies, farming practices with deleterious effects on soil health, post-harvest losses, low domestic value addition, and poor infrastructure. Increasing productivity and building resilient and sustainable food systems will require substantial and appropriate investments in productivity, market, and in strategies to address other structural barriers.

Recommendations

- Invest more in agricultural Research and Development (R&D) to develop pro-nutrition seed varieties
  that are appropriate for local conditions and consumer preferences.
- Enhance massive adoption of nutrient-rich crop varieties or bio-fortified crops and fertilizers through input subsidies and well-functioning extension systems.
- Promote sustainable production practices to sustainably raise the productivity of staple and micronutrient-dense crops and livestock.
- Develop livestock and fisheries sectors, especially small-scale livestock and fish production systems, with breeds that are resilient to extreme heat and diseases in order to increase the production, availability, and consumption of animal-sourced foods (ASFs).
- Make staple and nutrient-rich foods more affordable and accessible to consumers by investing more in productivity, market, and other structural barriers.
- Leveraging technologies of the digital age to adopt e-commerce by domestic food suppliers, keeping both domestic and international agrifood systems functioning, and supporting local (or homestead) food production for nutrient-rich foods to help improve access to nutritious foods, even in times of crisis like the COVID-19 pandemic.
- Introduce food subsidies for healthy foods, especially for most vulnerable groups including women and children.

Introduction

Sustainable and resilience food systems are inextricably linked with healthy farmers and consumers. Furthermore, the resilience of farmers, consumers, and food systems is mutually dependent.

The status of peoples' health worldwide is worrisome. Despite improving trends, one in every nine people in the world is hungry, and one in three is obese (Development Initiative, 2020; FAO et al., 2020). Moreover, an estimated 144 million children under five years of age are stunted with widespread micronutrient deficiencies (Zaharia et al., 2021; Gash et al., 2020; Unicef et al., 2019). By 2022, COVID-19-related disruptions could result in an additional 2.6 million stunted children (Osendarp et al., 2021). A total 40 percent of malnourished people in the world live in sub-Saharan Africa (SSA) (Kinyoki et al., 2020; UNICEF et al., 2019).

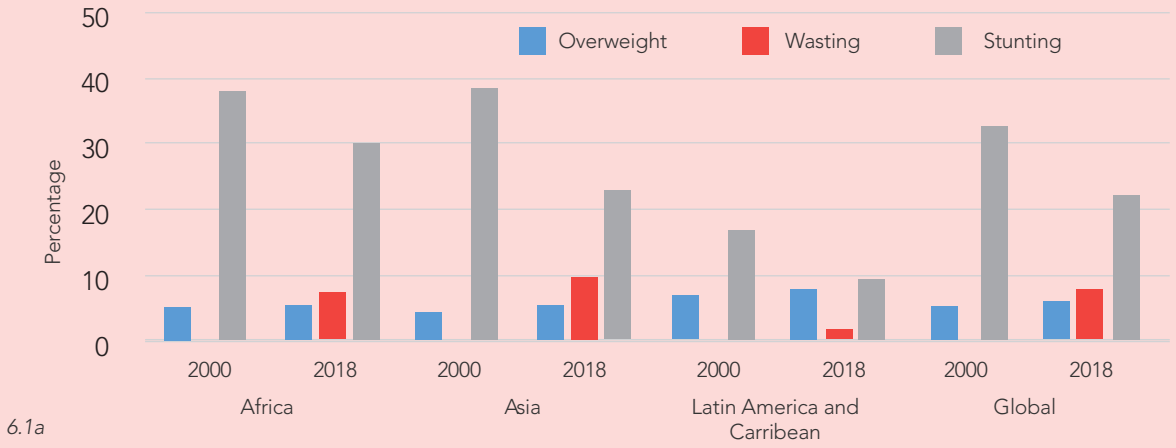
While many factors contribute to different forms of malnutrition, insufficient intake of nutrient-dense foods or excessive intake of calorie-dense foods are the most common factors (Zaharia et al., 2021; Khonje et al., 2020). Failure to access calorie-dense and nutritious foods or a healthy diet can lead to undernutrition and micronutrient deficiency (Giller and Zangore 2021; Hick et al., 2021; Gash et al., 2020). A healthy diet ensures adequate physical energy and all essential nutrients and prevents all forms of malnutrition as well as diet-related non-communicable diseases (Box 1).

Although Africa has high levels of malnutrition, several countries are making progress on reducing different forms of malnutrition. For example, child stunting rate has reduced from 38 percent in 2000 to 30 percent in 2018 (Figure 6.1a). The global target to reduce malnutrition in all its forms, including childhood overweight, wasting, and stunting is on the right trajectory in Africa (Development Initiative, 2020).

Box 1: What is food and nutritional security?

Food and nutrition security exist when all people consistently have physical and economic access to a healthy diet or nutritious foods for an active and healthy life. A healthy diet ensures adequate physical energy and all essential nutrients and prevents all forms of malnutrition and diet-related non-communicable diseases, such as Type 2 diabetes and cardiovascular diseases. A healthy diet includes adequate contamination-free fruits, vegetables, nuts, seeds, whole grains, and legumes; sufficient but not excessive calories and amounts of starchy staple and ASFs (meat, dairy products (excluding butter), eggs, and fish); and limited or no unhealthy foods such as sugar-sweetened beverages and ultra-processed foods (IFPRI, 2021; WHO, 2020).

While the exact makeup of a healthy diet varies depending on individual calorie and other requirements as well as physical activity, cultural context, local food availability and access, and dietary customs, there are general principles for making healthy diets possible. These include ensuring that a diversity of safe and nutritious foods is available and accessible year-round. Healthy diets should be affordable to all and should be produced with a low environmental footprint. Consumers should also be well-informed on healthy dietary choices (GLOPAN, 2020).



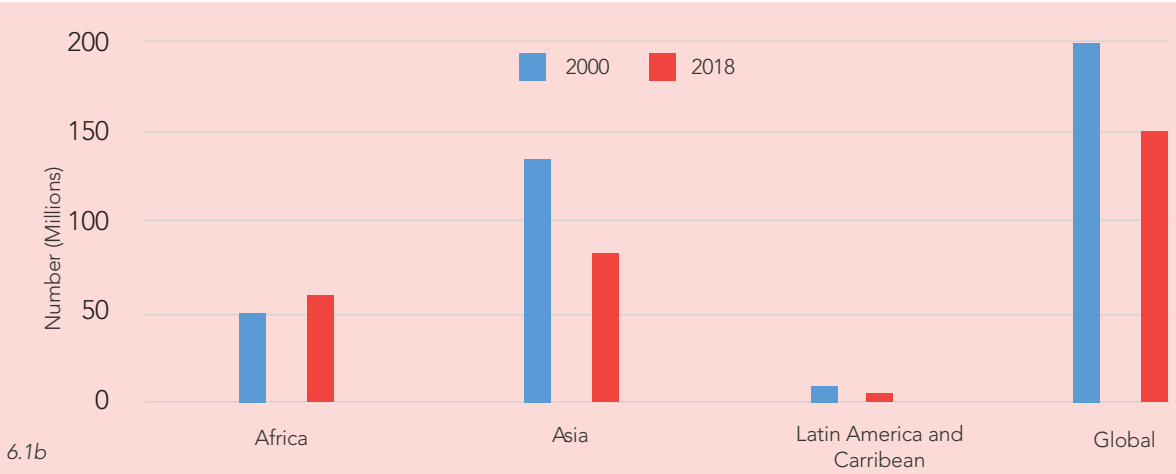


Figure 6.1: Comparative status on child nutrition in Africa and at global level, 2000-2018. (6.1a) Overweight, wasting and stunting prevalence. (6.1b) Trends in the number of stunted children under 5, by region. Data source: Unicef et al., 2019.

However, progress is too slow to meet global targets[4] on undernutrition and micronutrient deficiencies. For example, Africa is the only region where the (absolute) number of stunted children has risen since 2000 (Figure 6.1b). This is because the number of children in Africa in 2018 was roughly double what it was in 2000 (UNICEF, 2019). Not a single country in the SSA region can meet the targets for anemia in women of reproductive age and adult obesity (Development Initiative, 2020). Moreover, about 250 million people in Africa are hungry, and by 2030, Africa will have the highest number of hungry people (433 million ~ 52 percent of the world's total) (FAO et al., 2020). There is therefore an urgent need to find workable solutions to perpetual food and nutrition insecurity in Africa through resilient and sustainable food systems.

The objectives of this chapter are twofold: first, to explore barriers to food and nutrition security (Box 1) in Africa; and second, to provide recommendations relevant for local governments, the private sector, and international donor groups on how value chains for staple and nutritious foods could be more resilient and economically, socially, and environmentally sustainable in Africa.

Creating resilient and sustainable food systems will certainly have cost implications both for African governments and the private sector. However, there is increasing evidence that when we consider the detrimental downstream impacts on the environment, labor productivity, healthcare, and the need for societal safety nets, etc., the cost of not addressing malnutrition will be greater than the cost of changing the *status quo* (Rockefeller Foundation, 2021; TEEB Agrifood, 2015). Having a nourished, healthy, and productive workforce is a crucial precondition for a resilient and sustainable food system. The subject and discussions of this chapter are thus highly relevant to the overall theme of the 2021 AASR.

4 Achieving SDGs 2—to eliminate hunger and all forms of malnutrition and 3—to ensure healthy lives and promote well-being for all at all ages by 2030.

Barriers to food and nutrition security in Africa

Africa has the fastest growing agricultural sector of any continent in the world, with an average of 4.3 percent per year between 2000 and 2018 (World Bank, 2021). That notwithstanding, Africa still has the highest prevalence rate of total food insecurity of any continent (FAO et al., 2020). With the COVID-19 pandemic, the number of hungry people in Africa has increased from 214 million to 246 million since early 2020, and 16 countries out of 46 in SSA are at risk of acute hunger and famine (WFP and FAO, 2021).

Rising acute food insecurity in Africa is attributed to the social and economic impacts of the COVID-19 pandemic, low use of modern agricultural technologies or inputs, extreme weather events, invasive pests and diseases, conflicts and wars, natural disasters, and other shocks. Vulnerability to these shocks can be mitigated by raising productivity and reducing costs in the food system. This can partly be achieved by increasing access to input and output markets. Beyond addressing challenges in food production and access to staple and nutritious foods, it is also critical to deal with structural barriers in healthcare systems, which are key in tackling malnutrition. While Africa faces multiple production, marketing, and structural barriers, this chapter will focus on those identified as most critical to achieving sustainable food and nutrition security on the continent.

Low investment in agricultural research and development and extension

Most African governments devote less than 10 percent of their agricultural budgets to R&D&E (Fuglie et al., 2020). Total agricultural research spending including salaries, operating and program costs, and capital investments for all government, non-profit, and higher education agencies is thus less than 1 percent of agricultural gross domestic product (GDP) in Africa (Kurtz and Ulimwengu, 2019). After a period of growth between 2000 and 2014, total public agricultural research spending in SSA declined from US$2.4 billion in 2014 to US$2.3 billion in 2016 (Kurtz and Ulimwengu, 2019).

One consequence of underfunding in farm-level agricultural R&D is that few new breeds of livestock, seed varieties, or micronutrient-dense crops that are adapted to Africa`s local conditions have been generated (Schreinemachers et al., 2021; Ariga et al., 2019).

Agricultural extension agencies are also chronically underfunded and poorly coordinated (Arouna et al., 2021; Jayne and Sanchez, 2021; Maertens et al., 2021). Thus, even if new varieties were available, the likelihood is low that they would be adopted and used efficiently. Existing research suggests that locally-adaptive extension built on a model of bidirectional learning between farmers and agents, is also a necessary precondition for widespread uptake of nutritional food production and availability (Jayne and Sanchez, 2021; Snapp et al., 2002). It is no coincidence that Ethiopia, for example, boasts Africa's most impressive rates of agricultural growth since 2000 as well as half of all extension agents in SSA and the largest expansion of spending on agriculture (Jayne and Sanchez, 2021; Dorosh et al., 2020).

While greater investment in agricultural R&D is vital to sustain agricultural growth, there are growing concerns that most African governments and international development partners are not investing more resources to address issues of adaptive local agricultural R&D&E (Jayne and Sanchez, 2021).

Low use of improved seed varieties or planting materials

The few newly-developed (or adapted) seed varieties or planting materials that exist have low adoption rates. In addition to limited investments in R&D and weak (public) extension services, this is attributable to poorly performing seed systems and also a weak or non-existent regulatory environment in most SSA countries (Ariga et al., 2019; McGuire and Sperling, 2013). For example, maize is the single most important source of calories on the African continent providing nearly half of total calories and protein consumed in SSA. Yet, after two decades of maize breeding, demonstrations, and marketing campaigns, only 33 to 38 percent of the arable land is planted with improved maize varieties in Africa (Ariga et al., 2019). It is thus unsurprising that average maize yields in Africa have remained low at 1.8 tons/hectare (t/ha), compared to the global average of 5.1 t/ha (FAO, 2021a).

Extractive production systems and low fertilizer use

In Africa, soil nutrient depletion rates through crop production, leaching, and erosion are higher than 60 kg/ha per annum for an estimated 130 million hectares of arable land on the continent leading to widespread soil degradation (Wanzala and Groot, 2013). Losses of more than US$4 billion are incurred per year by not replacing depleted soil nutrients in Africa (IFDC, 2015). Extreme soil degradation on the continent requires organic or inorganic soil amendments to restore crop yield gaps (Tully et al., 2015; Vågen et al., 2005).

Fertilizer use is central to reversing the extractive nature of crop production and thus increasing productivity of most staple and nutritious food crops. However, fertilizer use in Africa is extremely low, averaging 19 kg/ha of nutrients, compared to the global average of 124 kg/ha (IFDC, 2015). Low fertilizer use is frequently explained by poor or inconsistent access to fertilizer markets, a situation that has exacerbated in 2020 as borders closed in response to the pandemic (Ayanlade and Radeny, 2020). Moreover, the quality of fertilizer is largely unknown to farmers; they have limited capacity to test fertilizers and farm soils, which reduces fertilizer efficiency especially with blanket recommendations on their use (Bold, 2015).

Fertilizer uptake is also low in some places because low response rates render fertilizer use unprofitable (Jayne et al., 2018). This is often attributable to a mismatch between fertilizer recommendations and the prevailing soil conditions. For example, response rates to phosphoric fertilizers are particularly inhibited on acidic soils that are common in countries like Zambia (Burke et al., 2017). Sandy soil textures and low carbon contents are associated with low response rates to nitrogen

on farmer fields in many countries such as Kenya (Marenya and Barrett, 2008), Uganda (Matsumoto and Yamano, 2011), Zambia (Burke et al., 2019) and Malawi (Burke et al., 2020).

Another burden to profitability of farm enterprises is Africa's heavy reliance on imported fertilizers. The accumulation of high transportation costs, inconsistent supplies, and inefficient custom procedures renders fertilizer two to six times more expensive to most African farmers than the average world price (IFDC, 2015). Most countries in SSA are landlocked and cross-border trade of fertilizer is often limited by poor infrastructure, weak economic integration, and conflicts (Ariga et al., 2019). Although several new fertilizer plants are in the pipeline, most notably in Nigeria, most fertilizer consumed in SSA is still imported.

Recurrent production shocks

Natural disasters are occurring at an increasingly high frequency with more than triple the number of annual occurrences, compared to the 1970s and 1980s (FAO, 2021b) and with evermore devastating economic and social impacts. Most notably, climate change-related disasters including floods, drought, and destructive storms have been rising in both incidence and gravity. In Africa, crop and livestock losses fluctuate widely with peak periods in 2012 and 2017, with a post-disaster production loss between 2008 and 2018 equivalent to 82 days of calorie intake per capita per year (FAO, 2021b).

Biological threats such as pests are another threat to production. Between 2008 and 2018, biological disasters caused a production loss of about 9 percent for all crops and livestock in Africa (FAO, 2021b). For example, the 2020–2021 desert locust crisis in East Africa and the ongoing fall army worm threat in southern Africa will likely cause major production disruptions.

Post-harvest losses and limited domestic value addition

In SSA, food loss and waste are estimated to be roughly 150kg of food per person per year (Sheahan and Barrett, 2017). On calorie basis, loss and waste is highest in cereals (53 percent) while based on weight, losses are greatest for fruits and vegetables (44 percent), which have a relatively high water content (80 to 90 percent) (GLOPAN, 2018; Lipinski et al., 2013). Economic losses from food loss take place at every step of food chain from the farm to fork. In SSA, a total of US$48 billion was lost due to postharvest losses between the farm and retail levels in cereals, legumes, fruits and vegetables, roots, and tubers translating to 15 percent lost income for 470 million people (FAO, 2019).

Processing or value addition is threatened by the declining number of patent publications in food sciences and handling technologies by Africans in Africa. To be specific, the number of published patents in various fields of technologies with greater application in downstream levels of the food system has declined during the last two decades. For example, published patents in food chemistry fell from 216 to 190 from 2000 to 2009 and 2010 to 2019 respectively (Traub et al., 2021).

Although processing or value addition is central to reducing food loss and waste in Africa, it is currently very limited in the region especially in the informal sector. Common barriers to investment in value addition include insufficient or inconsistent quantities of raw materials, limited access to electricity, and lack of affordable financing for storage, aggregation, and processing capital (FAO, 2019).

Poor and limited infrastructure

Only 34 percent of rural Africans live within two kilometers of an all-season road compared to more than 67 percent of rural populations in other developing regions (Transport & ICT, 2016). Only 38 percent of roads in rural Africa are tarred or paved (Transport & ICT, 2016). The average distance from farmers' fields to a market range from as low as 7 km in Kenya to over 20 km in sparsely-populated countries. Poor and limited infrastructure depresses productivity of small and medium enterprises by around 40 percent in low-income African countries and generates an additional 30 percent to 40 percent of costs for intra-Africa commodity trading

(UN-Habitat, 2014). On the other hand, improved infrastructure accounts for more than half of recent growth in the volume of crops and livestock traded in SSA especially in countries such as Ethiopia (Jayne and Sanchez, 2021; Reardon et al., 2019).

In addition to physical infrastructure, policy makers are also still struggling to identify a sustainable model for agricultural markets information systems in Africa for communicating prices and other information to farmers in real-time (OECD/FAO, 2016). The potential beneficiaries of reliable market information include producers, retailers, and wholesalers along with government policy makers, donors, non-governmental organizations, universities, and other research organizations (USAID, 2013). However, in the few cases where systems have been put in place, they have often failed at the end of their external financial support; there are few publicly owned agricultural market information systems.

Structural barriers in the health care systems

African governments are often characterized by low investments in public health care systems as their resources are highly constrained. Several structural barriers in the health care system such as inadequate health facilities, lack of properly trained health personnel, insufficient drugs, limited access to clean and safe water and sanitation facilities, and low education in rural areas threaten efforts to reduce malnutrition (Azevedo, 2017). With the COVID-19 crisis, increasing productivity and building resilient and sustainable food systems will largely depend on addressing productivity, market, and other structural barriers.

Options to improve resilience and sustainability of staple and nutritious food value chains

Addressing low production, processing, and distributional challenges for staple and nutritious foods is critical. This section highlights six pathways to making staple and nutritious food value chains more resilient and sustainable.

The section initially focuses on staple cereals, roots, and tuber and pulses for two reasons. First, the average diet in Africa is dominated by staples, which provide 70 percent of daily calories, while ASFs, sugar and sweeteners, and fats contribute about 10 percent each (OECD/FAO, 2021). Second, Africa is expected to remain heavily dependent on proteins from staple crops accounting for about 66 percent of daily protein requirements compared to ASFs and other foods (OECD/FAO, 2020).

With lower average household incomes in most African countries and capacity constraints to preserve and trade in more perishable foods, affordability and access to ASFs and fruits, for example, will remain a big challenge in achieving nutrition security (Bai et al., 2021; Haile et al. 2021; Laborde et al., 2021; Ryckman et al., 2021; Hirvonen et al., 2020; Masters et al., 2018). That said, this section also discusses food groups such as vegetables, fruits, and ASFs as important sources of most essential micronutrients (Bai et al., 2021).

Options to improve production at primary agricultural level of the food system

#1: Farm production—specialization or diversification to improve nutrition

Increasing small farm diversity could potentially have positive diet and nutrition effects through the subsistence and market-led pathways. However, emerging evidence on the linkage between farm production diversity and dietary quality or nutrition is mixed and scanty.

Several studies have analyzed the links between farm production diversity and household dietary diversity in the small farm sector of Africa finding positive associations in many but not all situations (e.g., Mulenga et al., 2021; Sibhatu and Qaim, 2018; Sibhatu et al., 2015). In contrast, very few studies have examined links between farm production diversity and child anthropometrics in Africa with inconclusive results. For example, in Tanzania and Zambia, crop diversification was positively associated with child height-for-age Z-scores (HAZ) and some of the associations were even negative or ambiguous (Chegere and Stage, 2020; Lovo and Veronesi, 2019; Kumar et al., 2015). A study by Bakhtsiyarava and Grace (2021) found that farm

production diversity is positively associated with child HAZ in Ethiopia.

While a meta-analysis of more than 45 original studies consistently found positive and significant associations between farm production diversity and dietary diversity or nutrition (Sibhatu and Qaim, 2018), on average, the magnitude of the effect seems to be small. This suggests that when well-functioning markets exist, not every household needs to produce the full diversity required for healthy nutrition at home. Improving the functioning of markets for diverse and nutritious foods (Haile et al., 2021) and specialized rural households' access to these markets is therefore probably a better strategy to improve nutrition and wellbeing than over-relying on diversifying subsistence production.

#2: Greater investments in research and development and extension

Low public investment in developing higher yielding pest and disease resistant nutrient-dense seed varieties and livestock development is one of the biggest threats to sustainably achieving food and nutrition security in Africa. National public research institutions have limited human resources (e.g., very few breeders). Furthermore, research infrastructure is often inadequate. Investment in cutting-edge laboratory facilities to support national breeding programs beyond conventional breeding is relatively low. This limits capacity to develop new seed varieties or planting materials for nutritious crops and livestock breeds that are adapted to local conditions.

Evidence suggests that investments in input subsidy programs (ISP), a popular policy intervention in SSA, is crowding out investments in agricultural R&D&E. For example, between 2009 and 2019, Malawi`s ISP received an average of 41 percent of the Government's agriculture budget while other crucial sectors such as R&D&E, irrigation, and livestock development had budgetary allocations of less than 1 percent of the total agriculture budget (Nyondo et al., 2021). Moreover, most African governments devote less than 10 percent of their agricultural budgets to agricultural R&D&E (Jayne and Sanchez, 2021).

Even in countries where substantial R&D investments have been made, more often, pro-nutrition crops such as orange-fleshed sweet potatoes, yellow cassava, vitamin A-biofortified maize, and beans biofortified with vitamin A, iron, and zinc are underemphasized and adoption is low largely because seeds are less available and public extension services are ineffective. With data from Kenya, Tanzania, Mozambique and Uganda, evidence suggests agricultural extension investments are essential for effectively promoting adoption of pro-nutrition crops (Kpaka et al., 2021; Ogutu et al., 2020; de Brauw et al., 2018).

Moreover, digital delivery of personalized extension services with good management practices and farmer-led demonstration plots could improve productivity and livelihoods in SSA (Arouna et al., 2021; Kpaka et al., 2021; Maertens et al., 2021; Schreinemachers et al., 2021). Extension is also essential for guiding farmers facing unfamiliar threats such as pest and disease outbreaks, climate change effects, and detrimental effects of pesticides and mineral fertilizers where these are not properly used (Jayne and Sanchez, 2021; Kassie et al., 2020). Unfortunately, most existing public extension services are chronically unfunded and effectively defunct.

Although access to micronutrient-dense crops is crucial in addressing micronutrient deficiencies and undernutrition, ASFs, especially fish and livestock products, are equally important. ASFs have been key in reducing stunting in some parts of Africa (Zaharia et al., 2021; Headey et al., 2018). However, livestock and fisheries sectors are relatively neglected in most African government and development partner budgets. In short, greater investments in adaptive local agricultural R&D&E by African governments and international development organizations is critical to sustainably increase productivity of nutrient-dense food crops, livestock, and fish in Africa. Genetic improvements could increase the production of nutrient-dense food crops such as legumes and beans, biofortified crops, and small livestock production (Madzorera et al., 2021).

#3: Increasing the use of modern agricultural inputs

The Asian green revolution was mainly driven by intensive use of improved seeds, fertilizer, irrigation, and pest control methods (Ariga et al., 2019). By contrast, modern agricultural input use in Africa today remains low (Jayne and Sanchez, 2021; Ariga et al., 2019; Sheahan and Barrett, 2017). For example, in 2018, Uganda had the lowest fertilizer consumption of 3.3 kg/ha of arable land against a global average is 136.8 (Table 6.1). This implies that Uganda would have to increase fertilizer consumption sixfold from an estimated 45,000 MT to approximately 306,00 MT to meet the country`s agricultural growth targets (Table 6.1). Moreover, most African countries have not yet started using blended fertilizers on a large scale (Jayne and Sanchez, 2021). This further hampers productivity growth of nutritious food crops due to inefficient fertilizer use as mentioned earlier.

Despite progress in increasing the use of improved maize seeds and inorganic fertilizers through ISPs in some SSA countries, there are growing concerns that most ISPs largely target improved seeds for cereals and non-food crops only as opposed to improved seeds for legume crops and improved livestock breeds (Theriault and Smale, 2021; Sheahan and Barrett, 2017; Wossen et al., 2017; Awotide et al., 2013).

While achieving a green revolution in Africa is possible, it requires a holistic approach (Ariga et al., 2019; Sheahan and Barrett, 2017). African governments, international development agencies, and local non-governmental organizations would therefore need to increase the use of diverse improved seeds or planting materials particularly bio-fortified crops and micronutrient-dense crops, organic inputs and site-specific blended inorganic fertilizers, and improved livestock breeds that are resilient to local conditions such as heat, drought, pests, and diseases (Fanzo et al., 2017). More investment in small-scale irrigation in SSA is required to raise the production of vegetables and fruits (Haile et al., 2021).

Some African countries are subsidizing cereal seeds and inorganic fertilizers as a means of further increasing the use of modern agricultural inputs and boosting productivity of pro-nutrition crops (Jayne et al., 2018). However, if food and nutrition security is to be achieved in Africa, these ISPs may need to expand to include other inputs such as improved legume seeds, pesticides, herbicides, atoxigenic treatments to reduce aflatoxin contamination in maize and groundnuts (e.g., Aflasafe), fish and livestock, and drugs for livestock treatment. Furthermore, innovation in farm management practices (e.g., agro-ecological approaches adopting pollinator-friendly practices) may improve yields of fruits, vegetables, nuts, seeds, and legumes (Madzorera et al., 2021). Moreover, scaling up pro-nutrition seed varieties through productivity pathways could be a key driver for improving profitability of different commodity value chains.

Table 6.1: Fertilizer use in selected African countries

	Ethiopia	Ghana	Kenya	Mozambique	Rwanda	Tanzania	Uganda	Zambia
Year	2012	2012	2012	2012	2014	2012	2014	2013
Total fertilizer required to meet growth targets ('000 MT)	1200	570	910	300	144	528	306	500
Current use ('000 MT)	500	200	489	50	35	263	45	250
Fertilizer use in 2018 (kg/ha,)	36.2	29.4	15.7	6.7	10.9	15.9	3.3	15.9

Notes: The global average for fertilizer consumption (kg/ha of arable land) is 136.8. Total fertilizer requirements are estimates to meet the agricultural growth targets set in national agricultural development plans (IFDC, 2015). Data sources: IFDC, 2015 and World Bank database; https://data.worldbank.org/indicator/AG.CON.FERT.ZS.

#4: Promoting the use of sustainable production systems

With declining soil fertility and low use of modern agricultural inputs in Africa, the challenge to feed current and future generations with nutritious foods or healthy diets is huge (Ariga et al., 2019; Tittonell and Giller, 2013). Moreover, soil fertility degradation is a key contributor to low productivity of staple food crops and nutrient-dense crops especially in SSA and regions with high and rapidly increasing population density and reduced fallowing (Willy et al., 2019; Ricker-Gilbert et al., 2014). Although conventional wisdom dictates that promoting sustainable production systems could sustainably increase productivity of staple and nutrient-dense crops through improvements in soil health, is this expectation supported by empirical evidence in Africa?

Emerging research from Ethiopia, Ghana, Malawi, and Zambia suggests that use of sustainable production systems increases crop income and micronutrient consumption and reduces poverty (Khonje et al., 2021; Tesfaye et al., 2021; Adolwa et al., 2019; Khonje at al., 2018). Replenishing organic matter in the soil requires more investment in public extension systems and a diversified strategy for input subsidies by African governments and development partners. This will be instrumental in increasing the uptake of sustainable production systems such as crop-livestock integration, conservation agriculture, soil and water conservation technologies, and organic inputs or fertilizers.

Post-harvest, processing, and distribution pathways

The quality of food available in the food market may influence nutrition through issues of food safety such as mold and mycotoxin contamination, zoonotic diseases, fecal contamination, and exposure to hazardous chemicals (Headey and Masters, 2021). Moreover, access to staple and nutritious foods through food markets may also influence people's diets and nutrition through price and income effects (Headey and Masters, 2021).

#5: Invest in processing to reduce food loss and waste for nutritious foods

Processing and/or value addition for nutritious foods not only increases food quality and hygiene and prolongs shelf life but it also enables consumers to access nutritious foods beyond a production region. In addition, food processing may reduce food and nutrition insecurity by improving economic access to healthy diets. Moreover, blending (food formulations to make them more palatable) key staple food products such as maize flour with nutrient-rich foods such as legumes, pre-cooking foods for consumer convenience, and packaging nutritious foods in small quantities to make them more economically accessible, can significantly reduce different forms of malnutrition in most developing countries especially among under-fives and adolescents (Raza et al., 2020; WHO, 2016).

However, conserving the nutrient content of nutrient-rich foods through processing, storage, and distribution requires greater investments in rural electrification, storage and cold chain facilities, and transport infrastructure (Haile et al., 2021; Lecoutere et al., 2021). This would ensure that nutritious foods are readily available to all types of consumers including those in rural areas. Moreover, appropriate post-harvest interventions including pesticides (e.g., Actellic), improved storage (e.g., hermetic) bags, and atoxigenic treatments can improve food safety of nutritious foods by reducing storage losses and contamination with mycotoxins, which can lead to serious health conditions and malnutrition in children (Raza et al., 2020). Greater investments in building appropriate infrastructure and technologies can therefore reduce post-harvest losses, reduce food loss and waste, facilitate domestic and international trade for nutritious food products, and improve the movement of nutritious foods to consumer markets, in essence ensuring that consumers can buy nutritious foods through different market channels.

Table 6.2: Dietary quality in households or individuals using and not using modern retailers in urban Africa

	Kenya			Zambia (Adults > 18 years)		
	Modern retailers			Modern retailers		
	Users (N=264)	Non-users (N=224)	Diff.	Users (N=713)	Non-users (N=217)	Diff.
Food variety score (0–18)	40.90 (10.98)	33.13 (10.51)	7.77***	6.64 (1.85)	6.26 (2.11)	0.38**
Dietary diversity score (0–9)	8.29 (0.68)	7.81 (0.95)	0.48***	3.23 (1.02)	3.12 (1.00)	0.11
Food groups (1,0; grams/day)						
Fruits	1.00 (0.00)	0.98 (0.15)	0.02**	3.30 (18.94)	3.04 (21.75)	0.26
Meat	0.97 (0.16)	0.91 (0.29)	0.06***	36.66 (43.8)	22.64 (47.43)	14.02***
Dairy products	0.99 (0.09)	0.99 (0.09)	0.00	19.76 (76.96)	7.85 (47.41)	11.91**
Sugar, beverages	1.00 (0.06)	0.99 (0.07)	0.01	171.80 (196.37)	124.83 (173.95)	46.97***

Notes: Dietary quality indicators are calculated at the household level in Kenya as individual-level dietary data was not collected. Mean values are shown with standard deviations in parentheses. Mean differences between users and non-users of modern retailers were tested for statistical significance. **, *** indicates statistical significance at 5%, and 1% level, respectively. N, number of observations.
Source: Debela et al., 2020; Khonje et al., 2020.

#6: Foster economic access to nutritious foods through food markets

Food markets play a crucial role for consumers to access healthy diets. Unlike rural consumers, urban consumers in SSA source at least 80 percent of their food from both small-scale and modern retailers (Moustier et al., 2021; Tschirley et al., 2020). However, food purchases from both markets are often influenced by price and income effects (Headey and Masters, 2021).

 # 6.a Make nutrient-dense foods more affordable and accessible

As discussed at the beginning of this chapter, undernutrition and micronutrient deficiency are still widespread in SSA (Kinyoki et al., 2020; UNICEF et al., 2019). Access to nutrient-dense foods such as vegetables, fruits, and ASFs is key to addressing malnutrition. However, emerging research suggests that most consumers in SSA cannot afford these micronutrient-rich foods (Headey and Masters, 2021; Laborde et al., 2021; Hirvonen et al., 2020; Headey et al., 2019; Masters et al., 2018).

As such, nutrition-sensitive agricultural investments should be making nutrient-rich foods more affordable and accessible to both rural and urban consumers. Productivity investments in staple and nutritious foods could raise farm incomes, which could in turn determine affordability and utilization of several nutritionally-relevant goods and services including food, health care, education, water, sanitation, and hygiene (Headey and Masters, 2021), and cushion against price fluctuations. African governments, development partners, international research organizations, and the private sector may need to invest more in livestock and fisheries which are highly under-invested compared to staple crops (Headey and Masters, 2021). With the current (COVID-19) pandemic, addressing trade distortions or restrictions that limit importation of nutritious foods is also paramount.

 # 6.b Enhance use of modern retailers to improve diets and nutrition

In many developing countries, food environments are changing rapidly; modern retailers (supermarkets) are gaining importance due to increased globalization, urbanization, westernization of lifestyles and diets, efficiency, and economies of scale (Qaim, 2017). For example, at least 54 percent of urban consumers bought food from modern retailers in Kenya and Zambia (Debela et al., 2020; Khonje and Qaim, 2019; Kimenju et al., 2015). However, it remains unclear whether the rapid growth of modern retailers in Africa positively influences people`s diets and nutrition or not.

Although studies have been done elsewhere, empirical evidence on the role of modern retailers in influencing sustainable diets and nutrition is extremely scarce in Africa. Generally, the few studies that have been done in Africa suggest that modern retailers can influence both diets and nutrition in two ways.

First, modern retailers improved household diets in urban Kenya and Zambia, mainly through consumption of meat and dairy as well as fruits (Table 6.2). In contrast, modern retailers can also promote high consumption of unhealthy foods especially ultra-processed foods often rich in fat, sugar (see Table 6.2), and salt, but poor in micronutrients (Popkin, 2017; Rischke et al., 2015). As a result, the rapid growth of modern retailers in developing countries may worsen dietary quality by promoting higher consumption of ultra-processed foods (Hawkes et al., 2020; Popkin and Reardon, 2018; Demmler et al., 2018; Rischke et al., 2015).

Second, emerging research from urban Kenya and Zambia suggests that modern retailers can improve child nutrition (Table 6.3). A 1 percent increase in the share of modern retailer purchases leads to a 0.02 higher HAZ. This a welcome finding as malnutrition, especially stunting, is common in Africa. Modern retailers are key source of nutritious foods, such as meat, dairy products, and fruits (Table 6.2). Processing these perishable food products ensure that consumers access safe and nutritious foods through modern retailers (Table 6.2). This probably explains why modern retailers are associated with positive nutritional effects, especially in reducing stunting among children in urban Africa.

On the other hand, emerging research suggests also that modern retailers contribute to rising rates of overweight and obesity (Table 6.3) among the African urban population. This is probably associated with high consumption of unhealthy foods, which are mainly sourced from modern retailers (Demmler et al., 2018; Kimenju et al., 2015). This is undesirable, as obesity increases the risk of diabetes, cardiovascular diseases, and other chronic diseases (Khonje et al., 2020; Demmler et al., 2018; Demmler et al., 2017; Kimenju et al., 2015). Studies have also found that nutritious foods are usually more expensive and less accessible in modern retailers than in small-scale food retailers (Moustier et al., 2021; Tschirley et al., 2020; Wanyama et al., 2019).

Table 6.3: Effects of modern retailers on adult and child nutrition in urban Kenya and Zambia

	Kenya		Zambia	
	Child HAZ (1)	Adult Overweight/ Obesity (2)	Child HAZ (3)	Adult Overweight/ Obesity (4)
Share of modern retailer purchases (%)	0.020*** (0.004)	0.010** (0.005)	0.026*** (0.008)	0.004*** (0.001)
Controls	Yes	Yes	Yes	Yes
Observations	547	615	472	863

Notes: HAZ is height-for-age Z-score. Marginal effects from regression models are shown with cluster-corrected standard errors in parenthese-s. **, *** indicates statistical significance at 5%, and 1% level, respectively. Source: Debela et al., 2020, Khonje et al., 2020 and Kimenju et al., 2015. See original publications for full model specifications.

 # 6.c Embrace use of small-scale (local) food suppliers to harness local nutritious foods

While modern retailers are an important source of both staple and nutritious foods, consumers also buy food from traditional retailers. For example, data from rural Ethiopia shows that children in close proximity to rural markets that sell healthier foods have more diverse diets (Headey et al., 2019). Even urban consumers in Africa patronize traditional food retailers to buy fruits, vegetables, and other local nutritious foods (Khonje and Qaim, 2019). Traditional retailers are probably the only source of nutritious foods for rural consumers as is typical for many African countries with limited access to modern retailers.

Consumers sometimes avoid buying nutritious foods from small-scale (traditional) food suppliers due to food safety concerns such as unclean or partially processed food products. Low investment in state-of-the-art processing facilities may limit the regular availability and supply of some nutrient-dense foods such as fruits and vegetables (Khonje and Qaim, 2019; Maestre et al., 2017). As such, more investment in public infrastructure (e.g., good markets, water and toilet facilities, and transport) and appropriate processing technologies can greatly reduce these food safety concerns. African governments and donors should thus work to enhance access to credit and training on food processing and storage for small-scale food suppliers.

On the other hand, traditional retailers occasionally repackage fortified foods such as sugar and flour into very small packets, which enjoy high demanded from low-income customers. Moreover, these small-scale (local) food suppliers are more resilient in times of crisis, including during the ongoing COVID-19 pandemic (Moustier et al., 2021; Tschirley et al., 2020).

 # 6.d Promote resilience innovations for staple and nutritious food value chains

The COVID-19 pandemic has worsened the ability of consumers to access healthy diets to some extent. Studies suggest that during the pandemic, most consumers could not access nutritious foods through market-based entitlements for several reasons such as employment and income losses, food supply constraints or disruptions, and rising food costs (Bonuedi et al., 2020; Headey and Ruel, 2020; Heck et al., 2020; Reardon and Swinnen, 2020). Most nutritious foods are out of economic reach for low-income earners and consumers are buying cheaper nutritious foods (Headey and Masters, 2021; IFPRI, 2021; Bhavani and Gopinath, 2020). In addition to supply-side interventions to improve affordability, special interventions are required to increase consumer demand for underappreciated protective (nutritious) foods such as pulses and nuts/seeds and vegetables (Headey et al., 2021).

With the digital revolution, the adoption of e-commerce by domestic food suppliers may improve access to nutritious foods even in times of crisis like during the COVID-19 pandemic (Reardon and Swinnen, 2020). Headey and Ruel (2021) propose multiple interventions that could help consumers access healthy diets amidst the global pandemic, including: 1) keeping both domestic and international agrifood systems functioning; 2) supporting local (or homestead) food production for nutrient-rich vegetables, fruits, and eggs; and 3) using social safety net programs to improve dietary quality. Non-market-based interventions such as food aid or food subsidies are required for the most vulnerable groups to access micronutrient-rich foods. Overall, building resilient food systems requires African governments and donors to scale up nutrition interventions. Such interventions could be considered a priority (Osendarp et al., 2021).

Greater investments in public health care systems and other structural barriers

Beyond addressing production, processing, and distributional challenges for staple and nutritious foods, addressing structural barriers in public health care systems is key in tackling malnutrition in all its forms and diet-related non-communicable diseases. As such, African governments and international donor groups may need to invest more in public health care systems especially health facilities, health personnel, and water and sanitation facilities.

Low education in rural areas, especially for women, could also result in malnutrition (Lecoutere et al., 2021; Azevedo, 2017). Reducing child undernutrition thus calls for empowering women with targeted nutrition information. In addition to using rural primary schools as dissemination hubs for pro-nutrition seed varieties and nutrition information, institutional purchases of healthy meals in schools, hospitals/health care facilities, and factory environments could further help to reduce malnutrition (Kpaka et al., 2021; Lecoutere et al., 2021).

Policy recommendations

Production pathways

- Invest more in human resources and technical equipment for national and international breeding programs to develop more or new crop varieties and biofortified crops that are rich in vitamins and minerals. This is especially important for cereals, roots and tubers, and legume crops that are appropriate for local conditions and consumer preferences.
- Invest more in adaptive local agricultural research and development and extension. This requires African governments, private seed companies and international development organizations to heighten focus on pro-nutrition seed varieties and nutritious crops in Africa to respond to emerging challenges such as heat, recurrent droughts, pests, and disease outbreaks.
- Promote adoption of nutrient-rich crop varieties or bio-fortified crops through input subsidies, small-scale irrigation, and well-functioning extension systems. This also calls for working with the private sector to identify production constraints for seed or planting materials and other inputs used to produce micronutrient-dense crops. Promoting greater use of pro-nutrition seed varieties and livestock by African governments, non-governmental organizations, the private sector and international development organizations would help to increase production and consumption of nutritious foods thereby reducing malnutrition in all its forms.
- Promote (perhaps through subsidies) sustainable production practices by African governments, local non-governmental organizations, and international development partners to sustainably raise productivity of staple food crops, micronutrient-dense crops or bio-fortified crops, and livestock. Moreover, diversifying subsidy portfolios or adopting a flexible input subsidy so that inputs other than fertilizer, e.g., pesticides/herbicides, aflatoxin inhibitors, and livestock drugs, may be beneficial.
- Develop livestock and fisheries sectors through greater investments by African governments, local non-governmental organizations, and international development partners. Particular emphasis on developing small-scale livestock and fish production systems with breeds that are resilient to extreme heat and diseases to increase production and consumption of ASFs is recommended. Moreover, fish is the cheapest form of protein in African coastal cities. It offers superior proteins compared to plant-based proteins and has better leverage in combating malnutrition, especially for women and children.

Post-harvest, processing, and distribution pathways

- Invest more in public infrastructure (roads, markets, and warehousing) and appropriate post-harvest technologies including pesticides,

improved storage (e.g., hermetic) bags, and atoxigenic treatments by African governments and international funding agencies is required. This is key to overcoming post-harvest food loss and waste, production, and distribution challenges, and for consumers to access healthy diets through their own production as well as food markets.

- Adopt e-commerce by domestic food suppliers in the digital revolution, keeping both domestic and international agrifood systems functioning and supporting local (or homestead) food production for nutrient-rich foods may improve access to nutritious foods even in times of crisis like the COVID-19 pandemic.
- Introduce food subsidies for healthy foods by African governments especially for most vulnerable groups including women and children and introduce taxes on for unhealthy foods.
- Foster compulsory nutrition labelling, large-scale awareness campaigns, and nutritional education programs by African governments in collaboration with international development partners on healthy and unhealthy foods to encourage healthy consumer behavior.

Other pathways

- Invest more in public health care systems especially health facilities, health personnel, and sanitation facilities by African governments and development partners. Beyond ensuring access to staple and nutritious foods, addressing these barriers is key in tackling malnutrition in all its forms and diet-related non-communicable diseases.
- Promote women's empowerment and target women with nutrition information to help improve the status and sustainability of food and nutrition security.
- Adopt or expand school/hospital feeding programs, particularly institutional purchases of healthy or fortified meals in schools, hospitals/health-care facilities and other public institutions or feeding programs by pan-African organizations, to address undernutrition and micronutrient deficiencies. This is over and above promoting pro-nutrition seed varieties and nutrition information in rural (primary) schools by African governments and development partners. Institutional feeding programs could help to create markets for locally-produced foods and ultimately increase disposable income.

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7 Knowledge and Capacity Development for Resilient Agri-Food Systems in Africa

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Key messages

1. With few exceptions, knowledge and institutional capacity development investments in Africa since the 1980s have focused on short-term programmatic objectives, designed and driven by external funders and spread thinly across multiple organizations in multiple countries. For the most part, the levels of investment barely go beyond meeting the immediate organizational or programmatic needs of the supported African institutions and the associated development partners.

2. Food systems function according to the capacities of the individuals, organizations, and institutions engaging in them. Resilience is not just about setting up systems to anticipate shocks – it requires sufficient capacity in government ministries and agencies to respond effectively to shocks and stressors, which in turn depends on policies in place to improve nations' education systems and the capacities of their institutions.

3. African countries should team together and lobby to ensure that Africa's interests are represented in global food system governance and decision-making, importantly through expansion of the G20 to G21 with Africa as the 21st member.

4. International development partners are encouraged to integrate inclusive, demand-driven, and adaptive agricultural research prioritization and technology development in their programs.

Food systems function according to the capacities of the individuals, organizations, and institutions in them. Strong local knowledge development systems are required to build resilient and sustainable food systems across the continent. Building endogenous knowledge and institutional capacity of countries to feed Africa's population is more urgent now than ever before. This chapter examines the evolution of knowledge and institutional capacity in Africa's AFS and provides practical and actionable policy recommendations for enhancing knowledge and institutional capacity to build resilient and sustainable AFSs in Africa.

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Introduction

The impacts of the COVID-19 pandemic are a lesser problem when compared to the longstanding hunger pandemic facing the world today, especially in Africa. That said, COVID-19 will intensify the food insecurity threatening the lives of millions of people around the world. World Food Program (WFP) estimated that at the end of 2020 about 265 million people could be on the brink of starvation globally. This is almost double the pre-pandemic food insecurity level which stood at about 135 million people at the end of 2019, 73 million of whom were in SSA.

Several factors, including low factor productivity on farms, post-harvest losses due to poor food product handling and distribution systems, poor food product marketing systems, and other social, economic, and environmental factors, drive persistent food insecurity concerns in Africa. At the root of these core drivers of food insecurity is weak knowledge systems and institutional capacity to build resilient and sustainable food systems across the continent.

In recognition of the general development challenges facing the world, including food-related challenges, the 2015 SDGs created great momentum for increasing development financing "from billions to trillions" to accelerate the achievement of the Goals, including SDG 1, 2, 3, 6, 14 and 15 on no poverty, zero hunger, good health and wellbeing, clean water and sanitation, life below water, and life on land, respectively. These goals, and arguably all the SDGs, are directly related to and are impacted by food systems resilience. Recognizing the importance of institutional capacity, among other things, to achieving the goals, SDG16 called for "building effective, accountable and inclusive institutions at all levels".

Before the SDGs, AfDB approved a Capacity Development Strategy 2010 – 2014 (CDS 2010 – 2014), which recognized that "no matter the amount of financial resources mobilized for Africa's development, such funds would yield only limited or modest results if countries do not have the human, organizational, and institutional capacity to absorb and effectively utilize them" (AfDB 2020).

Local knowledge systems and local institutional capacity are key to achieving a resilient and sustainable AFS everywhere, especially in Africa. Institutions shape the performance of economies through their effects on the costs of exchange and production and on technological progress (Boliari N., 2007). Institutional capacity drives transaction costs, the creation of markets, specialization and division of labor, economic productivity, and economic performance of countries. It also drives the behavior of organizations, the process of creative disruption, technological progress, and wealth creation in countries. Institutional capacity constitutes the "soft infrastructure" that shapes the way economies cope with market failures and exogenous shocks like COVID-19.

Yet, recent assessments of capacity for development in Africa show that although some African countries have made significant progress during the past decade, capacity in all its forms (individual, organizational, and institutional) remains a binding constraint on development for the continent, and more specifically agricultural transformation. Most African food systems continue to depend on subsistence farming systems with very low technological inputs, as well as underdeveloped food processing, distribution, and marketing systems, to mention a few.

For decades, there have been significant interventions by international and bilateral development partners to improve agricultural research on African food systems. However, the model of financing has mostly favored international organizations as primary grantees. Investments in locally-relevant and adaptive national-level agricultural R&D, including the investments in improved institutional and absorptive capacity and ownership at NARS and improved education for innovation actors, have been significantly low. The large-scale supports provided by multilateral

institutions and bilateral organizations are often project-based and prioritize use of established foreign expertise to deliver on the short-term project goals. Other support provided to think tanks, NGOs and community-based organizations (CBOs) is fragmented, and uncoordinated; and focuses on supporting small- and medium-scale players in the agri-food value chain with little capacity to reach economies of scale that foster transformative and sustainable change.

Building on Chapters 1 – 6 of this report, Chapter 7 explores the evolving knowledge and institutional capacity development challenges that constrain AFS resilience and sustainability in Africa. "Capacity" refers to the availability of resources and the efficiency and effectiveness with which individuals, organizations, or institutions deploy these resources to identify and pursue their development goals on a sustainable basis. Institutions are the formal or informal rules of the game of a society (Hodgson, G., 2006). Organizations are the actors or players – groups of individuals bound by a common purpose to achieve defined objectives within the rules of the game.

Individuals are the key actors and beneficiaries from both institutional and organizational systems of a society. Knowledge includes facts, information, and skills acquired through experience or education, in essence the theoretical or practical understanding of a subject. The quality of knowledge, individuals, organizations, and institutions in a country ultimately define the quality, resilience, and sustainability of its AFS. COVID-19 pandemic has demonstrated the risks and uncertainties associated with dependence on global knowledge systems and value chains. Building the endogenous knowledge and institutional capacity of a country to feed itself has therefore now become more urgent than ever before.

The rest of the chapter examines the evolution of knowledge and institutional capacities in Africa's AFS and provides practical policy options on how to strengthen them to deliver a resilient and sustainable AFS.

Background

Weak institutional capacity limits the ability of countries to develop and adopt new technologies, financial systems, markets, and other systems innovations required to build resilient and sustainable food systems. Lack of capacity for research and innovation and low associated investments are an especially binding constraint on Africa's development. Studies show a strong correlation between investments in research capacity for development and GDP growth rates (Tuna, K. et al., 2015). The gross expenditure on research and development (GERD) in Africa remains low. GERD in all high-income countries has been over 2 percent of GDP since the year 2000. In Africa, GERD was consistently below 0.4 percent of GDP on average until 2004, rising marginally to 0.42 percent and 0.61 percent in Sub-Saharan and northern Africa respectively in 2016 (Figure 7.1).

Investments in African institutions (from both external and domestic sources) accounted for only 0.8 percent of the $2 trillion spent on research and development globally in 2018. This limited investment in African institutions undermines locally-driven R&D and creates a weak environment for innovation in Africa's AFS. Within this limited funding environment, the dominance of external funding in Africa's agri-food research systems and the nature of those funding programs – deployed through external intermediaries based in the funders' home countries – creates structural constraints that further exacerbate institutional capacity deficits on the continent. Taken together, these funding arrangements can stifle national human and institutional capacity development and capacity utilization making it more difficult for African countries to break the cycle of knowledge and technology dependence (Urama, 2009; Urama et al., 2010; Ezeh A. et al., 2019). Furthermore, a significant part of the agricultural research and development in African countries is performed by external research institutes, consultants, and contractors, as well as CGIAR systems. Because these external organizations tend to have considerably more resources to work with than

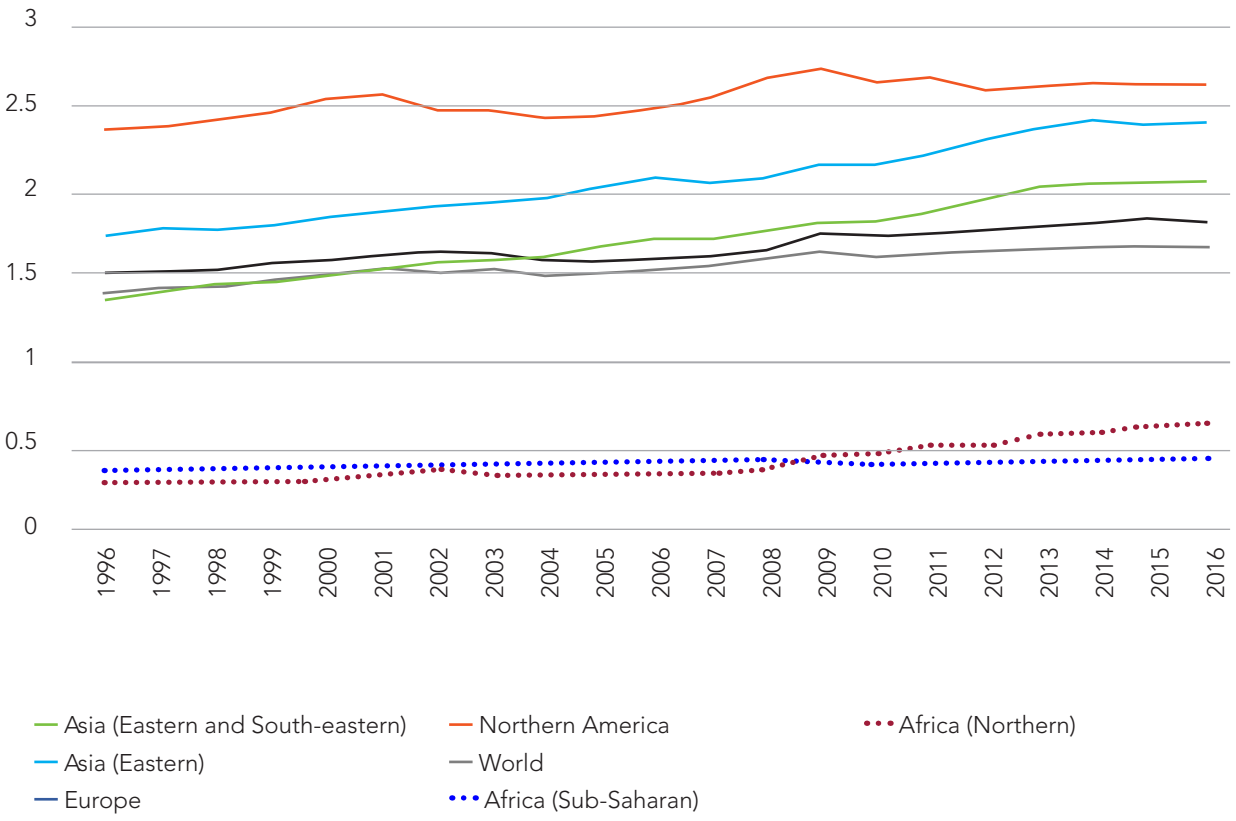

Figure 7.1: GERD by SDG Regions, 1996 - 2016

Source: African Development Bank Group Capacity Development Strategy, 2021 - 2025

African research organizations, they compete for the pool of well-trained Africans and make it more difficult for local organizations to attract and retain talented African researchers (Barder, O. et al., 2019). In 2019, Africa had just 82,000 agricultural scientists, compared to an ideal number of 169,000 by 2023 as estimated by the African Capacity Building Foundation.

A recent review of capacity development effectiveness in Africa-led capacity development organizations summarized in AfDB's CDS 2021 – 2025 shows several constraints that impede the resilience and sustainable development of all economic sectors, including agriculture (African Development Bank Group, 2021). These include development partner dependency and unstable funding for program implementation; supply-driven agenda-setting; low productivity and variability in the quality and relevance of work produced; low utilization of local capacity and low demand for technical services by African experts in African countries; lack of appropriate infrastructure for capacity development and research; high staff turnover and brain drain due to lack of resources to offer competitive salaries and benefits; inability to cope with the rapid technological transitions in their respective sectors; and, more generally, non-conducive environments and incentives for quality research and impacts (African Development Bank Group, 2021). These factors lead to lack of continuity and longevity in Africa-led institutions. In 2017, the Think Tanks and Civil Society Program at the University of Pennsylvania estimated that about 60 percent of think tanks in Africa were highly vulnerable with a serious risk of disappearing due to unstable funding, staff turnover, and brain drain.

A review of recent evidence in independent publications of the African Development Institute of the African Development Bank Group (African

Development Bank Group, 2020), the World Bank Group (WBG, 2020) and the USAID Board for International Food and Agriculture Development (BIFAD) (USAID, 2021), underscored the importance of technical innovation driven by R&D&E as drivers of agricultural productivity growth, and the catalytic role of agricultural productivity-led growth in poverty reduction, food systems resilience, and economic transformation. Available evidence shows that investments in agricultural R&D&E generate among the greatest impacts on agricultural productivity growth and poverty reduction per dollar spent. With the low gross expenditure on agricultural R&D&E in African countries, currently below the Khartoum Target of 1 percent of agricultural GDP, the AFS in African countries remain highly exposed to exogenous shocks in global value chains to which African countries contribute little. In effect, these challenges not only present existential threats to many African think tanks, but also directly impact the resilience capacity of AFSs and broader economic transformation on the continent.

While this underscores the need for prioritizing investments in agricultural knowledge and institutional capacity in Africa, it is noteworthy that individual capacity on the continent has improved significantly over the past two decades. Universities and research institutes are key vibrant knowledge systems throughout the world. However, these institutions are often not highly prioritized and as such are underfinanced by African governments. To illustrate, most African governments are failing to invest even 1 percent of their agricultural budgets to agricultural research, resulting in low knowledge generation. In Africa, while the number of universities and university enrolments have grown rapidly over the past 20 years, investment in higher education has stagnated in many countries. Poor infrastructure and non-competitive salary scales in African universities and research institutes have contributed to significant brain drain, often through highly skilled migration schemes to countries that need them less but value them more.

Evolution of knowledge and institutional capacity development in Africa: 1960 to 2021

Agricultural knowledge and institutional capacity development in Africa have shifted from a special focus on strengthening higher education – universities and colleges of agriculture during the post-independence period – to increased share of support going into food aid and humanitarian support. With this, the objective shifted from building Africa's capacity to feed itself to feeding Africa through grants, food aid, and other short-term emergency interventions by foreign development partners working through international and multinational development agencies.

The agricultural research policy during the colonial era focused on production of cash crops for exports. The focus was thus on research for the production of cocoa, coffee, cotton, palm products, rubber, tea, sugarcane, and similar commodities. Livestock and food commodities were later included (Johannes, R. and Kathleen, F., 2016) and the research landscape was dominated by foreign researchers.

In efforts to build capacities of local scientists to replace foreign experts in the post-independence era from the 1950s to early 1960s, a series of Land Grant Universities and Colleges of Agriculture were established across the continent. These included: the Alemaya College of Agriculture in Ethiopia (now Haramaya University); Ahmadu Bello University, Nigeria; Malawi's Bunda College of Agriculture; and School of Agriculture and Food Sciences, Njala University, Sierra Leone, among others. In further efforts to shore up the development of the capacities of local scientists, in the 1970s, CGIAR established a number of international agricultural research centers. These include the International Institute of Tropical Agriculture (IITA), the International Council for Research in Agroforestry (ICRAF), Agricultural Research Council (ARC), International Livestock Research Institute (ILRI), etc. The major value addition of these centers was their introduction and management of multi-country and

inter-regional research works, capacity building and project management. The Forum for Agricultural Research in Africa (FARA) was added to the list of institutions in the late 1990s.

The support to the Land Grant Universities as well as the activities of the CGIAR centers significantly increased the percentage contribution of the agricultural sector to GDP across the countries (Juma, C., 2012).

Several countries experienced significant increases in agricultural export earnings from several cash crops during the 1990s. However, this positive trend did not continue. A confluence of factors during the 1970s, including a series of droughts and associated crop failures across the Sahel region (from Senegal to Ethiopia), and the associated spikes in food prices drained forex reserves in most African countries. The constrained national capacities to foot the rising food import bills shifted attention to urgent humanitarian support through food aid. This has not contributed to resilient and sustainable food systems in Africa. Competition and lack of coordination among development partners led to multiplication and duplication of programs to the extent that most national governments were unable to track projects and programs within their countries let alone align them with national agricultural development priorities. The generation of agricultural knowledge – science, technology, and innovations – thus became more the preserve of international development partners and research agencies rather than of national governments. The boom in other commodity prices (oil, gold, and minerals) during the 1970s also shifted the focus of resource-rich African countries away from agriculture.

During the 1990s and in the first decade of the 2000s, there was an emerging consensus among researchers and policy analysts that policy incentives to refocus on building knowledge institutions is a pre-condition for achieving sustainable agricultural development in African economies. Many countries established policy research institutions to support policy analyses for informed decision-making. Examples include: the Agricultural Policy Research Unit (APRU) at Bunda College in Malawi; the Tegemeo Institute at Edgerton University in Kenya; Ethiopia's Agricultural Transformation Agency (ATA); and several NGOs, think tanks and networks established to deepen local agricultural policy research, each providing critical inputs to the policy and practice of agricultural transformation in Africa. These efforts continued and expanded into building continental and regional networks. The AU launched the CAADP process in Maputo in 2003. Yet, core funding for these institutions remained mostly from external sources. With frequent changes in donor priorities, these agricultural research organizations and networks continue to face existential challenges. National Agricultural Research Organizations (NAROs) continue to face significant budget constraints. Although new initiatives are beginning to emerge since 2000, the funding models remain largely external.

As aptly noted by a report published by the Centre for Global Development (Ezeh and Lu, 2019): "Africa tends to be a child with many parents, very many parents. And unfortunately, most of the parents want their child to learn how to walk their way… and most of the parents do not want to hear and listen to the child when the child is asking to walk their [own] way. Our researchers, our PhDs, our patents, our ideas, we are a child, and nobody wants to allow us to walk our way. If you unpack that analogy, there's quite a bit in there" (Ezeh, A. and Lu J., 2019).

With few exceptions, knowledge and institutional capacity development investments in Africa since the 1980s have focused on short-term programmatic objectives, designed and driven by external funders, and spread thinly across multiple organizations in multiple countries. For the most part, levels of investment barely go beyond meeting the immediate organizational or programmatic needs of the supported African institutions and the associated development partners. In addition, the limited engagement of African stakeholders in the design and funding of these efforts means that they often collapse once the contributions of external funders cease (Ezeh, A. and Lu J., 2019).

In summary, the evolution of investments in knowledge and institutional capacity development in Africa requires a critical review. While pre- and post-independence interventions focused on building endogenous knowledge and institutional capacity for Africa to feed itself, the focus since the 1980s has shifted towards feeding Africa, instead of helping Africa to feed herself. The impacts of this transition speak volumes. Despite being home to over 60 percent of remaining arable land in the world today, African farmland has the lowest factor productivity of all regions (Figure 7.2).

The continent is therefore largely dependent on food imports, has among the least mechanized agricultural production sector in the world, and remains highly vulnerable to global agricultural value chains and food price shocks.

Institutional capacity building in Africa

A few institutions such as the African Development Bank Group, AGRA, the World Bank Group, and others have been providing catalytic grants to build institutional capacity in universities and national agricultural research programs in Africa. These investments have resulted in improvements in irrigation facilities and refurbishment of cold storage, field and laboratory equipment, and transportation that have enabled more efficient capacity building and knowledge generation for priority staple crops. For example, AGRA-funded scientists in plant breeding constitute 40-50 percent of all active plant breeders in the NARS of Rwanda, Malawi, Mozambique, Burkina Faso, Mali, and Niger and are managing 60 percent of all active crop improvement research programs that are releasing drought-, disease-, and pest-tolerant varieties, and some that are more efficient in nutrient uptake, making them more resilient. NARS-funded scientists have produced over 700 improved varieties with over 75 percent of these now in farmers' fields. The varieties developed have traits such as drought tolerance, disease-, insect-, and pest-resistance, and early season that help in ensuring the resilience of farmers. AGRA-funded scientists have also produced over 500 publications of excellent research conducted in Africa addressing African priority crops production and processing bottlenecks that are now being used all over the world. Governments need to follow up on these investments by investing more in research programs and paying meaningful salaries for staff retention.

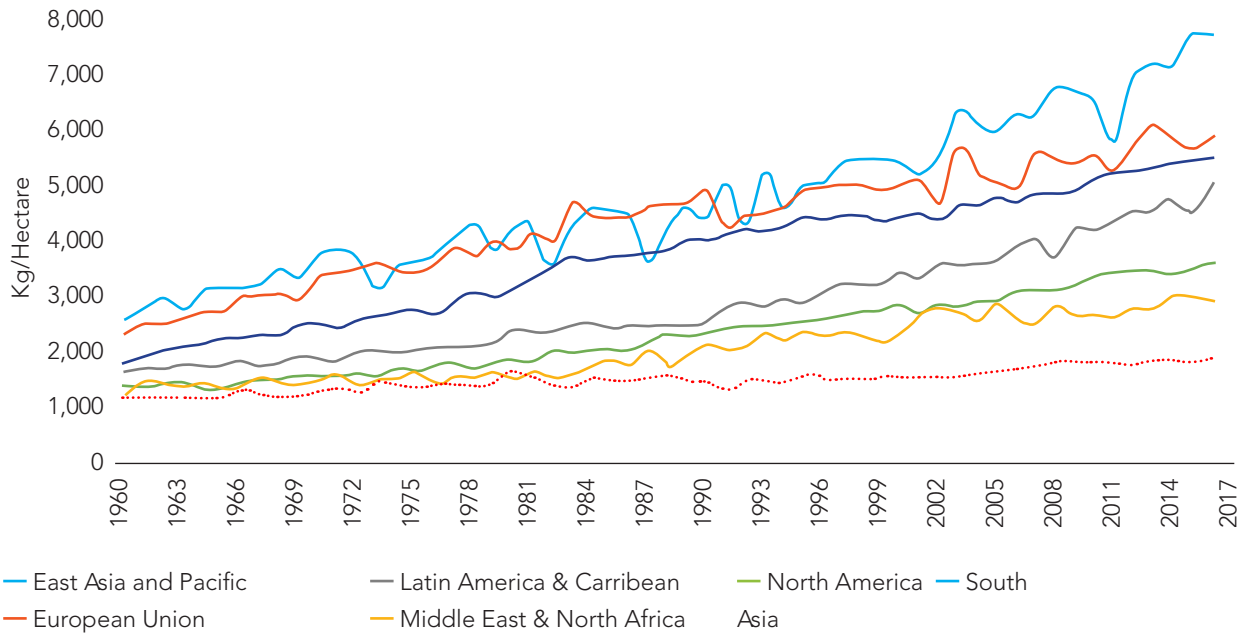

Figure 7.2: Cereal Yield (kg per hectare)

Source: World Bank Data, May 2020

In extension systems, AGRA is building capacity of local institutions including NGOs to build the capacity of thousands of Village-Based Advisors (called Community-Based Advisors in West Africa and Community Agribusiness Entrepreneurs in Mozambique) who in turn train farmers on Good Agricultural Practices (GAP), post-harvest handling, business, and produce marketing resulting in increased adoption of yield-enhancing technologies and larger quantities of produce sold in structured markets. Several governments such as Ghana, counties in Kenya and provinces in Mozambique are interested in adopting this approach and have started mobilizing resources for such interventions. Building sustained capacity of such institutions is critical to increasing resilience of food systems in Africa.

The African Development Bank Group scaled up its investments in institutional capacity development in all sectors, including in agriculture, during the past decade. Through its Feed Africa Strategy, the Bank has invested in all areas of the AFS to enhance its resilience. Generally, institutional capacity development is an intrinsic part of all operations with specific resources tied to delivering capacity where the need exists. These interventions usually focus on technological, institutional and policy reforms that would trigger a lasting transformation of the rural economies of Regional Member Countries (RMCs) by empowering their rural populations to improve their productivity and real incomes in an equitable and environmentally sustainable manner.

The World Bank's African Centers of Excellence (ACE) program also started with a focus of building universities to train experts in various research fields to find solutions to regional developmental challenges. The program fostered linkages with companies, government agencies and research centers for workplace learning input into the curricula, consultancies, and joint research. All these are some of the building blocks of knowledge and institutional capacity. The only addition to this system is resilience, especially sustainability. The ACE I Project, which included 22 Universities in West and Central Africa, focused on funding specialized courses for industry professionals in universities in the sub-region - a good move to attract the private sector, which is important for sustainability. The universities also established a regional faculty body and attracted additional top-level faculty therefore strengthening the programs. In addition, under the Project, the universities provided learning resources, built laboratories, and rehabilitated existing facilities.

The World Bank followed this up with an ACE II program, taking continued steps in knowledge and institutional capacity building for resilience.

The West African Center for Crop Improvement (WACCI)

Established with AGRA funding in 2007, WACCI has been sustained with funding from several other donors and its activities expanded with funding from both the ACE I and ACE II programs of the World Bank. WACCI has expanded to add Master of Science (MSc.) training in Seed Science and Technology and the Kofi Annan Youth Agripreneurship Centre. The faculty at WACCI runs robust research programs that are targeted at addressing the region's pressing food security and related challenges. Partnership with both the government, private sector, international centers for research, and universities has contributed to the success of the center as it stays current on teaching and research and is therefore well positioned to raise the necessary resources. WACCI has currently trained over 149 PhD and 65 MSc. students from the West and Central Africa Region. The PhD students have to date released 95 varieties of a wide range of crops that are resilient to climate change with a focus on drought tolerance, insect- and disease-resistance/tolerance and nutrient efficient. When asked about the Center's sustainability, WACCI's Founding Director Prof. Eric Danquah stated that "sustainability is in provision of future leaders". He also highlighted that it is important that the centers outputs attract investments from both the public and private sectors.

The ACE programs have also encouraged governments to invest in universities through loans. It remains to be seen whether African governments will continue this enhanced level of funding support for their universities' capacity strengthening and for their respective NARS when the programs are completed.

Actionable policy recommendations for enhancing knowledge and institutional capacity to build resilient and sustainable agri-food systems in Africa

It is imperative to highlight a few stylized facts that provide the basis for actionable policy recommendations proffered in this chapter. First, available evidence shows that investment in technical innovation driven by R&D&E is the key driver of agricultural productivity growth and a catalyst for agricultural productivity-led growth, poverty reduction, food systems resilience, and economic transformation in countries. Second, investments in agricultural R&D&E have been consistently found to generate great impacts on agricultural productivity growth and poverty reduction per dollar spent (Fuglie et al., 2020). Third, most African governments invest less than 1 percent of agricultural GDP on agricultural R&D.

This chapter is a call to action to ensure sustained support for agricultural R&D at national, regional, continental, and global levels. This call to action is encapsulated in the actionable policy recommendations below.

Recommendations for African governments

Demonstrate political commitment for national agricultural R&D&E investments. National governments need to follow through on their commitments to invest in R&D rather than over-relying on the international development community as has been the practice. This will help to scale R&D&E input in locally-relevant, adaptive, national-level agricultural research and development, make national R&D&E more accountable to national entities, improve institutional absorptive capacity for internationally-funded R&D&E, and enhance local ownership of the R&D&E agenda aligned to national priorities to drive resilience and sustainability in the sector. Local content should be prioritized in the entire research and capacity development process. They demonstrate this commitment through sticking to commitments such as the Maputo Declaration to increase annual national budgetary allocations for agriculture to at least 10 percent and to ensure a growth of the agricultural output of at least 6 percent annually. Indeed, given the enormity of financial resource requirements in Africa, countries should leverage and build on investments of international development partner and private sector investments. Another way the government demonstrates its commitment is by investing time and efforts in developing policies and regulatory reforms that facilitate private sector and foreign direct investments in the food production system. The focus should be on radical change from the status quo. The key to achieving meaningful development and poverty reduction in Africa lies in its willingness and readiness to invest in its knowledge institutions.

Develop and support the National Agricultural Innovation Systems (NAIS) with a focus on adaptive, sustainable, and competitive agri-food systems in Africa. This can be achieved through honoring the Maputo Declaration. Each NAIS should focus on local relevance, strengthening national and regional agri-food value chains, regional trade competitiveness, and climate resilience. AfCFTA will provide expanded markets for African farmers and provide incentives for the adoption of farm technologies that increase productivity. These technologies need to be developed and adapted to Africa's highly-varied farming conditions to realize these benefits.

Prioritize inclusive, demand-driven, and adaptive agricultural research and technology capacity development. Several agri-food production technology adaptation trials are ongoing at different

locations in Africa. Although these attempts are already field-tested for suitability and performance on different moisture and soil conditions as well as field sizes in the African context, they are under-funded and under-staffed. Knowledge and capacity development that aims to deliver technology and innovation and is adaptive to environmental changes and local contexts would most likely be better embraced because it already reveals and reflects the preference and choice of local stakeholders (innovators, women, and youth) who are usually smallholders. Building on this foundation through field trials, exhibitions, and demonstrations will likely have a more lasting impact on the resilience of agri-food production systems. Knowledge and technology capacity development that is demand-driven and emphasizes upscaling and out-scaling of existing locally-adaptive technology promises to be more sustainable, resilient, and relevant to the needs of the people.

Invest in digitalization of African agri-food systems. The global AFS has always been under stress. This has been recently exacerbated by the COVID-19 pandemic through additional strains on labor supply, farmers' access to information and local markets, food supply chains for food import-dependent countries, and logistics. Digitalization offers succor to most of these challenges, just as it is the future of global socio-economic interactions and transactions. In addition to providing succor, it also provides emerging abundant opportunities through making the food system more effective, efficient, transparent, traceable, and sustainable. For example, agri-food digitalization not only promotes food safety, but also assists food business operators to properly and more accurately predict and monitor consumer food demand trends over the immediate to the long term, thus improving food and nutrition security. This promotes planning and makes it easier for food business entities to respond to current and emerging food needs more accurately. Agri-food digitalization also reduces transaction costs associated with buying and selling agricultural produce and food. To achieve agri-food digitalization, there is need for massive investment in upscaling the e-technology platform across the continent. Intellectual property ownership, food systems governance, data protection and data sharing between food businesses and governments, intellectual property management, investment in technology adoption, and innovation incubation are some of the key issues requiring attention for any form of food digitalization to succeed. African government need to take the lead by undertaking an integrated bit-by-bit digitalization of their economies with a view to moving toward digitally-driven engagements that guarantee data and information flow. To ensure no one is left behind in the food system digitalization process, the youth and rural communities must be empowered to continue to be relevant in the AFS. This requires specialized capacity development on digital solutions and geospatial systems for these important players in the agri-food value chain.

Lobby to ensure that Africa's interests are represented in global food system governance and decision-making. One specific area of focus here is for the expansion of the G20 to G21 with Africa as the 21st member. Given that EU is a member of the G20, Africa, through the AU should also be granted membership to the expanded G20. Through this membership, an additional more than 1.4 billion people will rightly have a voice in the global food system governance and decision-making process.

Promote enabling business environments and facilitate public-private partnerships and dialogues. The primary role of governments in promoting a sustainable and resilient AFS is ensuring that the relevant conducive business environment is created through relevant regulatory and private sector reforms. Regulatory frameworks that hinder the private sector's access to land, credit, inputs, and other relevant requirements for establishing, building, and nurturing agri-business will stifle and stunt innovation and solution-driven interventions. Governments at all levels must make deliberate efforts to remove existing barriers. For example, land tenure, ownership, and title systems in many countries stifle private sector

involvement in agri-food production systems and impede agricultural productivity growth, which is an important component of resilient and sustainable food systems. Fiscal, monetary, trade, and competitiveness policies as well as private sector regulation are some specific areas where reforms are required to promote access to financing and inputs. Such reforms will also reduce pressure from foreign competition and dumping of inputs and food items that can be produced locally.

Recommendations for Pan-African development organizations

Establish an Agricultural Science, Technology, and Innovation Trust Fund for Africa to identify and leverage opportunities for strengthened cooperation and coordination among national, regional, and international R&D&E funding in the spirit of the Paris declaration on aid effectiveness. The rationale for this Fund derives from the existing gap in science and innovation financing in Africa. In addition, the fact that Africa accounts for 60 percent of remaining arable land globally demands a coordinated knowledge system that optimizes local knowledge and indigenous skills to develop this potential. Establishment of the Fund will provide a steady flow of funds for Africa-based institutions undertaking innovation in research, development, and extension through development of local and indigenous skills. This will promote and resuscitate local content in agriculture and food systems technology. Establishment of the Fund should be as inclusive as possible and thus distributed across public, private, bilateral, multilateral, and development financial institutions.

Recommendations for the private sector

Be solution-driven and innovate. Given the myriad challenges facing the African agriculture and food systems, the private sector has ample opportunities to innovate through solution-driven interventions and technology solutions as long as the enabling environment is supportive. The envisaged role of private sector is to harness the opportunities offered by the public sector through promotion of an enabling environment to promote agro-industries and agribusiness development. These interventions promise a good return on investment, thus helping the private sector to achieve its bottom line of making a healthy profit. Such interventions would also reduce transaction costs in the production, management, and distribution processes, thus benefitting both producers and consumers. Other ancillary beneficial outcomes include increased decent employment opportunities, especially for women and youth, and promotion of competitiveness and value addition in the food system.

Recommendations for international development partners

Demonstrate sustained commitment to institutional capacity development and knowledge and technology transfer by shifting funding models to benefit long-term institutional capacity for agricultural research, technology, and innovation governance in national, regional, and pan-African research organizations and networks. Development partners are also called upon to support national, regional, and continental institutions through scaled agricultural R&D&E investments to help leverage international development partner and CGIAR investments and enhance multiplier effects of such investments. Current models on programmatic support crowd out opportunities for long-term institutional capacity and good governance of agricultural research, technology, and innovations, which are the foundations for structural transformation, resilience and sustainable development.

Integrate inclusive, demand-driven, and adaptive agricultural research prioritization and technology development, both tacit and codified knowledge systems, and public and private sector actors across all agricultural research and development efforts. This should include community-based endogenous knowledge systems that are yet to be codified in the language of modern science, experiences gained through various forms of research and enquiry, as well as social innovations among African youths and

women, farmer-based organizations, and similar stakeholders. In its capacity building and R&D programs, AGRA funded agroecology-based participatory variety development that utilized some of the farmers' knowledge and local germplasm in the seed systems development. Some of this work is published in international journals such as Crop Science. There is need to establish a system of documenting indigenous knowledge from various actors and storing it in a systematic manner to render it accessible to as many stakeholders as possible.

Restructure the global food system to accommodate the challenges facing poorer countries. This requires the respect of human dignity in the universal declaration that food is a human right. Yet, through unfavorable actions that include harsh trade policies, many developed countries do not recognize the rights of African countries in this regard. This suggests that all stakeholders, especially developed countries, should work towards emergence of a new system that not merely adopts the status quo but takes cognizance of principles of sovereignty, economic and food rights of African countries.

Restructure the global development finance architecture to give more access to African countries in financing agriculture and food systems resilience. While rich countries can borrow at zero or almost zero cost, African countries are cannot borrow or have to borrow at extremely high rates just to provide the basic needs and rights of their citizens including the right to food. The global development finance architecture should be reconfigured to allow African countries, including other low- and middle-income countries, to borrow at rates and terms similar to those for rich countries. Without such favorable and equitable borrowing conditions, financing agriculture and food system resilience will remain a mirage for most African countries and the current hunger pandemic narratives will remain unchanged.

Conclusion

Developing knowledge and capacity for resilient AFSs in Africa requires the simultaneous development of sustainable policies and sustainable institutions. This involves myriad interlinked issues that include sustainable financing for capacity development at individual, organizational, and institutional levels, which are all pre-conditions for agricultural transformation in Africa. It also involves development of local content in the wide areas of R&D investment, agenda-setting, and policy priorities.

One important lesson learned from economic development history is that development cannot happen from outside. African agriculture cannot be transformed by external interventions and financing alone. African governments need to take ownership and prioritize investments in building regional and national institutions to address regional and national development needs. To be clear, models that provide emergency responses for technical assistance and food needs are necessary for short-term solutions. However, sustainable agricultural transformation requires sustainable investments in strengthening Africa-led institutions where local experts lead agenda-setting, implementation, monitoring and evaluation.

Another important fact that must not be lost in the process of developing knowledge and capacity for resilient AFSs in Africa is the importance of scale. The required capacity must be developed at a scale that is capable of making the necessary positive dent on AFSs. This, in turn, requires effective networks, partnerships, and collaboration at all levels ranging from global to community levels. Indeed, no one government, development finance institution, development partner, or agricultural policy institution is either sufficiently well-equipped or buoyant to meet the diverse development needs of the agri-food sector. Therefore, institutional networking and collaboration is needed to tackle current challenges. The conditions required for such partnerships and collaboration to blossom must be created through institutional networks and collaborative platforms that can deliver the needed scale.

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8 Capturing the Synergies Between Youth livelihoods and Resilient Agri-Food Systems

Felix Kwame Yeboah[1]; David Feige[2]; Hillary Proctor[3]; Thomas Yeboah[4]

Key messages

1. Building sustained and resilient agri-food systems (AFSs) in Africa is an intergenerational mandate and demands the active engagement of African youth who constitute a significant share of Africa's current and projected future population.

2. Youth livelihoods in Africa are intricately intertwined with the performance of AFSs. Hence, public investments that support broad-based agricultural productivity growth and resilience remain a crucial component of an effective youth livelihood strategy.

3. To foster youth engagement, the structure of the AFS needs to promote and broaden opportunities that are profitable, less physically arduous, offer quick returns and have low asset requirements.

4. Policies that facilitate youth access to productive resources (land, finance, digital technology, mechanization) and create enabling environment to develop their skills and innovative capacity are critical to enhancing youth engagement and effective contribution to building resilient AFSs.

5. Harnessing youth potential for a resilient AFS requires youth-focused initiatives to actively integrate positive youth development approaches, elevate youth voices in program and policy decisions, and carefully segment and tailor interventions to the needs of the heterogeneous youth population.

Introduction

Africa's present and immediate future is young. Over 60 percent of the population is less than 25 years old and the projected doubling of Africa's population by mid-century would make the continent home to one in three of the world's youth (15-24 years) and one in four of young adults (25-34 years) (Figure 8.1 and 8.2) (UN, 2020). This unprecedented demographic shift will amplify Africa's influence on the global economy and create new pressures on Africa's food production systems and social systems, which are already struggling to deliver food, nutrition, and decent livelihoods for the growing population. Young Africans will significantly determine the region's growth trajectory and its overall impact on global affairs. If adequately equipped with demanded employable skills and/or entrepreneurship skills,

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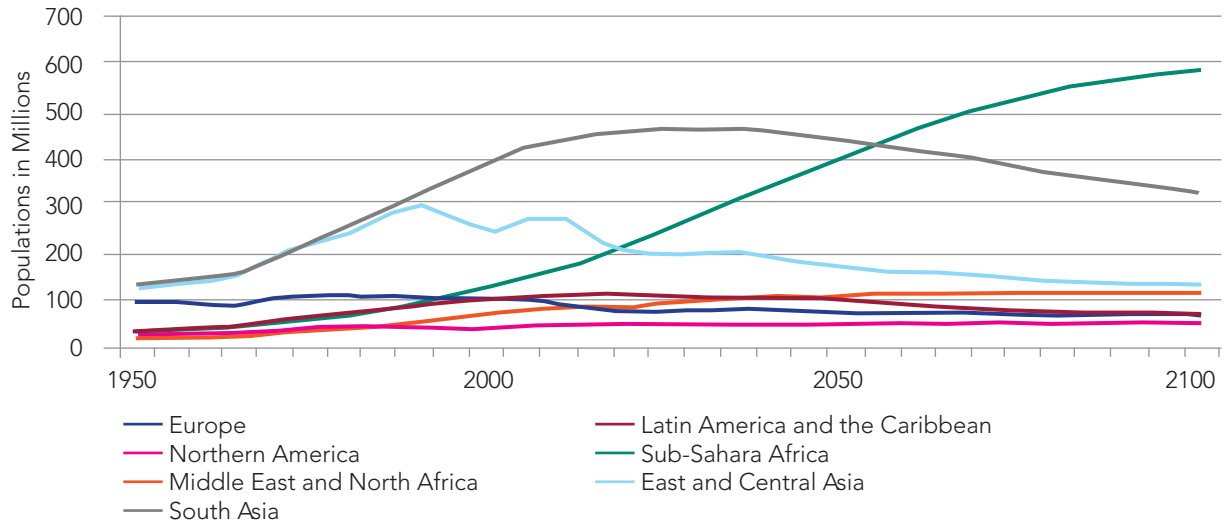


Figure 8.1: Global youth (15-24 years) population trends by region

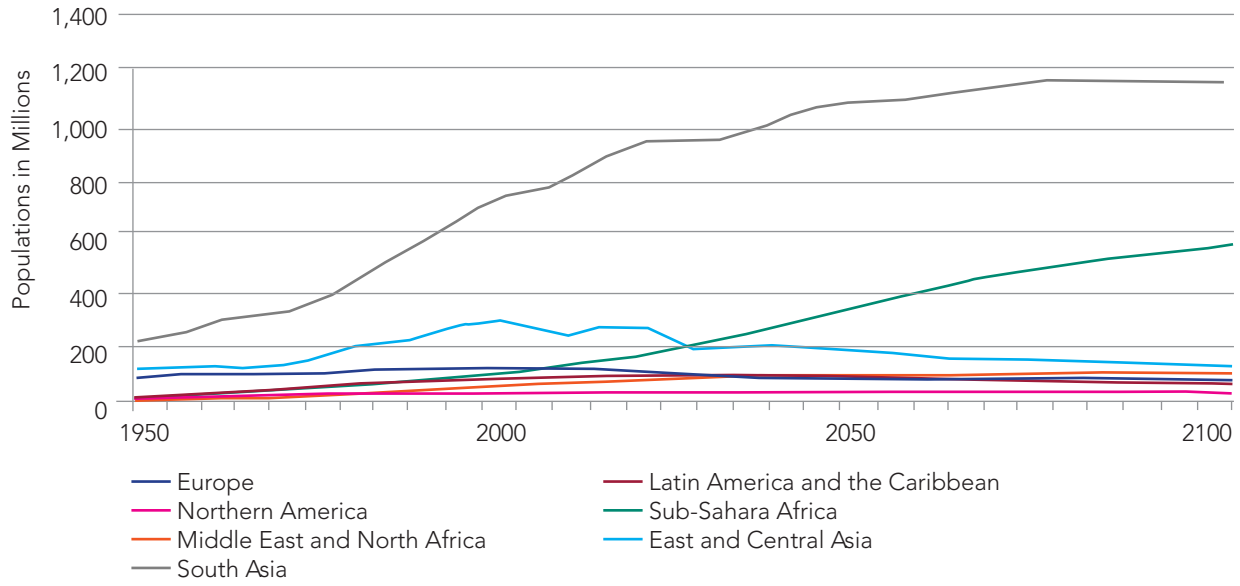


Figure 8.2: Global youth (25-34 years) population trends by region

and engaged in productive employment, young Africans could be a catalyst for accelerated social and economic transformation. Yet, such opportunities are limited, leaving too many African youth facing food insecurity, unemployment and/or underemployment in poverty wage jobs in the informal sector, and limited avenues to develop relevant employable skills (Losch, 2016; AfDB, 2020) – a situation that has been exacerbated by COVID-19 (ILO, 2021). Consequently, efforts supporting youth employability skills training and job creation need to expand dramatically to forestall economic stagnation, increased migration and social unrest that could arise if youth continue to become disillusioned about their future.

Productive agri-food systems (AFS) offer opportunities for addressing youth employment, food security and the poverty alleviation challenges that Africa faces. However, there is growing concern about the prospects of increasing and sustaining agricultural productivity amidst emerging threats to AFS from shocks and stressors such as climate change, FAW and locust infestation, avian influenza, and African swine fever. Indeed, crop productivity is projected to decline by 5 percent for every degree rise in temperature above historical levels (Challinor et al., 2014). This is compounded by the economic and health shocks from the COVID-19 pandemic that have significantly disrupted food markets, reversed progress towards poverty reduction, and exposed remaining weaknesses in social and economic life. Yet, the 2019 Biennial Review of Progress towards achieving the Malabo Declaration targets indicate that many African countries are not on track to implement relevant climate change adaptation policies (AU, 2020). Making Africa's AFS resilient to these threats is critical for the continent to achieve its youth livelihood and food security promise.

However, building a sustained and resilient AFS in Africa is an intergenerational mandate which demands the active engagement of African youth. With their large population, relatively high educational levels, and affinity for digital technology, African youth represent an indispensable resource, which if properly harnessed, can foster a more resilient and productive AFS. This chapter reviews existing evidence on the synergies between youth livelihoods and resilient AFSs in Africa. It is structured as follows: First, it provides an overview of the structure of youth livelihood challenges as well as entry points and barriers to youth engagement in the AFS, highlighting the relevance of the sector to youth livelihoods. This is followed by a discussion of the role that youth can play to promote a resilient AFS. The chapter concludes with a discussion of policy and pragmatic investments that could position young Africans to effectively contribute to a productive and resilient AFS.

Youth livelihoods depend on productive and resilient agri-food systems

Youth livelihoods refers to income-generating activities that youth engaged in to secure the necessities of life. Although youth livelihoods are not markedly different from other demographics, youth as a transitory life stage is associated with peculiar features that disproportionately disadvantage young people in their quest to secure a decent livelihood. For instance, relative to adults, youth often lack the experience, social networks, productive resources, and skills to effectively access income-generating opportunities. Consequently, youth face greater challenges accessing livelihood opportunities. Indeed, youth unemployment rates are about twice those of adults and young people are more likely to engage in vulnerable employment – 80 percent of the working youth in SSA are engaged in vulnerable employment, and nearly two-thirds live in poverty relative to half of the adult population (ILO, 2020). Relatedly, young people are also likely to see their livelihood most severely impacted during an economic crisis. They are often the first to lose their jobs and the last to be hired during such times. The recovery of youth employment after economic shocks takes a longer time than that of the general population. For instance, 10 years after the 2008 global financial crisis, the global youth unemployment rate is yet to return to its pre-crisis level of 11.7 percent. This has been exacerbated by the COVID-19 pandemic, which has left young people unemployed in far greater numbers than adults (Fleming, 2021). Youth unemployment increases the probability of future unemployment, lowers lifetime earnings, and reduces future job satisfaction and contribution to national development (Bell and Blanchflower, 2011; The Economist, 2011). Therefore, interventions addressing youth-specific livelihood challenges remain critical.

Young Africans face a livelihood challenge with three overarching facets. The first relates to the oversupply of labor arising from rapid population growth rates leading to about 11 million young African's entering the labor force each year (AfDB,

2020). The second relates to the job-readiness of the labor being supplied. Although the current cohort of young people are the most educated the region has ever had, their educational levels remain low. About two in three youth entering the labor force have less than a secondary school education; access to quality education that imparts the requisite skills befitting of the 21st labor force remains out of reach for many young Africans (Arias et al., 2019). School closures leading to the loss of almost a year of learning coupled with the economic crisis created by COVID-19 have only aggravated the skills development challenges that youth face (UN, 2021). The third facet relates to the slow pace of job creation, which reflects the slow structural transformation of African economies. Notably, Africa's impressive economic performance over the past two decades has created opportunities for well-educated and highly skilled young people to be pulled from farming into productive non-farm employment. Rapid demand for food fueled by urbanization, income growth, and diet changes has also created new incentives for investment in agriculture, especially among a relatively entrepreneurial class of young people who have access to productive resources (e.g., land, finance, technology, and markets) and, in the process, has transformed sections of the youth labor force into successful farmers (Hollinger and Staatz, 2015; Tschirley, 2015). Nonetheless, the pace of job creation in Africa's growing economies lags behind the rapid labor force growth. Estimates indicate that the gap between the number of young Africans entering the labor force and available opportunities in the formal wage sector widens by about 8 million annually (AfDB, 2020). Hence, a large share of the youth labor force, especially those without productive assets and skills, are consigned to underemployment in poverty jobs in farming and the non-farm sector. The long-term sustenance of youth livelihoods in Africa would depend on how well policies could successfully transition these struggling labor force participants into productive and well-paying jobs or self-employment.

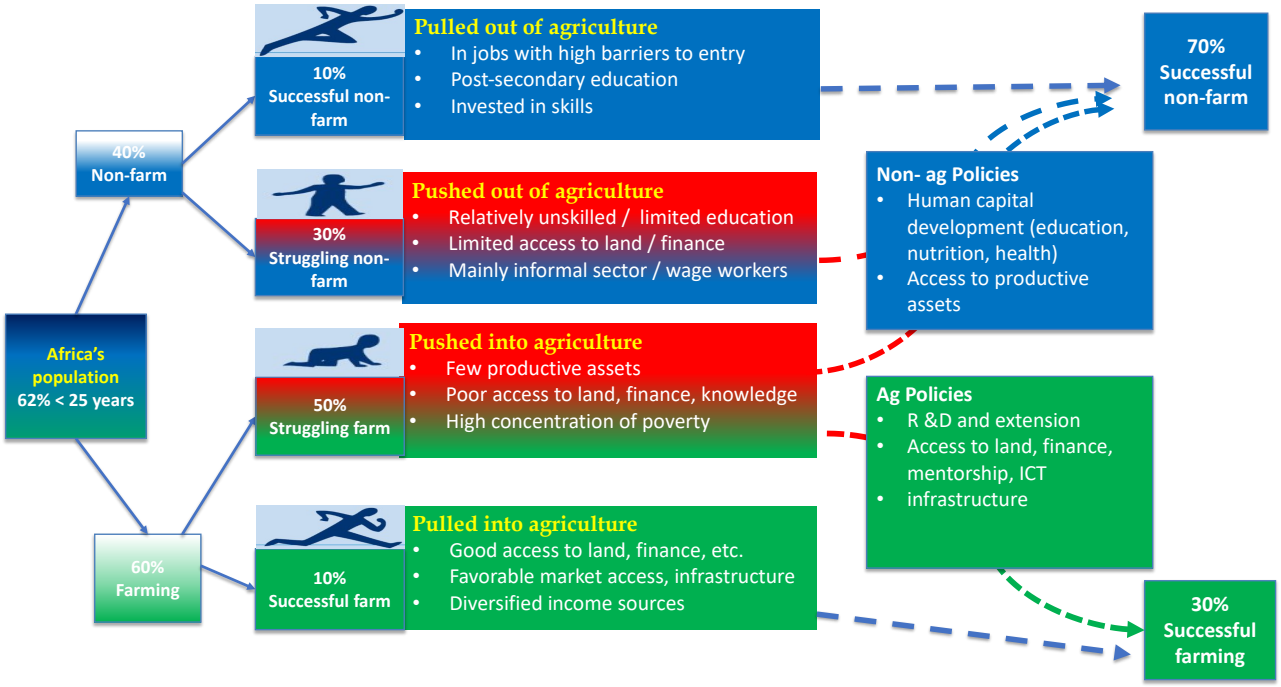


Figure 8.3: Structure of youth livelihood challenge and pathways for structural transformation

Africa's AFS comprising of farming and off-farm activities in agricultural value chains is critical to securing youth livelihoods both in terms of direct provision of jobs and its potential to stimulate employment opportunities in other sectors of the economy. Presently, employment in the AFS represents the majority of youth livelihood opportunities. Farm-based activities still account for more than half (52 percent) of total employment for young Africans (ILOSTAT, 2020). An analysis of nine African countries shows that the share of the youth labor force (15-24 years) engaged in farming, even when accounting for total time devoted to farming, ranges from 40 percent in Ghana to 63 percent in Tanzania. For young adults, farming's share in full-time equivalence terms ranges from 25 percent in Ghana to 49 percent in Uganda. Economically active youth (15-24 years) are also engaged in farming at higher rates than older age cohorts (Figure 8.4). Dolislager et al., 2020) estimate that on average, rural youth devote about 51 percent of their total work time to farming relative to 36 percent for adults. While the proportion of young Africans entering farming is lower today than it was several decades ago, there remains a sizable share of the rapidly growing youth population engaged in farming. As a result, Africa's agriculture is not yet the preserve of the elderly. Indeed, contrary to popular beliefs, Yeboah and Jayne (2020) show that the average age of Africa's agricultural workforce is less than 45 years due to downward pressure from the large proportion of young farmers. However, most of these engagements occur as unpaid activities on family farms that operate seasonally due to a rainfed agriculture approach and are often less profitable, and not sufficiently productive to assure them a decent livelihood (ILO, 2016). With climate change causing increased temperatures, erratic rainfall patterns, and pest infestations, the ability of young people to secure livelihoods from these rain-dependent agricultural systems is in jeopardy. Strategies that enhance the productivity and resilience of farming therefore remain crucial to securing youth livelihoods.

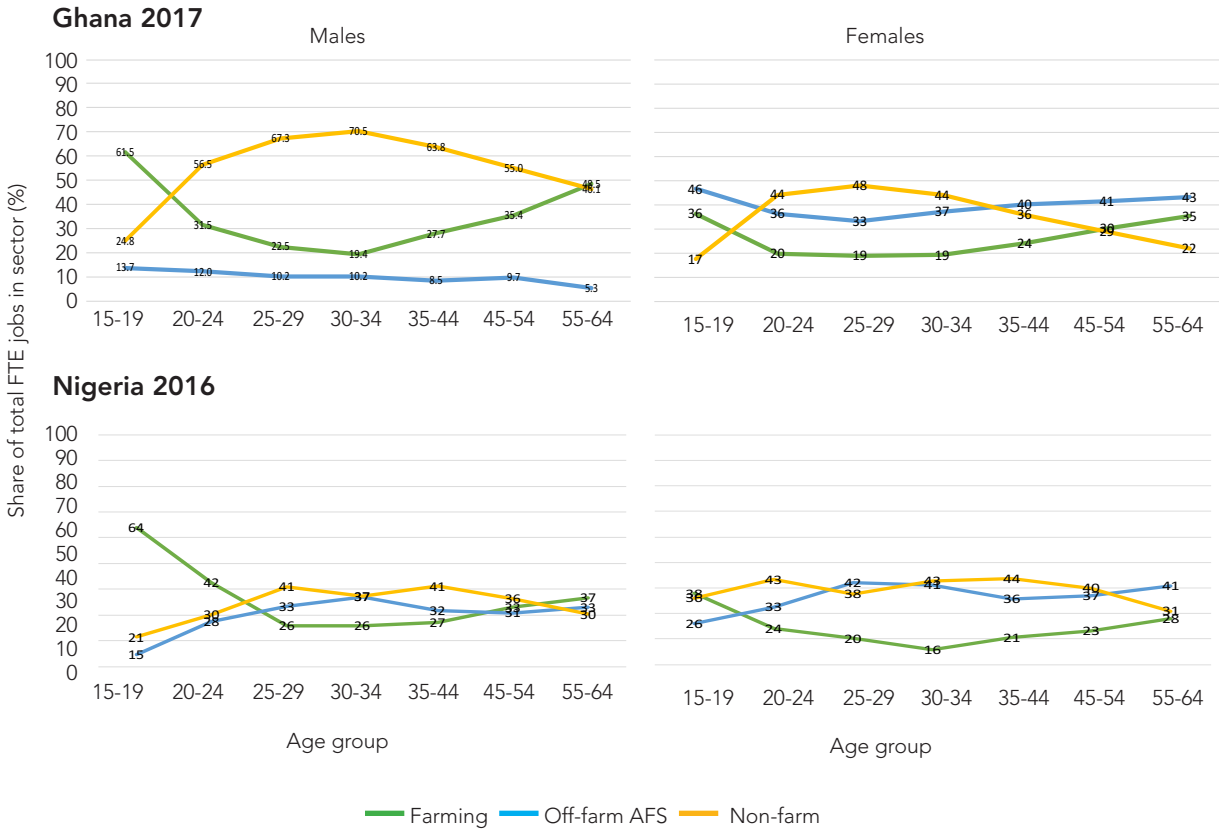
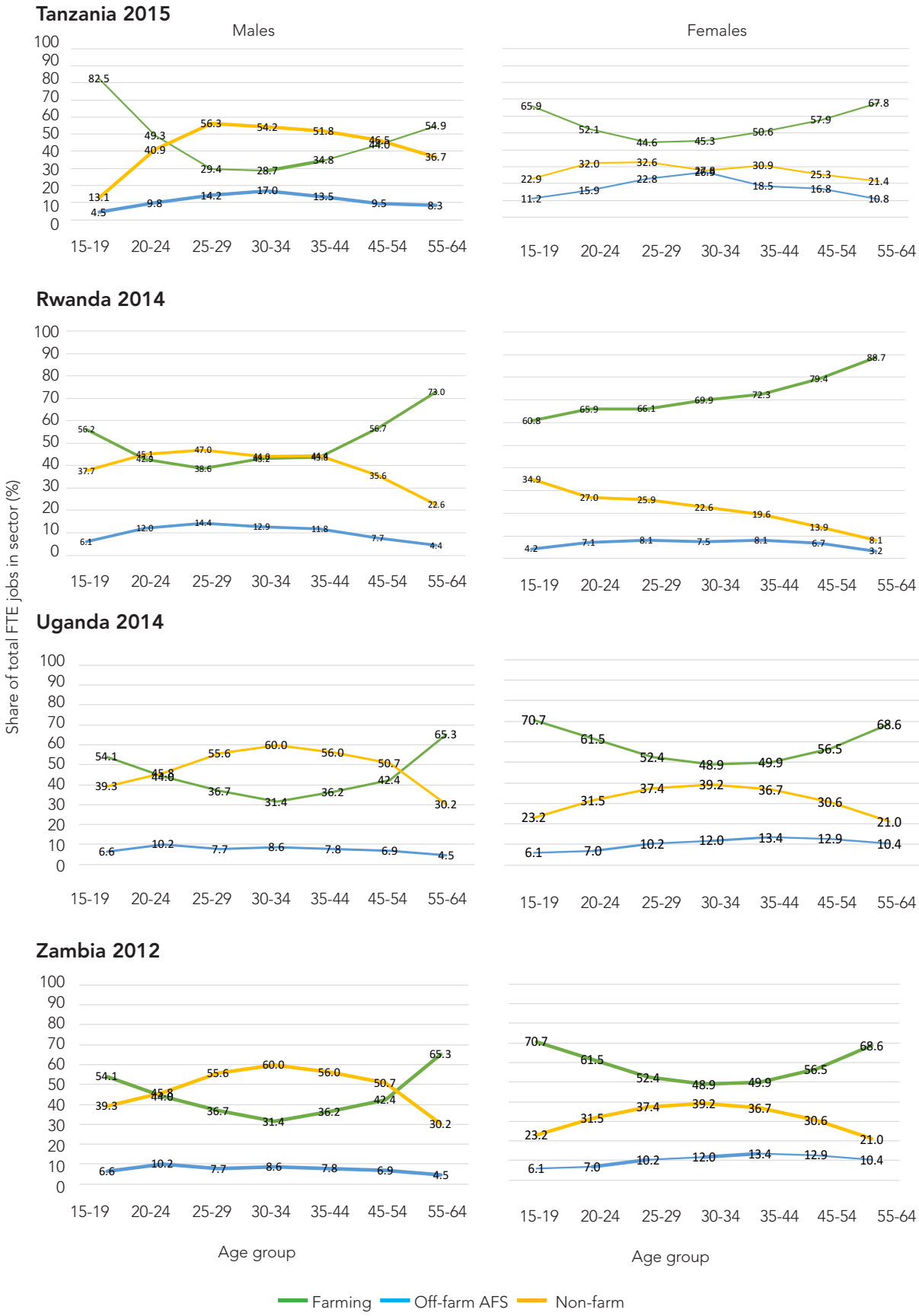


Figure 8.4: Proportion of total full-time equivalent (FTE) jobs, by employment sector, age group and gender

Figure 8.4 (continued): Proportion of total full-time equivalent (FTE) jobs, by employment sector, age group and gender



In addition to farming, the off-farm segment of the AFS has been an important and growing source of livelihood for young Africans. Depending on countries' level of structural change, the off-farm segment of the AFS accounts for 8 to 16 percent and 10 to 25 percent of total full-time equivalent (FTE) jobs held by youth (15-24 years) and young adults (25-34 years) respectively (Yeboah and Jayne, 2018). However, the sector remains underdeveloped in most countries with most of the jobs concentrated in commerce and distribution. Agro-processing remains largely small scale and thus does not create the economies of scale necessary to attain competitiveness and high levels of productivity. Hence, despite its rapid percentage job growth in the last decade, it is estimated that in most countries, job creation in the off-farm segment of the AFS will not surpass on-farm job creation until at least 2025 or even later (Yeboah and Jayne, 2018). Together, farming and off-farm segments of AFS represent a significant source of youth livelihoods. Any shocks that undermine their growth and resilience would thus invariably impair the ability of young Africans to secure their livelihoods.

A key relevance of AFSs to youth livelihoods stems from agriculture's role as a precursor of structural change. Global evidence shows that higher on-farm productivity is closely correlated with the growth of off-farm opportunities. In much of Asia, sustained agricultural productivity growth from green revolution technologies and supportive government policies kick-started rural economic growth processes that pulled millions of farmers into productive off-farm jobs leading to overall improvements in living standards (Johnston and Mellor, 1961; Mellor, 1976). A similar pattern seems to be underway in Africa. Evidence shows that African countries (e.g., Rwanda, Ethiopia) that achieved the highest rates of agricultural productivity growth generally experienced the most rapid exit of labor out of farming, and the highest growth in labor productivity in non-agriculture sectors. This is due to the "multiplier" effects associated with an increase in farmers' income, which they in turn spend on the purchase of assets from off-farm industries. In Ethiopia, for instance, a US$1 of output generated in agriculture was shown to stimulate a further $1.23 in economic activity in other parts of the economy (Diao and Takeshima, 2016). Fostering resilience and agricultural productivity growth is therefore crucial not only for young people who remain fully or partially engaged in agriculture but also to expand the pace of employment and income growth in the off-farm segments of the economy. Consequently, public investments that support broad-based agricultural productivity growth and resilience remain a crucial component of an effective youth livelihood strategy.

Youth engagement is necessary for building resilient agri-food systems

By their sheer numbers and energy, Africa's youth represent an enormous human resource that can be engaged in diverse ways to build resilience of AFS. They could be engaged as advocates interfacing with policymakers on various platforms to influence policies, entrepreneurs and innovators developing innovations and businesses to address resilience challenges, educators promoting adoption of new technologies, direct service providers, wage workers, etc. For instance, youth could be recruited into an integrated mentorship and public works program to support the development and maintenance of physical infrastructure, provide extension services and/or direct farm services such as spraying that are critical to developing resilient agri-food systems. Sensitizing young people to these opportunities and creating lucrative spaces to meaningfully engage them is necessary for building resilient AFSs for several reasons.

First, resilience demands cross-generational learning and collaboration. As experienced actors, the older generation may be custodians of indigenous knowledge that has helped to sustain AFSs for several years and offer a strong foundation upon which current and future innovations that could assure resilience can be built. Creating mentorship programs for young people to meaningfully engage and build sustained relationships with older generations in the solutioning process would enhance preservation

and intergenerational transmission of such indigenous knowledge systems and ensure youth have support systems as they step forward in leadership roles.

Second, youth have a longer time horizon and would likely face the long-term impacts of the resilience strategies we adopt today. The meaningful engagement of youth as equal partners in development of resilient strategies is thus critical to garner youth buy-in and widespread adoption of those strategies. It will also ensure that the strategies and expected outcomes closely align with the future they envision for themselves.

Third, youth can be a catalyst for innovation and technology adoption that fosters AFS resilience. Africa's agri-food sector will increasingly need new knowledge and innovative techniques that promote resilient and sustainable forms of agricultural productivity growth. For instance, drought-resistant seed varieties and soil amendments that hold moisture for longer periods and provide greater crop response to fertilizer will be essential for climate-smart agriculture. The development of local agricultural research systems and robust extension services that can effectively create, borrow, screen, adapt to local context and disseminate such innovations will be crucial to the long-term sustenance and resilience of Africa's AFS. Systems that seamlessly integrate R&D&E services and foster bi-directional learning between researchers and end users of innovation have proven particularly effective at leading to discovery of practices that actually fit with farmers' varied resource constraints (Reij and Smale, 2009). Digital technology that allows for timely and efficient collection, storage, analysis, and dissemination of information has tremendous potential to advance the development of such bi-directional extension systems and improve overall productivity and resilience outcomes. Digital technologies can support AFS actors to make informed decisions on the risk, production, and market options through a range of services including mobile-based extension services, internet-enabled climate-smart irrigation services, and market information services (Townsend et al., 2019). Such technologies also hold great prospects for removing historical barriers between remoteness and access to services.

Although a systematic analysis of whether youth are more innovative than adults is lacking (Sumberg et al., 2019), reports from youth consultations indicate that digital technology has a broader appeal among youth. Younger farmers tend to pick up new technologies more easily and are often keen on increasing production through improved modern technologies (MIJARC/IFAD/FAO, 2012). In fact, Africa is replete with youth-led agricultural start-ups that are leveraging digital technologies to improve efficiencies in production, processing, and service delivery across agricultural value chains. For example, in Nigeria, a mobile-based platform, Kitovu, is providing farmers with data-driven information to match their soil to specific inputs and production technologies and connecting them to off-takers. In Kenya, FarmDrive is using data-driven assessments to make it easier for creditworthy farmers to get much-needed loans. Similarly, Farmcrowdy, a digital agriculture platform, is connecting farm sponsors with real farmers to increase food production while promoting youth participation in agriculture. With a relatively higher educational attainment, entrepreneurial spirit, and affinity for digital technology, African youth are primed to catalyze the development and widespread adoption of information and communication technology (ICT)-based solutions to resilience challenges in Africa's AFS.

Youth face significant barriers to engaging in agri-food systems

Despite the potential synergies between youth livelihoods and resilient agri-food systems, youth often face a well-documented set of endogenous and exogeneous obstacles to engaging in the AFS. The endogenous barriers emanate from young people themselves; it is worth highlighting the widespread narrative of general youth disinterest in agriculture. Several studies have noted a number of significant contributors to youth lack of interest in the AFS: negative youth perceptions of agriculture

as a sector of last resort and the preserve of poor, uneducated, and failed youth; the drudgery associated with traditional agricultural practices; and the negative manner in which families, the, media, and Africa's education system, which emphasizes white collar jobs, socialize agriculture to young Africans (Minde et al., 2015). Across the continent, it is common for schools to use labor on the school farm as a punishment for pupils and students and for families to encourage youth to seek opportunities outside of farming. Kimaro et al. (2015) assert that young people's poor participation in agriculture can be traced back to the lack of clear-cut career pathways in schools and poor promotion of the sector as a viable venture at the different levels of education and at home (Kimaro et al., 2015).

Nonetheless, it is worth noting that most studies on youth interest in agriculture tap into youth aspirational goals, which are often divorced from livelihood opportunities available to them. In fact, evidence indicates that when given the opportunity for productive and profitable engagement in agriculture, youth take advantage of them (Mabiso and Benfica, 2019). Also, these studies often treat youth as a homogeneous group and fail to segment their responses across the various youth demographics. Evidence suggests that youth disinterest in agriculture is predominant among the educated youth who typically view opportunities in AFSs to be at variance with their aspirational lifestyles (Afande et al., 2015; Mulema et al., 2021). As Metelerkamp et al., (2019) note, youth are sharply divided on the prospects of the sector with some showing clear interest while others hold negative views.

A second barrier to youth engagement in the AFS is the general lack of skills and technical know-how to take advantage of opportunities in the increasingly knowledge- and technology-intensive AFS – a phenomenon that is closely tied to limited educational opportunities to develop relevant skills. This lack of skills is particularly critical for emerging opportunities in the off-farm segment of AFS where actors are increasing required to comply with ever-changing safety and nutrition standards. In most African countries, agricultural curriculum is often absent in the early years of education and many youths drop out of school before being exposed to agriculture training. This, combined with the general lack of career guidance in African higher education and common social pressures to seek white collar employment, implies that many youths are unaware of the suite of opportunities available for decent employment along agricultural value chains.

That said, many young people see the opportunities in AFSs and seek to tap into them. However, their efforts are constrained by a number of exogenous structural barriers such as lack of access to and control of affordable capital. Access to finance remains a major barrier across AFSs as financial institutions are often unwilling to lend to agri-enterprises, much less youth-led agri-enterprises, due to enduring perceptions of agriculture as a risky venture. For young people, the added disadvantages of lack of a credit history, demonstrated experience executing funded agricultural activities, and/or lack of collateral disproportionately affect their ability to access financial support. Lack of funds thus limits the ability of youth to make the needed investments that would make their enterprises productive and resilient to shocks. These external financing factors are often coupled with household dynamics where youth are often pressured to share resources with the family structure. This can further disincentivize youth from seeking capital or increase their risk in holding capital as they can lack total control of these resources.

A growing body of research has also highlighted the difficulties that young people interested in farm-based activities face in accessing land (Bezu and Holden, 2014; Yeboah et al., 2019). Contrary to the widespread perception of land abundance, evidence indicates a growing land scarcity in Africa as a result of population growth and increased interest from both local and foreign investors. About 91 percent of Africa's remaining arable land is concentrated in nine countries, and the remaining 45 countries are either land-constrained

or approaching the limits of their arable land (Chamberlin et al., 2014). This increasing land scarcity and associated rising land values are restricting youth access to land. Moreover, the primary mechanism through which many young Africans access land is through inheritance. However, even in areas where land is available, youth are forced to wait until late into their adulthood to inherit land due to increasing life expectancy of adults. This situation dissuades many young people from engaging in the sector at a youthful age. Lack of land also makes it increasingly cumbersome for the youth to present collateral to financial institutions to obtain funding to start or expand their businesses (Njeru and Gichimu, 2014).

Other general economic growth barriers such as poor infrastructure networks, especially in rural areas where most agricultural activity takes place, and associated limited access to markets, also hinder young people's ability to build profitable agricultural enterprises. Despite progress in recent decades, much of Africa is inadequately resourced with road networks, reliable and cheap sources of energy, internet connections, and relevant social amenities that can support the development of profitable agricultural enterprises. Closely aligned with this is the lack of Africa-specific data or information on which youth can base their agricultural enterprises. Most African countries do not consistently collect information on consumer behavior, markets, weather, and soils information that could inform production and market decisions of actors in the agri-food value chains. Where such data exists, it is often inaccessible to youth due to educational limitations and/or other barriers. Further, such data collection often relies on technical definitions that are generated for Western contexts, leading to data that may not accurately reflect Africa's specific context. Consequently, entrepreneurial youth in agriculture are forced to make major decisions about enterprise growth based on limited information on market operations, conditions and prices, and consumer preferences, which depresses returns from agricultural production. Improving physical infrastructure and access to information remains critical to strengthening rural-urban linkages and making the AFS and rural landscape attractive to young people (Mulema et al., 2021).

There are also issues with bureaucratic red tape and corruption, which can be particularly challenging for youth who do not have the social and/or monetary capital necessary to navigate these business challenges. Despite concerted efforts by governments to encourage youth to develop SMEs, the regulatory environment is often not conducive for the SMEs that young people start in the AFS. Young entrepreneurs are often saddled with cumbersome and expensive business registration processes leading many enterprises to operate informally, which subsequently impairs their ability to secure support from investors and access international markets. Even where support exists, lack of transparency and political clientelism often prevents youth-owned enterprises that merit the support from receiving it, dissuading many from active engagement in AFS.

Although the above factors are pervasive in constraining young people's ability to access opportunities, they do not impact the heterogeneous youth population equally. The intersectionality of a range of vulnerability factors yields different barriers/outcomes for various youth groups. For instance, gender determines the extent to which young people are hindered from taking up agriculture. In most African societies, young men have privileged access to productive resources such as land relative to women (Woldenhanna and Tafere, 2014). Additionally, education levels and other factors of vulnerability such as family/caregiver economic status, refugee/IDP status, and limitations related to remote rural areas increase or decrease youth's constraints. These constraints may be binding and require intentional support to reduce barriers. Without addressing these specific constraints of the heterogeneous youth population, policies and programs will likely benefit those youth with greater assets and resources the most.

Profitable agri-food system opportunities that are less physically arduous, yield quick returns, and have low asset requirements provide entry points for engaging youth

While much has been made of young people's supposed aversion to agriculture, available literature also provides clues on potential entry points for engaging young people in the AFS. First, young people unsurprisingly tend to respond most strongly to profitable opportunities that yield quick returns and require limited assets for entry. The fact that crops differ in their profitability, timing of returns, and/or asset requirements for production suggests that they will generate uneven interest among young people. Similarly, not all opportunities along the value chain of a given crop will generate uniform interest among youth; young people have regularly expressed greater interest in off-farm activities (such as service and downstream value chain opportunities) than in on-farm activities that are perceived as and sometimes culturally reinforced to be "drudgery." In this respect, agricultural mechanization and labor-saving technologies that enhance profitability and reduce the "drudgery" associated with on-farm activities have been instrumental in attracting youth into the agricultural sector. As a recent study shows, younger farmers are more likely to use mechanized inputs to cut down on labor requirements on their farms (van der Westhuizen et al., 2018). Mechanization increases labor productivity and incomes through timely field operations, freeing up young peoples' time for off-farm income-generating activities (Ommani, 2011). Mechanized irrigation systems also address seasonality in agriculture and allow for year-round agricultural production, which increases farm incomes (Biggs and Scott, 2015). Hence, policies promoting mechanization offer an avenue to engender positive perceptions and engagement of young people in the AFS. Such policies will also support youth to pursue the diversified livelihood strategy (combining on-farm with off-farm employment), which is critical to their resilience to shocks (Mastewal, et al., 2019).

The structure of the AFS also shapes available opportunities in the value chain and hence youth's involvement in the sector. Generally, "longer" value chains (those with more downstream opportunities) offer more opportunities for youth engagement than "shorter" value chains that may involve, for example, only production and sale, with little in the way of trading, processing, service provision, or other opportunities for value addition. Longer value chains tend to correspond more closely to high-value crops; while the latter may be more closely associated with staple crops which are land-intensive and offer little in the way of non-production opportunities (World Bank, 2016). Staple crop production also tends to be highly centralized and commercialized, creating barriers for youth participation. Indeed, high-value horticulture has proven to be a more efficient job creator than staple crops, generating 10 to 100 times more employment than staple crops per hectare (Allen et al., 2016). With rising incomes and urbanization projected to fuel a growing demand for higher value crops, investments to develop value chains of high-value crops could open up opportunities to expand productive youth engagement in the AFS (Zhou and Staatz, 2016).

Finally, young people's involvement in the agri-food sector is also shaped by the relevance (interest) and accessibility of the AFS opportunities given youth's own resource endowment including education and skills, gender, land, family and community support, and access to capital. These assets often determine the segment as well as the type of activities youth gravitate towards along the value chain. An asset-rich young person, for example, will be better placed to engage in commercial on-farm production; a young person with education but without other tangible assets (such as capital) may be more attracted to service opportunities along the value chain (such as ICT-enabled market discovery services); and a young person lacking

tangible assets may be attracted more toward services (such as integrated pest management) that requires neither. For instance, in Kenya, although high-value crops such as mango and passion fruit offer numerous and diverse opportunities, they are highly regulated making it difficult for young people to engage with as entrepreneurs. Hence, young people are typically found engaged as hired or household farm workers. Thus, interventions that focus on building the assets of youth (skills, education, access to land, decision-making authority, reduced gender constraints, social and financial capital, etc.) can help expand entry points for meaningful engagement of youth in the AFS.

Young people need skills, space, and productive resources to meaningfully contribute to more resilient agri-food systems

To enhance youth engagement and their effective contribution to building resilient AFSs, Africa's policymakers and development partners would do well to invest in strategies that promote youth-inclusive broad-based agricultural productivity growth and human capital development that would, among others, develop the skills and innovative capacity of youth. Specific interventions in this regard include policies that: foster a youth-inclusive innovative culture that is responsive to the changing demands of resilience; upgrade skills of the labor force in AFSs; expand youth access to productive resources; and promote adoption of best practices with regard to youth programming.

a. Foster a youth-inclusive innovative culture that is responsive to the changing demands of resilience

To ensure sustainability and resilience in agri-food systems, policymakers need to foster an innovative environment that anticipates, rapidly responds and/or flexibly adapts to prevent, mitigate and/or recover from evolving threats and shocks. Cultivating such an environment requires public investments in research and development and complementary robust extension services that promote efficient use of current resources and support integration of indigenous knowledge systems with modern science to develop innovative technologies (e.g., climate adaptation strategies) that are adaptable to local context. It is estimated that a doubling of agricultural research spending alone could increase agricultural output by 3.4 to 4.1 percent with significant income and employment multiplier effects that will be supportive of youth livelihoods (Fuglie and Rada, 2013).

Young people could be enlisted to support the requisite research and bi-directional extension services through programs that support young innovators to nurture their ideas and bring them to scale. To this end, public investments are needed to expand access to seed capital, and/or incubators where prototypes of new innovations can be developed and launched. Michigan State University's Product Center and associated Food Processing and Innovation Center provides customized counselling, commercial processing space with food processing equipment, and state-of-the-art technologies and facilities that entrepreneurs and businesses can rent to create new innovative products for the marketplace and is an example of a much-needed space to support young innovators in Africa's AFS. An innovative culture will also require a supportive regulatory environment, including changes to business registration and patent regimes broadly relevant to innovation systems.

b. Upgrade skills of labor force in agri-food systems

Agricultural education and training (AET) is relevant to young people at all levels of the educational system. At elementary levels, improved literacy and numeracy is closely linked to higher levels of output. Indeed, increasing the average schooling level of the agricultural labor force to six years could increase output by 1.3 percent (Fuglie and Rada, 2013). For older youth, expanded access to technical and vocational education and training (TVET) is central to the acquisition of new skills related to AFS requirements. However, in most African countries, such training programs are often unavailable (particularly in rural areas) or inadequately resourced to impart the relevant skills. Negative perceptions about TVET being less "professional" and only

suited for those who are less academically inclined also persist. Restructuring TVET education and agricultural training colleges offers a vital entry point to addressing skills mismatch and enhancing the capacity of low-skilled young people to successfully take advantage of emerging opportunities in AFS as self-employed service providers or adopters of innovative technologies that promote resilience and productivity. In this respect, the German dual vocational training system, which integrates work-based and school-based learning, provides a good model to flexibly adapt skills training to changing labor market conditions, strengthen the linkages between industry and skills training, and facilitate young people's transition to full- time employment. Each of these areas will require sustained long-term public investments.

However, unless it is complemented with start-up capital, mentorship and/or expansion of job opportunities where the acquired skills can be applied, skills training alone is inadequate to ensure the meaningful engagement of youth in agri-food systems (Fox and Rada, 2013). An exclusive focus on skills training independent of demand-side considerations will result in a mismatch between skills development and actual job opportunities. Hence, skill-building efforts should be done in consultation with the private sector, which could also provide hands-on practical education to the students. Reformed curricula should also foster the acquisition of digital literacy and soft skills such as stress management, critical thinking, problem-solving and tenacity that will enable youth to deal with shocks and uncertainties that the future of work will bring.

c. Expand youth access to productive resources (digital technology, land, finance, mechanization)

Youth need access to productive resources to effectively engage in the AFS. One key resource is access to digital technology and mechanization that makes agriculture less arduous and more profitable. Despite widespread diffusion of mobile technologies, they remain inaccessible to many rural residents in Africa. The tendency of some governments to prioritize revenue from the sale of licenses to private telecoms over keeping cost to consumers low has resulted in some African countries experiencing high mobile phone charges, which further constrain rural youth access (Mabiso and Benfica, 2019). Developing more consumer-friendly telecoms policy and complementary education to promote their productive use may therefore be an enabler of youth involvement in AFS. To promote widespread adoption, such policies could foster expanding access to affordable digital devices that require low literacy and skills to operate and offer interactive voice response functionality in local languages.

However, land and finance likely remain the two greatest constraints to young people's active participation in AFS. Youth (particularly young women) in many parts of rural Africa are increasingly unable to inherit land or acquire enough land to make farming a viable business (Yeboah et al., 2019). Programs promoting youth access to land, such as those that lobby traditional leaders to allocate land to youth, rehabilitate marginal lands for distribution to young people, use incentive schemes including retirement packages for older community members to facilitate intergenerational transfer of land/or support young people with loans to access land, will be increasingly important to enable youth engagement in the AFS (FAO, 2014). Additionally, if the AFS is to benefit from significant youth engagement, proactive measures to expand access to credit and insurance for young people and agriculture in general is essential. Financial products to assist youth, particularly in rural areas, to access start-up capital and credit to expand existing businesses is sorely needed. This could be achieved through loan-back guarantees that lower the risk in lending to young people, streamlining regulations to encourage private financing of agriculture through crowdsourcing, and development of youth-focused financial products (FAO 2014).

d. Adopt best practices for engaging youth in agri-food systems

Programs implemented by national governments, foundations, the private sector, international development partners, or others should actively follow industry best practices when designing

and implementing activities focused on youth's engagement in agriculture. Below are six programmatic considerations.

1. **Do no harm.** This is especially critical from the resilience perspective given the vulnerability of both young people and the AFS of which they are a part. Projects should consider potential negative outcomes associated with project interventions and work to mitigate those wherever possible, avoiding interventions where mitigation is not possible.

2. **Integrate positive youth development approach in youth programming.** Capitalize on the opportunity to enhance overall youth development through young people's engagement in agriculture by employing a positive youth development approach (PYD). PYD is an intentional, prosocial approach that engages youth within their communities, schools, organizations, peer groups, and families in a productive and constructive manner; recognizes, utilizes, and enhances young people's strengths; and promotes positive outcomes for young people by providing opportunities, fostering positive relationships, and furnishing the support needed to build on their leadership strengths.

   Organizations such as 4H have utilized the intersection of agriculture and youth development to create meaningful space to promote engagement in agriculture and foster healthy growth and transition from childhood to adulthood. The integration of PYD into youth and agriculture programs allows for intentional development of youth assets, agency, contribution, and development of an enabling environment,
   all of which are critical for youth development and advanced AFSs.

3. **Engage youth in project design and development.** Engaging youth as equal partners in project design, decision-making and implementation can be an effective way to ensure that youth-focused interventions are consistent with their interests and talents. Moreover, resilience characteristics are socio-culturally bounded (Tol et al., 2013; Klasen and Crombag, 2013). Hence, to be at all meaningful, strategies should come from the populations that will employ them. Of particular importance is the incorporation of youth in the identification of target value chains in agricultural development projects given that different agricultural value chains offer varying opportunities that appeal differently to young people. The authors of this chapter have witnessed a number of projects that conducted value chain selection activities without consulting the youth and then retroactively tried, with limited success, to incorporate youth into project activities. Youth can also be helpful in identifying their specific barriers to engaging in the AFS thereby allowing the project to undertake interventions that target those obstacles and facilitate the entry of youth into the AFS. The obstacles that young people face (and therefore the support they require) for participation in AFSs differs from that required by adults. Projects should target support that is both youth- specific and relevant to the particular resource constraints that hinder access to relevant entry points.

   Enhancing youth inclusiveness in matters related to AFSs can be achieved by organizing youth into groups and providing them with a platform to share their ideas and challenges, and/or building their ability to lobby for policy change. The Africa Farmers Club and Youth Konnekt Africa forum are notable examples.

   Young people could also be encouraged to take up leadership roles in policymaking where they can advocate for and implement youth-friendly solutions. Mentorship programs that pair young people with experienced actors in AFSs and promote open communication also offer entry points for strengthening youth voices and facilitating the intergenerational transfer of knowledge. Policymakers could also facilitate the creation of youth- driven and focused

publications that could serve as a mouthpiece for youth.

4. **Seek a variety of agri-food system entry points.** While production-oriented opportunities are more prevalent in most agricultural value chains, off-farm and service provision opportunities are often more appealing to young people. Furthermore, programming that focuses on a single value chain activity is inconsistent with attempts to build resiliency and also reinforces the mistaken notion prevalent among young people that opportunities in AFSs are synonymous with "farming". Programs should embrace the wide range of entry points discussed here including short-cycle crops at the farm-level and downstream opportunities in areas such as processing or services such as providing market information. In some countries, such as Kenya, the emergence of young people as agri-dealers has also been observed. In each of these roles, young people have demonstrated an ability to meaningfully contribute to value chain upgrading and productivity. Empowering youth to access multiple income streams along the value chain would help them to diversify their livelihoods and enhance their ability to respond effectively to shocks.

5. **Segment carefully.** Youth-focused initiatives should segment and tailor interventions to the needs and constraints of the heterogenous youth population. They should seek an appropriate "match" between youth segments and value chain entry points consistent with relevance and accessibility. For example, educational level plays a critical role in determining the opportunities available to young people; those with higher levels of education or financial literacy may be better able to manage their own business or deliver ICT-based services, while others with less education may be more equipped to work as wage workers in processing facilities. Projects should carefully analyze the requirements of value chain entry points to ensure that the characteristics of each segment are appropriate to the needs of that particular job.

6. **Develop skill-building initiatives aligned with available jobs**. Projects often engage in youth capacity-building activities without consideration for the match between targeted skills and the opportunities for young people in AFS. Therefore, projects should work backwards from agri-food value chain entry points to skill-building activities rather than building skills without regard for their applicability to identified entry points for youth within the AFS. Job profiling, whereby job descriptions are developed by value chain entry point with training targeted at developing those skills, has been employed effectively as a tool for ensuring alignment between workforce initiatives and available jobs.

Conclusions

The ongoing COVID-19 pandemic and recent extreme weather and pest infestations point to an urgent need to enhance the resilience of Africa's AFS to safeguard its food security and employment potential. If properly harnessed, young Africans, who comprise a significant share of Africa's labor force, and represent a valuable human resource could help advance a more resilient and productive AFS. In examining the potential synergies between youth livelihoods and resilient AFS in Africa, this chapter has highlighted salient features of the youth livelihood challenge, opportunities and barriers young people face in the AFS, and pragmatic investments that could position young Africans to effectively contribute to a productive and resilient AFSs.

This chapter concludes that Africa's AFS is critical to securing youth livelihoods both in terms of direct provision of jobs and its potential to stimulate employment opportunities in other sectors of the economy. Employment in the AFS is and will likely remain the dominant source of livelihoods for young Africans at least for the immediate future. Hence, public investments that support broad-based agricultural productivity growth and resilience remain a crucial component of an effective youth livelihood strategy.

Second, despite widespread perceptions of youth aversion to agriculture, the review of available evidence suggests that youth are eager to take advantage of profitable and less physically arduous AFS opportunities that offer quick returns and have low asset requirements. Expanding such opportunities in AFSs could foster meaningful youth engagement and contribution to building resilient AFSs. However, this should be complemented with policies that support young people to overcome key barriers to accessing these opportunities. This includes interventions that facilitate youth access to productive resources (e.g., land, finance, digital technology, and mechanization) and create an enabling environment to develop their skills and innovative capacity.

Lastly, fully harnessing youth potential for resilient AFSs requires youth-focused interventions that are rooted in positive youth development approaches, elevate youth voices in program and policy decisions, and carefully segment and tailor interventions to the needs of the heterogeneous youth population.

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9 The Missing Link: Understanding the Role of Social Protection in Fostering Sustainable Food System Transformation in Africa

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Key messages

1. Social protection programs have positive effects on the capacity of farm households to become more productive and resilient; they are not simply safety net programs.
2. Social protection programs can enable households to make investments, take on risks, reallocate labor, and meaningfully engage in markets. They also help households cope with shocks.
3. There are synergies and complementarities between social protection and community resilience providing unexploited opportunities to improve the functioning of food systems.

This chapter reviews emerging experimental and quasi-experimental evidence on the impacts of social protection programmes on productive outcomes in rural SSA, paying particular attention to the synergistic relations between social protection and agricultural interventions. The search process identified 20 scientific papers, most of which were produced in the last decade. The chapter describes pathways through which these interventions may help better the economic prospects of smallholder farmers and how such changes may help foster a food-systems transformation in the region. The evidence suggests that social protection programmes and multifaceted interventions lead to changes in labor allocation, favoring time dedicated to own enterprises, and improved results in terms of productive asset accumulation and income. These behavior changes and investments are necessary but by no means sufficient to achieve a sustainable and inclusive food system transformation in SSA.

Introduction

The opportunities and challenges facing agrifood systems in SSA are immense. Over the past two decades, the region has witnessed 4.3 percent growth in annual agricultural output, the highest of any region in the world (Jayne and Sanchez, 2021). However, most of this growth has come from area expansion rather than input intensification or total factor productivity growth (Goyal and Nash, 2017; Jayne and Sanchez, 2021). Rapid agricultural land expansion has potentially severe consequences for the region's ecosystems and biodiversity and is a key driver of desertification and deforestation (Vlek et al., 2008, Zingore et al., 2015). Despite the agricultural output growth in the region, 73 million people remain acutely food-insecure[2] while the number of stunted children continues to grow (Development Initiatives, 2017). Moreover, even though poverty rates have declined in SSA, the

1 United Nations Food and Agriculture Organization

2 Households are considered in Crisis if "Have food consumption gaps that are reflected by high or above-usual acute malnutrition or are marginally able to meet minimum food needs but only by depleting essential livelihood assets or through crisis-coping strategies" (2020 Global Report On Food Crises, 2020, p. 14)

number of poor people is still increasing; 82 percent of the extreme poor in the region live in rural areas and their livelihoods depend mostly on farming (Beegle and Christiaensen, 2019). These challenges are further exacerbated by changes in precipitation patterns and temperatures due to climate change.

Addressing these challenges will require transformative changes in Africa's agrifood systems. This entails, among other things, radical changes in how food is produced and distributed, transformations in incentives structures, and the distribution of rents within food systems. In particular, there is urgent need to support sustainable agricultural intensification across a wide segment of the rural farm population, while at the same time enabling an exit from agriculture into the non-farm sector for rural dwellers for whom agriculture is not a viable livelihood option or pathway out of poverty. The canonical literature of structural transformations in Asia suggests that these two channels are interlinked and mutually reinforcing (Johnston, B. F. and P. Kilby. 1975; Johnston and Mellor 1961; Mellor, J. 1976). As they demonstrated, the adoption of new farm practices and technologies helped to boost agricultural labor productivity. This in turn provided farm households with more disposal income, which they tended to spend on local consumables. New employment opportunities in the non-farm sector were consequently created, which helped to pull marginal farm households out of agriculture and into more remunerative non-farm wage labor and enterprises.

However, this stylized vision of rural transformation is complicated by the severe resource constraints faced by many people in rural SSA, and the livelihood risks and uncertainties associated with making any change in resource allocations or livelihood orientation. These challenges are magnified in rural SSA by the fact that markets for insurance and credit, which may help to offset risk and liquidity constraints to investments, are often absent or unavailable to poor households. Moreover, climate change is increasing the frequency of severe weather events and the distribution of agricultural pests, which contribute to increased risk and uncertainty for rural livelihoods. In this context, livelihood and investment decisions are inseparable from concerns over food security for many farm households in SSA. This tends to push them toward production choices that minimize short-term consumption risks but are often low in return, and oriented toward subsistence.

As the preceding discussion suggests, the challenges to fostering a sustainable food system transformation in SSA are multifaceted and will therefore require multi-sectoral approaches. One particularly promising approach is integrating agricultural sector interventions with social protection. While social protection, particularly non-contributory social assistance, is typically thought of as a tool for addressing acute deprivation and supporting the extremely poor to maintain sufficient consumption levels, emerging evidence demonstrates its productive and transformative power in the context of rural areas. This chapter reviews emerging experimental and quasi-experimental evidence on the impacts of social protection programmes on both farm and off-farm productive outcomes in rural SSA. The chapter also highlights evidence on potential synergistic relationships between social protection and standard rural development interventions, which have the potential to reduce poverty and better the economic outcomes of smallholder farmers (Veras Soares et al. 2017). Finally, this chapter examines outcomes that are indicative of more resilient, participatory, and inclusive agri-food system transformations in a bid to identify key leverage points where programme integration may have the most impact to achieve an inclusive and sustainable food systems transformation in SSA.

The following section provides a brief background on social protection trends in SSA followed by a discussion of the review processes used for this chapter. The chapter then provides a schematic theory of change, which explores how social protection can contribute to agrifood system transformation. This is followed by a systematic review of existing evidence on the impacts of social protection on productive outcomes in

SSA. The chapter concludes by discussing policy options for strengthening the coherence between social protection and agricultural interventions and the potential implications of this for fostering a more inclusive and sustainable food system transformation in SSA.

Background: Social protection trends in Africa

Social protection interventions can be defined as initiatives, public or private, that seek to minimize vulnerability and risk and reduce poverty. The most common types of social protection are:

- **Social assistance/social safety nets**: these non-contributory programs transfer resources to individuals or households. While transfers may have conditionalities, these programmes are increasingly unconditional. Their goal is to reduce poverty and inequality and smooth consumption.
- **Social insurance**: this comprises contributory programs such as health insurance and pensions, which protect against risks and situations that lead to financial instability.
- **Labor market interventions**: these programs include but are not limited to job training and services such as job matching or placement assistance to promote employment. They also include unemployment insurance, which aims to smooth income during unemployment.

Although social protection programs have a long history in other parts of the world, in Africa, their appearance is recent and rapidly evolving. At the beginning of the century, none of the countries in SSA had a national social policy program in place. By 2019, 35 counties in Africa had rolled out at least one social policy program (Devereux, 2020). This policy trend correlates with the relevance social protection has gained in the global development goals. In 2000, social protection was not featured in the Millennium Development Goals (MDGs), but 15 years later it is mentioned in four of the 17 SDGs.

There is considerable heterogeneity between Africa's sub-regions in terms of resources allocated to social protection policies. In SSA, 1.5% of GDP is spent on these programs, which is similar to the average expenditure of developing and transition countries worldwide. North Africa spends close to 1 % of GDP is spent on social protection programs (World Bank, 2018). Differences are also substantial at the country level. In 2015, South Africa had close to 36% of its vulnerable populations[3] receiving non-contributory cash benefits, while Cameroon and Nigeria reached just 0.2% (ILO, 2017). Although there has been progress in expanding coverage in recent years, majority of the population in SSA still has limited access to any form of social protection. Only 18% of the population on the continent is covered by at least one social protection benefit, excluding health protection (ILO, 2017). While the COVID-19 pandemic has led to an increase in social protection coverage on the continent, many of the programs put in place since the start of the crisis have been temporary and relatively small (Gentilini et al. 2021).

There is also considerable variation in the sources of funding for social protection on the continent. Richer countries (e.g., Angola, Botswana, Gabon, and Namibia) can fully fund their social safety nets, giving them more autonomy and flexibility to define their policy goals, while some of the poorest (e.g., Ethiopia, Malawi, South Sudan, and Somalia) rely exclusively on donor funds to provide social assistance (Devereux, 2020).

The rapid expansion of social protection programmes in SSA has led to a proliferation of scholarship on the impacts of these programs on beneficiaries. While most of this research has assessed the impacts of these programmes against their own objectives, which typically include consumption outcomes, educational attainment, and health, emerging literature has explored how these programs influence productive investments and economic decision-making with a focus on rural areas.

3 The ILO World Social Protection Report 2017-2019 defines vulnerable populations as: (a) all children; (b) persons of working age not contributing to a social insurance scheme or receiving contributory benefits; and (c) persons above pensionable age not receiving contributory benefits (pensions)

Data sources

The evidence and conceptual framework presented in this chapter is based on a systematic review of evidence on the effects of social protection programs on productive and economic outcomes in SSA with a particular focus on cash transfers and related, multifaceted interventions (also called graduation or economic inclusion programmes), which include social protection as part of a bundle of interventions. This review is restricted to empirical evidence published in peer-reviewed journals and that rely on rigorous econometric techniques. In total, 20 papers met our selection criteria, with evidence coming from programs in nine different countries. Table 9.1 in the appendix summarizes the reviewed papers and shows the type of evaluations analyzed, their selection criteria, and measured productive outcomes, among other elements.

Two approaches were adopted to identify appropriate articles. First, the search focused on existing databases and Google Scholar. The International Initiative for Impact Evaluation's (3ie) impact evaluation repository served as the primary database for the search. The database houses papers from more than 3,500 impact evaluations and its search engine allows a user to filter by topic and region. We also used combinations of words such as "cash transfers", "social protection", "productive assets", or "randomized control trial" (RCT), among others. This same approach was used when searching for papers in Google Scholar and other specialized search engines. The chapter authors complemented this review with a snowball approach, involving consultation with experts in the field to identify different articles on cash transfers and their productive impacts and on multifaceted programs. The chapter authors screened all articles resulting from both approaches for references of additional papers that may have escaped previous search efforts. It is worth noting that evidence on the effects of cash transfers has been steadily accumulating in the past decade. Nevertheless, most of it does not focus on evaluating changes in productive outcomes given that most transfer programmes were not initially conceived for this end. In recent years, evidence on the transformative potential of social protection policies has opened the door for more evaluations to focus beyond nutritional and food security outcomes. Furthermore, it should be emphasized that the popularity of multifaceted programs is recent, making it an area with few proper programme evaluations.

Conceptualizing the role of social protection in agri-food system transformations in SSA

The need for a transformative change in agri-food systems in SSA is undisputable. Substantial improvements in labor productivity, investment in soil quality, conservation of natural resources, and dynamism in the rural non-farm economy are all key elements of an agri-food system transformation that are required to reduce poverty, improve food security, build resilience, and adapt to climate change. Changes in how agricultural products are produced and by whom will be an important driver of this change. In rural SSA, most rural dwellers derive some portion of their livelihood from agricultural production, which underpins much of the rural non-farm economy. Enabling investments in sustainable agricultural intensification that improves agricultural labor productivity and restores and conserves natural resources is critical. At the same time, for many rural households with limited land and other necessary resources, agriculture is not a likely pathway out of poverty. For these households, a transition out of agriculture and into the non-farm economy is a more likely path to greater prosperity.

Improving agricultural labor productivity and enabling marginal farm households to beneficially exit agriculture requires that households possess the ability to bear the risks and costs of new investments and reallocate labor to new activities. While social protection programs are rarely designed to explicitly influence the economic activities of their recipients, they may, nonetheless, contribute to changes in economic behaviors

through three channels: relaxation of credit and liquidity constraints of poor and vulnerable households; reduction of consumption risks; and changes in labor allocations. The sub-sections below briefly discuss the conceptual underpinnings of these impact pathways.

Relaxation of credit and liquidity constraints

Rural households in poor countries typically have limited access to formal credit markets due to lack of collateral and steep borrowing rates. Social protection and cash transfers in particular provide a steady and predictable stream of cash that changes current and future economic prospects of beneficiary households. By improving current liquidity conditions, cash transfers also create opportunities for improved savings with implications for farmers' capacity to manage income shocks and access credit. Prifti, Daidone and Davis (2019) find that the prospect of receiving future transfers through regular cash transfer programs increases the *credit rating* of beneficiaries, which in turn relaxes present credit constraints. This allows households, including the poor and vulnerable, to make economic decisions and investments with longer time horizons. For farm households, longer time horizons and improved financial capacity is critical for making the sorts of longer-term investments in soil health and water management that are needed to sustainably intensify production (Maggio, Mastrorillo & Sitko 2021; Amadu et al., 2020; Scognamillo and Sitko 2021). Moreover, for rural households with limited agricultural potential, regular transfers provided through social assistance programs offer an important source of investment capital to diversify into non-farm activities (Asfaw et al., 2014; Gilligan et al., 2009).

Risk

Risk and uncertainty are pervasive features of rural life. Variability in prices and weather conditions leads to large fluctuations in farm output with consequences for both farm and non-farm income. In many parts of rural SSA, the absence of markets for insurance and credit, which severely limits people's capacity and willingness to take economic risks and can contribute to locking households into low-equilibrium poverty traps (Carter and Barrett 2006), compounds these risks. Addressing high levels of risk adversity in economic decision-making is critical for fostering transformative food system changes. By providing beneficiaries with a regular source of income or food, social protection programs help to reduce the consumption risks associated with new and uncertain investments on- and off-farm. In this way, social protection can alter household's *risk preferences* enabling preferences for longer-term and potentially more profitable investments (Daidone et al., 2019; Sitko, Scognamillo, and Malevolti, 2021; Schwab, 2020; Scognamillo and Sitko 2021). Indeed, as demonstrated by Haushofer and Fehr (2014), evidence on cash transfers indicates positive effects on beneficiaries' psychological wellbeing and increases their propensity for forward-looking economic behaviors. This is particularly critical for fostering the sorts of long-term investment required to restore degraded soils and improve the resilience of production systems. Moreover, regular social protection transfers can enable farmers and non-farm enterprise owners to better withstand income volatility without relying on liquidation of productive assets (Devereux 2007; Haushofer and Shapiro 2018).

Labor

The effect of cash and other transfers on labor is more nuanced. On one hand, evidence shows that transfers can break the cycle of piecework labor during the farming season, including *ganyu* work[4], which many poor farm households are trapped in (Covarrubias et al., 2012), and enable them to dedicate more of their labor to their own production (Sitko, Scognamillo, and Malevolti, 2021; Asfaw et al., 2014; Margolies and Hoddinott, 2012; Prifti et al., 2017). By enabling farm households to better allocate their labour to time-sensitive agricultural activities such as planting and weeding, social protection programs can enable recipients to improve agricultural productivity. Moreover, as Baird

4 Ganyu labor is a type of low wage casual labor performed in Malawi

et al. (2018) note, in contexts like SSA, farmers may well be undernourished during the farming seasons and cash transfers can help these individuals have access to more and better food, which will in turn improve their labor productivity and eventually their productive income.

On the other hand, transfers can contribute to a decrease in family labor dedicated to farm activities and increase the use of hired labor, depending on whether both types of labor are complements or substitutes (Prifti, Daidone and Davis, 2019). This, in turn, enables households to free up labor to dedicate to non-farm businesses and diversify out of farming. This impact channel holds potential for enabling marginal farm households to exit or diversify out of agricultural production into potentially more remunerative non-farm activities.

Through these three channels, social protection can affect investment choices and address some of the constraints that hinder the investments and behavior changes needed to foster a sustainable agri-food system transformation in SSA. Of course, social protection programs in SSA take a variety of forms, which will likely lead to important differences in impacts on economic outcomes. These include variations in which populations are targeted, the type, size, conditions, periodicity, and duration of transfers, and the extent to which the social protection intervention is integrated with other forms of support, such as skills training and asset transfers. Understanding these potential sources variations and their implications on economic outcomes can inform improvements in the design and implementation of policies and programs to foster sustainable rural transformation in SSA.

Consolidating evidence on the impacts of social protection on the drivers of agri-food system transformation in SSA

This section reviews evidence on the impacts of social protection programs on the economic behaviors of rural inhabitants in SSA. The section pays particular attention to available evidence related to cash transfers, which make up a large share of existing national and non-governmental-organization (NGO)-led social protection interventions in the region, and multifaceted poverty alleviation programs, which combine social assistance with other livelihood interventions such as skills training and financial literacy. These multifaceted programs are becoming increasingly popular globally and in the region (Andrews et al., 2021).

Consistent with the conceptual framework described above, this section discusses outcomes associated with key drivers of agri-food system transformation. These include: farm investment and productivity growth (farm asset accumulation; investments in farm practices and technologies; engagement in agricultural markets, income and farm output; investments in non-farm enterprises and; financial strengthening including creation of savings and access and use of credit. The authors summarize all the results from the papers reviewed in Table 1 in the appendix below. Some of the outcomes discussed in this chapter are not typically accounted for in evaluations of the impacts of cash transfers. There is vast literature on the effects on labor supply of cash transfers aimed at understanding how this exogenous wealth transfer reconfigures labor allocation. Beyond this literature, there is scant evidence on the effect of cash transfers on productive outcomes. The majority of available research revolves around understanding the effects of the programs on the problems they were designed to tackle, mainly food security and child wellbeing.

Stand-alone impacts of cash transfers on agri-food system transformation outcomes

Taken together, the bulk of the findings summarized below point toward beneficial impacts of providing cash to rural households, both conditional and unconditional, as a part of an overall strategy for fostering transformative change in agri-food systems in SSA. The evidence suggests that cash transfer programs help to foster higher levels of accumulated assets for rural households and changes in individuals' time allocation, with

beneficiaries shifting labor toward their own enterprises, both on- and off-farm. Moreover, evidence points to increased participation in commercial agricultural markets among participants and increased farm output and incomes. The bulk of evidence related to these results comes from evaluations made after at least a couple of years of being exposed to the intervention suggesting lasting effects of cash transfers. When accounting for heterogeneities, it is evident that the interventions have differentiated effects depending on the beneficiary's characteristics. There is also evidence that transfers have psychological effects, although not all the interventions measure these variables. Outcomes are influenced by how beneficiaries are targeted as well as the size and duration of transfers. This suggests that these are important factors to consider when developing programs to leverage social protection interventions as part of a rural development and transformation strategy. The next paragraphs expound on these findings.

Handa, Natali, et al. (2018) study the medium-to-long (24 and 36-month) effects of two cash transfer programmes in Zambia: the Child Grant Programme (CGP) and the Multiple Category Target Programme (MCP). The two programmes target different populations, with the CGP targeting households with children under the age of three years and the MCP targeting households with different vulnerabilities, including households with orphans. Evaluation of the programs occurs in different places; the CGP was implemented in three rural districts in the Western and Northern provinces, while the MCP was implemented in two districts in the Central and Northern provinces. The difference in location and targeting criteria of both programs does not change the fact that most households enrolled in either of the programs are poor with 90% of all beneficiaries living below the national poverty line. Moreover, the interventions lead to similar results, not least of which is that ownership of productive assets such as ploughs, sickles and axes, and livestock holdings increased as did the probability of saving and the amount saved. Both programs also increased beneficiaries' incomes and revenues. For MCP beneficiaries, the value of the harvest increased, while for CGP beneficiaries, most of the effect on income resulted from increased revenues from non-farm businesses. The latter result is particularly interesting since the CGP targeted women as caregivers. Given their limited capacity to control land in households headed by men, the women utilized income from the CGP to invest in economic activities for which they have more autonomy, namely non-farm businesses. Overall, the programs are shown to have a positive effect on productive outcomes (and protective results that are beyond the scope of this chapter) for beneficiary households.

For this sample, the cash transfers appeared to have relaxed credit and risk constraints, allowing households to make more forward-looking decisions. Handa, Daidone, et al. (2018) report labor-related outcomes for both programs and find that adult household members decreased their participation in wage labor and more households engaged in operating a non-farm enterprise. Prifti et al. (2017) also finds that the CGP causes a shift from agricultural wage labor to own-farm labor. These results indicate that households invest more in accumulating assets and allocating time to their own enterprises, both farm and off-farm, as a result of receiving the cash transfers.

de Hoop et al. (2020) confirms the previous results by further analyzing the MCP and Malawi's Social Cash Transfer Programme (SCTP). The evaluation measured the effect of being exposed to the programs for around 22 months. Both programs target mostly labor-constrained ultra-poor households, the MCP putting a more explicit emphasis on reaching households headed by women and elderly members. The evaluations found that the programs increased household productive investment with recipients of the programs being more likely to increase the total area of land cultivated or owned relative to non-recipients after 22 months. The authors also report increased labor engagement in household enterprises by both adults and children and a shift from paid work outside the households.

Both programs also supported intensified market engagement by recipients. In particular, beneficiaries were more likely to engage in livestock and crop markets relative to comparable non-beneficiaries.

In an earlier study, Covarrubias et al. (2012) found analogous results for the SCTP program in Malawi, based on a different sample collected from a pilot implemented in Mchinji District in 2007. Despite this, the results are strikingly similar; increased agricultural investment, and a shift from labor outside the household such as agricultural wage labor and ganyu work. The latter is one of the most important coping strategies for poor households in Malawi but diverts labor away from own production at a critical time in the agricultural calendar.

Prifti, Daidone and Davis (2019) provide further analysis on the importance of adult labor allocation decisions in the context of a cash transfer program. The aim is to explore if there are changes in labor demand and supply due to cash transfers and if the modifications in these input decisions translate to changes in the total value of farm production. They do this by analyzing the Child Grant Programme in Lesotho, a cash transfer programme that targets ultra-poor and poor households with at least one child. The program was evaluated using a sample of households from five districts: Qacha's Nek, Maseru, Leribe, Berea and Mafeteng. They find no evidence that transfers change the number of weekly hours of on-farm work of adult household members nor the number of hours of hired-in labor. However, they find gains in the total value of farm production among beneficiaries, suggesting other channels besides labor, such as the relaxation of credit and risk constraints, could explain this change. This result contrasts with the reported labor outcomes from both Malawi and Zambia where there are significant changes in the labor structure of the household, mainly increasing individuals' labor time to both own farm and off-farm labor. This highlights the context-specificity of outcomes, which are an important feature of flexible cash transfers.

Prifti et al. (2020) further evaluates the same data but focuses on establishing whether the observed positive effect on farm production is evenly spread across the sample, or if there are subgroups which are benefiting more from the transfer. According to the authors, households that are better endowed benefit more from the cash transfers. This is a key result that highlights that even if cash transfers end up generating positive effects on productive outcomes, although not designed for this end, there's a case for considering adding ancillary interventions that complement this program to enhance the transformative potential that social protection interventions are shown to have. This chapter examines these sorts of integrated programs in the next subsection.

Similar to the results of the Lesotho program reported in Prifti, Daidone and Davis (2019), Asfaw et al. (2014) finds little evidence of changes in labor supply for adults when analyzing Kenya's Cash Transfer Programme for Orphans and Vulnerable Children (CT-OVC). Similar to other evaluations discussed here, CT-OVC finds that beneficiaries increase their productive asset holdings although only for households that are small in size and headed by women. The authors break down the null overall effect in adult labor allocation of the program and find differences in impact when examining women and men separately and differentiating by other characteristics such as age and distance from local markets. It is worth noting that women increased their participation in non-farm enterprises as a result of participating in the program. As Prifti et al. (2020) observe, the impacts of the program are not homogeneously spread.

The above studies are all government-implemented programs, which provide transfers regularly and for extended periods of time. More recently, researchers have teamed-up with NGOs and governments to implement pilot programs through which selected households receive an unconditional sizable one-time transfer. The rationale behind this variation of cash transfers is that if given a larger amount, households would find it easier to relax immediate binding credit constraints thus facilitating the transition towards a virtuous cycle of investment, increased production, and

higher consumption. However, a one-off transfer does not generate the same insurance effects observed with regular transfers. The consistency of the payments provides certainty to beneficiaries allowing them to insure themselves against risks such as weather shocks (Veras Soares et al., 2017). Different mechanisms may thus be operating when comparing the effects of these types of programs.

Egger et al. (2019) tests the implications of this one-off transfer model by studying the effects on the wellbeing of a sample of poor households in Siaya County in western Kenya. The authors not only report the effects of the transfers on direct beneficiaries but also account for possible spillover effects on non-beneficiaries, given that the aggregate transfers implied a positive shock of around 15% of the local GDP. Direct beneficiaries are shown to increase their holdings of durable assets but their income and labor supply remain unchanged. They also find an increase in a psychological wellbeing index and no reported changes in a women empowerment index. Non-beneficiaries do not observe changes in the aforementioned indices nor in their asset holdings. Nevertheless, they are reported to increase their income and their wage earnings. The latter effect results from increased gains that local business experienced due to the local economy income multipliers of the intervention.

Also in Kenya, Haushofer and Shapiro (2018) study the effects of a pilot cash transfer programme in Rarieda District. In the pilot, the recipient (man or woman) in the households, size of the transfer, and mode of delivery (lump-sum amount or a series of nine monthly installments) was randomly assigned. Across all variations of the intervention, the authors report that recipients of the transfer increased their assets holdings, including the value of livestock and agricultural tools, and the total revenue. The effects are observed three years after the delivery of the initial transfer, which points to a transformative effect of the program. Additionally, the program also generates an increase in a psychological wellbeing index. In particular, lower levels of stress and higher levels of happiness and life satisfaction are reported. It is also worth noting that the authors did not find significant changes in a women empowerment index for households with cohabiting couples.

Evidence on the impacts of multifaceted programs on agri-food system transformation outcomes

In recent years, programs that involve a package of interventions have become increasingly common. Multifaceted approaches intend to provide a "big push" out of poverty to beneficiaries and set them on a productive path. This approach has gained momentum in response to findings of positive and sustained impacts of these types of programs on income (Banerjee et al., 2015; Bandiera et al., 2017). The most common of these approaches are graduation programs, which consist of a combination of productive asset transfers, cash transfers, financial literacy, and livelihood trainings usually for period of two to three years. Banerjee et al. (2015) was the first major publication to bring attention to the graduation approach and showed substantial positive impacts on a number of economic wellbeing measures including on productive outputs such as assets, income, and revenue. The paper reported results for six countries, including Ghana and Ethiopia with positive effects are reported even three years after the productive assets were initially transferred.

Banerjee et al. (2018), attempt to tease apart the effects of two of the components (transfer of a productive asset and access to savings) for the Ghana site from a previous paper. The authors show that after two years, there are no effects from receiving only the asset transfer but report positive impacts on financial inclusion for a group that only participates in the savings program. After three years the same results hold although the effect of only participating in the savings groups dissipates slightly. However, for participants who received the whole package, results show an increase in the values of their assets and income as well as a higher financial inclusion index. This suggests that two of the most important components of the graduation approach do not work if implemented in isolation

and that a multifaceted approach that includes a weekly cash transfer for up to 10 months is a cost-effective way of increasing economic inclusion.

There are other papers that study the effect of a bundled intervention without explicitly attempting to quantify the complementarities between integrated program components. In Ethiopia, in two woredas in Oramia region and in two woredas in the Southern Nations, Nationalities, and People's (SNNP) region, Prifti, Bhalla and Grinspun (2020) analyze the combined effects of benefitting from a social protection scheme (monthly transfers, monthly transfers but for only six months, and public works) with a pilot project that offered training activities related to nutrition-sensitive agriculture and transferred both livestock and agricultural inputs. The authors find that the combination of programs increased the average herd size of beneficiaries, the average harvest of certain crops, in particular coffee, and off-farm entrepreneurial activity. These results are derived from a sample of households with labor capacity and that also have women that are either pregnant or lactating and/or have children under the age of two years.

Gobin et al. (2017) studies the impacts of the Rural Entrepreneur Access Programme (REAP), a program that provides cash transfers in addition to business skills training, business mentoring, and savings to ultra-poor women in northern Kenya. The evaluation occurred in 14 locations in the southern and central parts of Marsabit County with the findings that beneficiaries of the program increased their savings and monthly income per capita and an index summarizing their durable assets. The authors show that the increase in income comes from changes in non-agricultural businesses. This result may stem from the fact that the program had a strong component that promoted the formation of microenterprises among groups of participants.

Ambler, de Brauw and Godlonton (2020a) evaluates a two-year cash plus pilot program in Senegal that provided a sizable one-time cash transfer and farm management advice for smallholder farmers. They find positive effects that are sustained after two years of the initial transfer on a series of agricultural outputs such as agricultural equipment value, agricultural expenditure, chemical fertilizer usage, and increased livestock stocks. This intervention does not compare the bundled intervention with a pure cash transfer to test for synergies between the two components. The same authors evaluate a similar intervention in Malawi (Ambler, de Brauw and Godlonton, 2020b) where transfers (either cash or inputs) are explicitly compared to a bundled intervention where extension support is also provided. The multifaceted intervention generates positive impacts on agriculture investment relative to a group that did not receive any treatment and also when compared to those that received stand-alone transfers or extension services. Beyond evidence favoring the existence of synergies between the transfers and extension services, the authors effectively demonstrated that the sustained impacts reported two years after the transfer mostly arose from participants who were offered additional extension support after the initial transfers had ended. This is a novel result that highlights how continued supply of extension services is a key element for helping to sustain the gains from the multifaceted intervention.

Sedlmayr, Shah and Sulaiman (2020) also tackle the question of understanding whether there are additional gains from including ancillary components particular expensive ones such as training and mentorship, over and above a cash grant in Ugands's Hoima, Amuria, Katakwi, and Ngora districts. They report on the effects of this integrated approach up to 30 months after the final installment of the transfer. Participants who receive a light-touch psychological intervention on goal-setting and plan-making on top of a cash grant end up with higher productive assets (livestock) compared to those who only received a transfer. No differences were found on other productive activities (e.g., paid employment, net farming inflows, and other sources of self-employment). Moreover, there are no differences in terms of asset holdings when comparing the cash transfer plus psychological intervention with the full program, which in this case consists of the latter

two interventions, plus business administration and saving groups training and group coaching. However, beneficiaries exposed to the whole package report increased levels of consumption.

Focusing also on the importance of psychological constraints, Bossuroy et al. (2021) evaluated a multifaceted economic inclusion pilot program implemented by the Government in Niger and aimed at women beneficiaries of the national cash transfer program. The intervention offered all participants a core package that consisted of the establishment of coaching groups that offer advice on income-generating activities, entrepreneur training, and the formation of saving groups. On top of the main package, the researchers randomized participants to each of the following additional interventions: i) a lump-sum cash grant, ii) a life-skills training module and, iii) the lump-sum cash transfer plus the life-skills training module. By offering these ancillary interventions, the program is able to assess the importance of addressing both capital and psychosocial constraints in unlocking potential avenues out of poverty. The authors report positive impacts after 18 months of the intervention with regard to investment, business revenue, in particular in off-farm enterprises, and days spent at these businesses for all three variants. Beneficiaries also increased the number of income sources and their livestock holdings but there was no effect on agricultural outcomes. Beyond the economic impacts, the intervention also shows positive effects on women empowerment and a series of psychosocial indexes including future expectations, mental health, and social cohesion and community closeness index. This paper brings the importance of addressing psychological constraints to the forefront of the discussion; the effects are usually larger when participants are exposed to both the lump-sum cash grant and the life-skills training module. Duflo (2012), when describing the results of one of the first graduation programs, mentioned that a change in mindset may have played a key role in sizable effects reported. This is one of the first studies that quantifies the effect of a program that aims to relax internal constraints. It is also relevant since it is not common for governments to be implementing these types of programs. Most evidence on the effectiveness of multifaceted programs comes from interventions led by researchers and usually in partnership with NGOs. Given that scaling up these projects is no small feat, having evidence of government-based implementations is crucial for mainstreaming the expansion of ancillary interventions layered on the national cash transfer programs.

In a similar program, Blattman et al. (2016) shows positive impacts on a series of productive outcomes including having a non-farm business, productive asset holdings, and cash earnings 16 months after the initial transfer. The intervention is aimed at young women in northern Uganda and consists of providing beneficiaries with a cash transfer of 150 USD in two installments, business skills training, and supervision. The program also generated increased levels of community participation. Beneficiaries were more likely to become members of any group and the number of times these groups met increased, particularly for savings and communal farming groups. The authors claim that the observed results are not only due to the cash transfer relaxing existing credit constraints but also point to the importance of the supervision and training provided since most beneficiaries in the sample had little previous exposure to entrepreneurial activities. Although these activities are the costliest, the intervention is cost-effective and provides further evidence favoring the implementation of additional program components that generate synergistic interactions with cash transfers interventions.

Gilligan et al. (2009) is one of the first papers to look at the effects of complementarities between safety net programs and programs aimed at enhancing agricultural productivity, both implemented by government. Beneficiaries of both programs (Productive Safety Nets Programme (PSNP) and the Other Food Security Programme (OFSP)) are found to be more likely to borrow for productive purposes, use improved agricultural technologies, and operate non-farm own business activities. However, their assets do not grow relative to a

comparable sample of households. Furthermore, labor supply to wage employment does not change as a result of being exposed to both programs. This is an important result since the PSNP operates partly through public works, paying beneficiaries to work on labor-intensive activities aimed at building assets for the community. Similarly testing for complementarities between governmental programmes, Daidone et al. (2020) studies whether there are any economic gains for a sample of beneficiaries of the CGP who are also receiving the Sustainable Poverty Reduction through Income, Nutrition, and access to Government Services (SPRINGS) intervention in Lesotho. The CGP is a national programme of unconditional cash transfers that targets poor and vulnerable households with children. The SPRINGS project is meant to complement this program by offering a community development package which, among other things, fosters the formation of savings and internal lending groups and set-up of homestead gardens as well as market development through market clubs. In terms of productive outcomes, participants who received both programmes are reported to have increased agricultural expenses, increased value of sales of fruits and vegetables, and have a higher financial inclusion index than participants who only received the CGP.

Pace et al. (2017) also test for the existence of synergies between the social cash transfer program and the farm input subsidy program, both implemented by the Government of Malawi. They find that after 17 months of being exposed to the programs, the value of production, number of productive activities and expenses, and number of livestock is higher for a subsample of beneficiaries who participated in both programs compared to those who only participated in one program in the short term. They find no evidence of synergies in input use.

What we know and what we do not know

Overall, cash transfer programs consisting of both regular and one-off transfers have the potential to relax credit constraints and lead to higher levels of accumulated assets. There is also evidence that they also lead to changes in labor allocation, increasing time dedicated to own enterprises, and improvements in farm output, incomes, and market engagement. These results are observed for both government- and non government-led interventions although evidence for the latter is limited.

Exposure to both forms of social protection combined with agricultural development programs or multifaceted interventions generate overall positive productive outcomes. Evidence shows the existence of clear synergies and complementarities between social protection and agricultural interventions. This chapter also shows that certain complementarities exist for multifaceted programs and that some of these components have no effect at all on productive outcomes in isolation (for instance, saving groups as in Banerjee et al. (2018)). It is worth highlighting how it is becoming very common to measure psychological variables and moreover, to attempt to directly influence them and measure their effect on productive outcomes. Bossuroy et al. (2021) reports that their findings for the evaluation in Niger are slightly larger for beneficiaries who received the transfer and life-skills coaching compared to those who received only one of these interventions. Although further research is needed, these findings suggest that addressing psychological constraints may also be important to achieving behavioral changes that foster forward-looking mindsets thus facilitating adaptation and increasing resilience. This program is also relevant since it is one of the few in the world that is entirely implemented by the government, providing evidence that these complex programmes can be implemented at scale.

It is worth highlighting that most papers report increased activity in the off-farm sector. This impact may be driven by farmers for whom returns on investment in agriculture are low and potential avenues out of poverty are through non-agricultural activity. Nevertheless, based on existing evidence, it is not clear if this observed trend is related to specialization in non-agricultural enterprises or diversification of livelihood portfolios.

There are still plenty of unknowns surrounding these results and programs. For cash transfers, it

is of paramount importance to understand what happens when households stop receiving these payments, for instance, once they are no longer eligible. The results presented here for conditional and unconditional cash transfers are based on programs that were still ongoing. A similar concern arises for the large one-off cash transfers. The evidence shows that in the medium-term, their effects persist although their impact dissipates slightly. Furthermore, the papers analyzed do not tell us whether risk preferences are actually changing as a consequence of the transfers. In a different study that does not examine productive outcomes, Martorano et al. (2014) show that for Kenya's CT-OVC referenced earlier, there is no effect on participant's preferences towards risk. There is therefore little evidence exploring this channel and more research is needed to evaluate its relevance. As for multifaceted interventions, which provide a holistic approach to achieving transformative change, it is still not fully understood why not everyone benefits from these programs.

A final and critical knowledge gap relates to the cost-effectiveness and cost-benefits of cash transfers and multifaceted programs on productive outcomes and how these compare with standard agricultural interventions. Current evidence focuses almost exclusively on consumption outcomes, particularly for multifaceted programmes. For example, Banerjee et al. (2015) report that for Ethiopia and Ghana, using a 5 percent social discount rate and considering consumption the ultimate goal of the program, a benefit/cost ratio of 260 percent and 133 percent is observed. Similarly, using 5 percent as a social discount rate, Bossuroy et al. (2021) provides a cost-benefit analysis under different scenarios; the authors report benefit/cost ratios that vary from 88 percent (assuming no impacts after the second year) to 260 percent (assuming impacts in perpetuity with a 2 percent annual dissipation rate). Blattman et al (2016), finds the internal rate of return of the program to be 24 percent using nondurables consumption as the outcomes variable equivalent to a benefit/cost ratio of more than 500 percent. While these programmes are shown to produce positive impacts on productive decisions and labor allocations, evidence on their cost effectiveness or cost/benefits is critical for guiding policy decisions.

Conclusions and policy implications

This chapter has shown that there is mounting theoretical and empirical evidence that social protection has a vital role to play in fostering the investments and behavior changes required to achieve a sustainable and inclusive food system transformation in SSA. The evidence suggests that social protection programs, particularly social assistance programs, can help to address the risks, costs, and labor availability barriers that prevent many poorer rural households from benefiting from and responding to market opportunities, both on- and off-farm. We must, therefore, re-conceptualize the roles and objectives of these programs in the context of rural SSA. These are not merely handouts to prevent destitution and hunger. In the absence of credit and insurance markets, these programs enable households to make investments, take on risks, and engage in markets. These are critical functions in places where poverty and resources constraints are widespread.

Yet, the practical challenges of achieving greater coherence between social protection and rural development interventions at scale are non-trivial. In particular, political economy, institutional, and financial barriers must be addressed. From a political economy perspective, government budgets and program development are typically carried out in designated ministries with limited coordination between ministries. As a result, planning, and implementation of social protection programs rarely consider activities developed by agricultural ministries and vice versa. Strategic dialogues between relevant ministries and joint work programs in rural areas are an important starting point for building this coherence.

From an institutional standpoint, improving the coordination and implementation of social protection with rural development interventions requires increased capacity to track and target interventions. In recent years, some countries

have begun investing in digital farm registries and social protection registries. However, no countries have harmonized these registries to facilitate more integrated actions. Investments to build and harmonize household registries that track information on agricultural and social protection interventions along with key socio-economic information can enable better coherence in implementation. Moreover, these systems can enable governments to respond to crises more quickly by scaling up and scaling out support when disasters occur. This capability was evident during the initial months of the COVID-19 pandemic during which countries with well-developed registries such as South Africa and Ethiopia could quickly provide cash and other forms of assistance to beneficiaries.

Finally, there is the issue of financing for social protection programs in SSA. Devereux (2020) provides a discussion of this topic drawing from guidelines from the International Labor Organization (ILO). Among other things, governments can consider reallocating a greater share of current public expenditures toward social protection. For example, some countries could consider reallocating resources dedicated to in-kind input subsidies or output price supports, which have yielded few poverty reduction benefits, towards integrated cash transfer and extension programs. However, further evidence assessing the relative cost effectiveness of social protection interventions and standard agricultural interventions on productive outcomes is needed to better inform policymaking.

The emergence of climate financing also creates opportunities to increase resources for social protection. In rural SSA, climate financing projects typically seek to promote the adoption of new land and resource management practice by farmers and to incentivize them to allocate their land and labor to public investments in ecosystem restoration. These activities all entail private costs and risks to farmers while generating primarily public goods. Payments for these services through cash transfers or public works is a potential avenue for increasing social protection coverage at least in the short term. Of course, there is no single recipe to follow to increase social protection coverage but understanding that it generates returns for beneficiaries and that there is no displacement of time allocation from labor to leisure (a common notion among those who oppose the expansion of non-contributory social protection schemes) is key to promoting further expansion.

Ultimately, to achieve a sustainable food system transformation that not only fosters aggregate growth but also improves the welfare and livelihoods of people, a multi-sectoral approach is required. As shown in this chapter, enhancing integration between social protection and rural development initiatives holds promise for addressing the failures of standard sectoral development models and may be the missing link to transforming food systems in Africa.

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Appendix

The following table presents a summary of the reviewed papers. The last column shows the measured productive outcomes. Given the multiplicity of outcomes measured in different papers, the outcomes are grouped into the following categories: income, assets (which includes productive assets and livestock), agricultural productivity, inputs (including the use of new technologies and practices), farm labor (time devoted to farm work), agricultural wage labor, off-farm paid labor, non-farm businesses (including the existence of such businesses) and sales (of agricultural products). Measures related to women empowerment and to psychological well-being are also included.

(+) represents positive impact, (=) no impact, and (-) represents negative impact. Multiple signs for a same category represent the number of measured outcomes that fall within the particular category. This helps to visually understand the robustness of the results.

Table 9.1. Overview of papers. Only productive outcomes are considered

Paper	Country	Intervention	Duration	Condition.	Periodicity	Targeting	Outcomes
Asfaw et al. (2014)[i]	Kenya	Cash Transfer Programme for Orphans and Vulnerable Children (CT-OVC	Until reassessed	None	Monthly	Ultra poor households with at least one OVC (one deceased parent, or a parent who is chronically ill, or whose main caregiver is chronically ill)	**Assets: (====)** **Ag productivity: (=)** **Inputs: (=========)(-)** **Farm labour: (-)** **Ag wage labour: (=)** **Non-farm business: (=)**
Covarrubias et al. (2012)	Malawi	SCTP (Social Cash Transfer Program), Zambia. Government-led	SCTP: 3 years, after which participation will be reassessed.	None	Every two months	Ultra poor (assessed using a proxy-means test). Labor constraints, operationalized as a dependency ratio.	**Assets: (+)** **Ag wage labour:** (--) **Farm Labour**: (=) **Non-farm business: (=)**

Paper	Country	Intervention	Duration	Condition.	Periodicity	Targeting	Outcomes
de Hoop et al. (2019)	Malawi, Zambia	Malawi SCTP (Social Cash Transfer Program), Zambia MCP (Multiple Category Targeted Program). Both are government-led.	SCTP: 3 years, after which participation will be reassessed. MCP: 5 years (2011-2016) retargeted	None	Every two months	SCTP: Ultra poor (assessed using a proxy-means test). Labor constraints, operationalized as a dependency ratio. MCP: Households: Poor female- and elderly-headed households with disabled persons.	**Income:** STCP (+) MCP (=) **Ag Productivity:** STCP (++) MCP (++) **Assets:** STCP(+) MC P(+) **Inputs:** STCP (+) MCP (+) **Farm Labor:** STCP (++) MCP (++) **Off-farm paid labor:** STCP (-) MCP (-) **Non-farm business:** STCP (++) MCP (=+) **Sales:** STCP(++) MCP (++)
Egger et al. (2019)	Kenya	NGO Pilot	NA	None	One time	Households with homes with thatched roofs in rural villages with high poverty levels where NGO had not worked before	**Income: (**+) (==) **Assets: (**+)(=) **Psychological wellbeing: (**+)
Handa, Natali, et al. (2018)[ii]	Zambia	Child grant program (CGP) and Multiple category target program (MCP). Government-led	CGP: 6 years (2010-2016) until retargeted MCP: 5 years (2011-2016) retargeted	None	Monthly	CGP: Households with a child under age 3. MCP: Poor women- and elderly-headed households with disabled persons.	**Income:** CGP (+) MCP (=) **Ag Productivity:** CGP (=) MCP (+) **Assets:** CGP (++++++) MCP (++++==) **Inputs:** CGP(+) MCP (+) **Non-farm business:** CGP (+) MCP (=)
Handa, Daidone, et al. (2018)	Zambia	Child grant program (CGP) and Multiple category target program (MCP). Government-led	CGP: 6 years (2010-2016) until retargeted MCP: 5 years (2011-2016) retargeted	None	Monthly	CGP: Households with a child under age 3. MCP: Poor female- and elderly-headed households with disabled persons.	**Ag wage labor:** CGP (-)MCP (-) **Off-farm paid labor:** CGP (=)MCP (=) **Non-farm business:** CGP (+)MCP (+)

Paper	Country	Intervention	Duration	Condition.	Periodicity	Targeting	Outcomes
Haushofer and Shapiro (2018)[iii]	Kenya	NGO pilot.	NA	None	One time or monthly over 9 months	Households with homes with thatched roofs in rural villages.	**Income: (**+) **Assets: (**+) **Female empowerment: (**=) **Psychological wellbeing: (**+)
Prifti et al. (2017)[iv]	Zambia	Child grant program (CGP). Government-led	CGP: 6 years (2010-2016) until retargeted	None	Monthly	CGP: Households with a child under age 3.	**Wage labor: (**-) **Farm labor: (+)**
Prifti, Daidone and Davis (2019)	Lesotho	Child Grant Program (CGP)	Eligibility	None	Quarterly	Ultra-poor and poor households (proxy means score) with at least one child	**Ag Productivity: (+)** **Farm labor: (==)**
Ambler, de Brauw and Godlonton (2020b)[v]	Malawi	NGO Pilot. Cash plus (ag training, 3 visits). Transfer is framed to be used for agriculture	2 years	First disbursements conditional on repaying twice the amount of seed to the farmers' association.	Cash (inputs) transfers: 3 times in the first year every three months.	Smallholder farmers members of the National Smallholders Association of Malawi.	**Income: (+=+)** **Ag Productivity: (=)** **Assets: (+)** **Inputs: (++=)** **Ganyu expenditures: (=+)**
Ambler, de Brauw and Godlonton (2020a)[vi]	Senegal	NGO Pilot. Cash plus	2 years	None	Cash: One time Ag. Training: monthly visits for 2 years	Households chosen by farmer associations based on socioeconomic diversity and willingness to participate.	**Ag Productivity**: (=) **Assets**: (+==+=) **Inputs**: (====)

Paper	Country	Intervention	Duration	Condition.	Periodicity	Targeting	Outcomes
Banerjee et al. (2015)	Ethiopia Kenya	NGO Pilot. Graduation (productive asset grant, training and support, life skills coaching, temporary cash consumption support, access to savings accounts and health information or services)	2 years	None	Ethiopia consumption support: food support through food-for-work program for the duration of the program. Ghana consumption support: weekly cash transfers during lean season	Ethiopia: Participant in food-for-work program, at least one member capable of work, no loans taken out by household Ghana: Exclusion criteria included: (i) ownership of >30 small ruminants or >50 fowl; (ii) member found to be alcoholic or drug addict; (iii) no strong, able-bodied adult; (iv) did not have a female member; (v) did not have a member between the ages of 18 and 65	**Income: (+)** **Assets: (+)** **Financial inclusion: (+)** **Female empowerment:** Ethiopia (+), Ghana (=) **Psychological wellbeing: (** =)
Banerjee et al. (2018)[vii]	Ghana	NGO Pilot. Graduation.	2 years	None	Cash: weekly cash stipend for 3-10 months. Other services: weekly visits	Household judged to be the poorest in study area	**Income: (+)** **Ag Productivity: (=)** **Assets: (+)** **Financial inclusion: (+)**
Blattman et al. (2016)	Uganda	NGO Pilot. Cash plus (business training)	6 months	Approval of business plan	Cash: two installments six weeks apart Business training: five days	Marginalized villagers nominated by communities in rural sub-counties	**Income: (+)** **Assets: (++)** **Farm Labor: (+)** **Non-farm business: (++)**

Paper	Country	Intervention	Duration	Condition.	Periodicity	Targeting	Outcomes
Bossuroy et al. (2021)[viii]	Niger	Government-led Pilot. Economic inclusion. National cash transfer program +coaching groups, entrepreneur training and formation of saving groups. On top, i) a lump-sum cash grant, ii) a life-skills training module and, iii) i)+ii)	2 years	None	National cash transfer: monthly (for two years). Lump-sum cash transfer: one time	Women over 20 in poor rural households.	**Income: (=======)** **Ag Productivity: (++==)** **Assets: (========)** **Inputs: (==)** **Farm Labor: (=)** **Off-farm paid labor: (=)** **Non-farm business:==(++++=)** **Sales: (==)** **Psychological well-being: (+)**
Daidone et al. (2020)	Lesotho	Child Grants Programme (CGP) + Sustainable Poverty Reduction through Income, Nutrition, and access to Government Services (SPRINGS) intervention. Government-led	2 years	None	CGP: quarterly payments	CGP: poor vulnerable household with children SPRINGS: Poor household with orphans and vulnerable children	**Income: (====)** **Ag Productivity: (==+)** **Assets: (==++++=)** **Inputs: (=++===++=+)**
Gillingan et al. (2009)	Ethiopia	Productive safety net programme (PSNP. public works (PW) and direct support (DS)) + Other Food Security Programme (OFSP). Government-led.	3 years (PSNP)	None	PSNP, public works: daily.	Poor households. Direct support is given to labor-scarce households including those whose primary income earners are elderly or disabled	**Assets: (=+)** **Off-farm paid labor: (====)** **Inputs: (++)** **Non-farm business: (+=)**

Paper	Country	Intervention	Duration	Condition.	Periodicity	Targeting	Outcomes
Gobin et al. (2017)	Kenya	NGO Pilot. Graduation (cash transfer, business skills and savings training, business mentoring, and an introduction to savings groups	2 years	Second cash conditional on having an active enterprise.	Cash transfer: Two installments, beginning of program and 6 months later	Poor women in rural areas with no other sources of income.	**Income: (+)** **Assets: (+=+)**
Pace et al. (2017)[ix]	Malawi	Social Cash Transfer Programme (SCTP) and Farm Input Subsidy Programme (FISP). Not coordinated. Government-led	17 months after initial SCTP planned transfer.	None	SCTP: bi-monthly payments	SCTP: ultra poor households. FISP: poor smallholder farmers and particularly vulnerable groups	**Ag Productivity: (+)** **Assets: (+++)** **Inputs: (++)** **Sales: (=)**
Prifti, Bhalla and Grinspun (2020)[x]	Ethiopia	Integrated Nutrition Social Cash Transfer (IN-SCT) and Productive Safety Net Programme phase 4 (PSNP4). IN-SCT was embedded within PSNP4	3 years (PSNP)	Soft conditionalities for PSNP4	(PSNP4. public works (PW) daily and direct support (DS) monthly)	PSNP4 is aimed at poor food-insecure households. DS is given to poor households with no abled-bodied adults. Temporary DS to households with women or with caregivers of children under-5. PW	**Income: (=)** **Ag Productivity: (++==+==)** **Assets: (++)** **Non-farm business: (+)**
Sedlmayr, Shah and Sulaiman (2020)[xi]	Uganda	NGO pilot. Cash-plus (Cash transfer, trainings, and mentorship). Tested different combinations of components.	2 years	Second transfer conditional on report showing initial transfer was invested in a business.	Cash transfer: two instalments.	Participatory targeting process as well as a proxy means test.	**Income:** Full program vs control (+), Full program vs transfers (=) **Assets:** Full program vs control (+), Full program vs transfers (=) **Psychological well-being:** Full program vs. control (+), Full program vs transfers (=)

i The reported treatment effects are for the whole sample.
ii The reported treatment effects are for the 36-month follow-up
iii The reported treatment effects compare recipients and non-recipients in the same villages.
iv The reported treatment effects are for the whole sample.
v The reported treatment effects are for the 2nd midline and for the whole sample.
vi The reported treatment effects are for the 20-month follow-up (endline)
vii The reported treatment effects are for 3 years after the initial transfer
viii The reported treatment effects are for the full intervention vs capital and 18 months after the intervention.
ix The reported treatment effects are for the combined interventions.
x The reported treatment effects are for the "mother-child" sample, which consisted of households with labour capacity
xi The reported treatment effects are only comparing the full intervention and controls and the full intervention and a group that received the cash transfer or the cash transfer plus the light-touch psychological interventions.

10 An Action Plan for Building Sustainable and Resilient Food Systems in Africa

Kevin Chika Urama[1]; Louise Fox[2]; Thomas Jayne[3]; Lulama Ndibongo Traub[4]

Key messages

1. This chapter contains priority actions and next steps for building resilient and sustainable food systems in Africa for four sets of actors: (i) African governments; (ii) pan-African development organizations; (iii) international development partners; and (iv) the private sector.

2. In some cases, where the policy actions or modalities of implementation are not clear, this chapter identifies the necessary steps to generate the evidence to subsequently guide and inform the required policy actions.

3. The overarching theme is that Africa needs to step up and take the reins from others, however well intentioned, who have been directing the flows of international assistance for decades. There is no substitute for African-led processes in local research and development, local policy formulation and implementation, and local institutional development. International partners cannot develop Africa by themselves, but they can contribute substantially if Africans and African organizations truly take ownership and lead the process.

Introduction

Developing resilient and sustainable food systems is crucial for building sustainable economies and livelihoods everywhere. The AASR21 explores what this would entail in Africa and calls for the necessary actions from national governments, pan-African organisations, bilateral and multilateral development partners, and the private sector. The report builds on the call to action from African governments to the UNFSS recognizing that we are in the last decade of global efforts to realise the SDGs. This concluding chapter highlights key actions for African Governments, pan-African institutions, bilateral, multilateral development partners, and the private sector to support a decade of action in building resilient and sustainable food systems in Africa.

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The challenges to sustainability and resilience of African food systems are discussed in detail in previous chapters of this report. Among the most pressing are:

- Increasing prevalence of shocks from diseases, climate change, extreme weather events, conflict, policy instability, and domestic and international economic instability affecting trade and financial flows and the living standards affected by these.
- Low crop yield per hectare and per person, and slow improvements over the past decade. The pace of technological innovations that drive factor productivity growth and value addition along agricultural value chains remains slow in Africa compared to other regions of the world.
- Agricultural output growth through land use extensification leading to a degraded natural environment in rural areas and making the agriculture, forestry, and land use sector the largest contributor to green-house gas emissions in Africa (IPCC-Ar5).

- Food processing, packaging, distribution/ logistics, and agricultural market and regional market integration in Africa leaves significant opportunities for improvement. Despite possessing over 60 percent of the earth's remaining potentially available cropland, African countries rely heavily on food imports to feed their citizens.
- Employment in food systems that features jobs that are mostly below or not far above the poverty line leaving millions of African hungry and highly vulnerable to shocks and stressors.

Having a resilient and sustainable food system can make the difference between life and death for millions of Africans.

Sustainable food systems require sustainable actions throughout the entire agricultural value chain - from input supplies, mechanization, irrigation, extension, transport, processing, distribution, and healthy consumption. Building and sustaining the system calls for significant investments in the requisite hard and soft infrastructures – agricultural R&D; education and extension; development of input supply chains; on-farm productivity increases; upgrading of agricultural product processing, distribution and logistics, and marketing to increase access to safe and nutritious food; and increased waste recycling from farm to table. Such a food system requires efficient markets that drive private sector investment and technical innovation at various stages of the upstream and downstream food systems.

Africa has developed several plans to foster agricultural productivity at the national, regional, and continental levels. CAADP, the Malabo Declaration, AU Agenda 2063, and the African Development Bank' Feed Africa Strategy are among pan-African initiatives that provide continental frameworks for the region's agricultural and regional development. While these provide sound frameworks for agricultural transformation in Africa, more concerted and sustained actions are required to implement them at scales that can achieve resilient and sustainable agricultural food system development in Africa. For example, under CAADP, African governments pledged to commit 10 percent of their respective national budgets to agriculture. However, only a few countries have fulfilled this pledge. Investments in agricultural research, technology development, education and extension services remain among the lowest compared to other continents. Consequently, value addition post farm in Africa is low by international standards.

The report is a call for urgent action directed first and foremost to African governments to take responsibility for the development of sustainable and resilient food systems at the community, national, regional, and continental levels. However, the call to action is also directed at the countries and international institutions and organizations which support African development but with a call to increase focus on empowering African countries to develop their own capacities. This means following Africa's lead and the countries' own development priorities. It also means bearing with African state capacity deficits while supporting Africans themselves to innovate, adapt, and develop their own institutions and functional forms. This call to action is encapsulated in the actionable policy recommendations in each chapter, some of which are highlighted below:

Priorities for African government action plans

1. **Prioritize investments in agri-food systems as a national security, poverty alleviation, and rural development agenda.** There is no more effective way to defeat a nation than to starve its citizens to death. This is what the current hunger pandemic is doing to millions of Africans year on year. Conversely, there is no better way to grow Africa's economies than through investing in its AFSs. A productive, resilient, and sustainable AFS in Africa will directly translate to increased labor productivity, lower health costs through reduced morbidity and mortality due to hunger- and malnutrition-related illnesses, and increased incomes for

the over 65 percent of Africa's population directly employed in AFSs. Investing in agri-food systems is investing in the health and productivity of a country.

2. **Demonstrate political commitment for government support to agriculture by honoring commitments such as the Maputo Declaration to increase annual national budgetary allocations for agriculture to at least 10 percent. Moreover, ensure that agricultural research, development and extension systems receive a significant share of total public expenditures on agriculture given their centrality to raising agricultural productivity.** Weak knowledge systems and capacity (individual, organizational, and institutional) are the key underlying drivers of African countries' challenges in their efforts to build resilient and sustainable food systems. Available evidence shows that investment in technical innovation driven by R&D&E is the key driver of agricultural productivity growth. Yet, most African governments invest less than 1 percent of agricultural GDP on agricultural R&D. While the scientific underpinning of agricultural science is the same globally, the evolution of agricultural science and technology development, diffusion, and adoption are always shaped by social, cultural, and environmental factors which are heterogenous across agroecological zones, countries, and continents. Low rates of adoption of agricultural technologies in Africa to date attest to the importance of integrating local knowledge in AFS R&D, education, and extension services. Greater public spending on national agricultural science, technology, innovations, education, and extension are necessary for building resilient and sustainable food systems in Africa. Increased funding for agricultural R&D&E must also be accompanied by increased accountability and management to ensure that the full impacts of these investments are realized.

3. **Commit to national agricultural action plans that lay out the specifics of how countries will transition from area expansion to productivity growth on existing farmland as the primary source of future agricultural production growth.** A key task is to prioritize farm productivity growth through strengthened national agricultural R&D&E systems, which entails increased funding for national agricultural R&D&E, support for more efficient use of funds, and stronger accountability frameworks to incentivize management of these organizations to achieve performance targets. Improved coordination between international CGAIR research systems and national R&D&E will also be important for achieving more resilient and sustainable food systems in Africa.

4. **African governments need to take charge of their destinies by not relying on international partners to fund and influence how agricultural R&D&E and other farmer advisory services are undertaken. Governments can take control and build resilience, sustainability, community empowerment, and inclusiveness principles into the performance measures of national agricultural institutions and international research partners working in African countries.** Modern science and agroecology principles can be combined to promote food systems resilience and sustainability. It is "both", not "either/or" and ultimately it is the responsibility of African governments to take charge of the agendas and mold the programs of international development partners to align with national agendas. Governments can and should determine how to ensure that smallholder farmers have adequate choice over the seeds they use and that intellectual property rights are fair to both the firms generating new technologies and the farmers and local communities applying these technologies. The COVID-19 pandemic has demonstrated the urgent need for Africa and other regions to build and upscale endogenous knowledge and capacities to feed their citizens.

5. If and when African governments make progress in achieving productivity growth on existing farmland, **a greater area of forests and grasslands can then be preserved through reserves and conservation areas to generate sustainable revenue streams for African citizens and national governments through developing ecosystem services.**

6. **Enact the African Continental Free Trade Agreement (AfCFTA) to expand the market for African farmers and create new incentives for the private sector to invest in African food systems.** This should be accompanied by government investments in transportation and communications infrastructure to lower the cost of food trade between African countries.

7. **Promote enabling business environments that facilitate public-private partnerships.** For AFSs to be resilient and sustainable, significant investments are required from both public and private sectors. Governments need to move beyond treating agriculture as a social sector to treating it as a bankable business. A key role of the government is to **enact and implement policies that encourage private investment, innovation, and competition in Africa's AFSs – recognizing that both informal small firms and large agribusiness firms are needed for a sustainable and resilient AFS. Smallholder farmers and consumers still rely greatly on the informal parts of African food systems.** Regulatory barriers that hinder private sector access to land, finance, inputs, and other requirements for establishing, building and nurturing agri-businesses need to be identified and revised or eliminated. Governments are encouraged to create incentives for private sector participation and remove relevant tariff and non-tariff barriers. To promote access to financing and inputs, policy reforms on land ownership, land-use, and fiscal, monetary, trade, and competitiveness as well as private sector regulation are needed.

8. **Invest in digitalization of African agri-food systems.** Digitalization offers opportunities for efficiency and productivity gains all through agricultural value chains. It makes food systems more effective, efficient, transparent, traceable, and sustainable. Digitalization reduces transaction costs and allows for vertical and horizontal integration of input sources, on-farm production systems, and off-farm activities including distribution logistics, agri-business marketing and finance, smart contracting, and waste recycling. It also offers opportunities for product tracing and intellectual property management. African governments need to take the lead by providing the information technology (IT) infrastructure required for the digital economy to take roots in their respective countries. The digital revolution provides the means for domestic food suppliers to adopt e-commerce, which can keep both domestic and international AFSs functioning and support local (or homestead) production of nutrient-rich foods thus ensuring access even in a crisis such as a global pandemic.

9. **Improving food systems productivity is a necessary condition for promoting youth and women's engagement in farming as a business and as productive employees in the agri-food sector.** Raising productivity will improve the profitability of jobs in Africa's AFSs. Efforts to raise productivity must be complemented by government actions to remove barriers to youth and women's participation and success. Some of these actions may include: (i) land-use policies that grant land ownership rights to youths and women; (ii) targeted policies that expand investment opportunities in food systems by small- and medium-scale firms; (iii) public investments that improve the productivity of farming as a business; (iv) investments in rural infrastructure that lower the costs of agri-business; (v) rules-based marketing, and trade policies that mitigate political risks/raise the level of predictability of government behavior in agricultural markets; (vi) targeted capacity-building programs for youth and women-owned agri-businesses; and (vii) upgrading education systems to improving the skill base of youth and women in agriculture.

Priorities for Pan-African organizations

With many small and relatively poor countries, Africa often experiences difficulties in getting its voice heard on the world stage. While African countries are heterogenous, they face many common problems. Solutions from outside the continent, which are not responsive to African contexts, have sometimes done more harm than good (Pritchett, 2004). Pan-African organizations operating under the direction of African political and economic leaders, have a particular responsibility to bridge these gaps. One recent example of this is the AU Africa Common Position to the UNFSS.

To support African leaders, farmers, private agripreneurs, and consumers to play a more effective role in the development of a sustainable and resilient African food system, Pan-African Organizations should take on the following responsibilities:

1. **Stand together with the African Union Commission (AUC) to amplify Africa's voice in global policy dialogue on agricultural system governance and decision-making**. This can be achieved by lobbying for expansion of the G20 to G21 with the AU as the 21st member. Like the COVID-19 pandemic, many shocks and stressors to Africa's food systems are exogenous. Because of low technological inputs and value addition to its agricultural products, African countries are generally price takers in global agricultural product markets including those that are dominantly grown in Africa such as cocoa. Decisions made outside Africa therefore significantly shape Africa's AFSs and national policies to encourage domestic production of staple food crops such as rice, wheat, maize, etc. are often compromised by trade polices enacted and enforced through international treaties. African countries and pan-African organizations should therefore liaise with the AUC to lobby the G20 to admit the AU (along with the European Union - EU, which is already a member) as the 21st member of the G20. This could create more national ownership for AFS-related global sustainability agendas. For example, transitions to climate-smart agriculture in Africa, which has global climate benefits and directly affects the livelihoods of Africans, can be better achieved through dialogues involving Africa as member of the G20.
2. **Invest in regional early warning systems, knowledge management, and dissemination strategies to help countries anticipate and mitigate the consequences of upcoming shocks.** Building resilience means more timely anticipation and response to impending shocks. Shocks and stressors do not respect national boundaries often affecting many countries at once or even a whole region. Pan-African organizations should develop and implement a plan to develop regional early warning systems in response to extreme weather, pests, human, animal, and plant disease, and related disasters. These regional systems would support, coordinate with, and build the capacities of national early warning systems. Pan-African organizations can also promote partnerships between regional early warning units and African-led agricultural policy research institutes in the region to fully utilize the information provided by early warning systems.
3. **Lead and coordinate with African governments to strengthen the international architecture for agricultural research and development in Africa**. This report calls for the vast expansion and upgrading of national agricultural R&D systems to enable both increased sustainability and resilience. However, agricultural R&D is a public good – the knowledge cannot be "used up" through application or consumption. While one of the problems Africa faces in developing and implementing a green revolution is the wide variety of microclimates and soil conditions compared with Latin American or Asia, there are nonetheless similarities across countries (especially where boundaries were drawn by colonial powers), which implies that discoveries in one country could benefit others.

This benefit was explicitly recognized when the CGIAR system was set up to complement and support national agricultural research institutes. While this system has had notable success in Asia and Latin America, results in Africa have not lived up to expectations.

This report recognizes that simply calling for greater spending on agricultural research in and by African countries is not enough. The record of past failures and institutional rivalries shows that additional investments in agricultural research without applying lessons learned would be a mistake. Rather, this report recommends a detailed stocktaking to assess progress and chart a way forward. **A specially commissioned report** on this issue could address the following elements: (1) estimating the overall continent-wide cost envelope for agricultural research to achieve productivity targets; (2) detail how the international CGIAR system should be reformed so that it coordinates effectively with national agricultural R&D&E systems and promotes food systems technical innovation in African countries; (3) identifying some best-bet technologies that would give early and high returns while the remaining agenda is developed; (4) assessing the institutional configuration that would recognize local needs, transboundary/regional opportunities and imperatives, and appropriate roles for the private sector; and (5) expanding or initiating the necessary policy and extension system reforms to create an enabling environment supportive of rapid, widespread, and equitable adoption of innovations emanating from agricultural research.

4. As **Africa's major development bank - the African Development Bank Group would be well placed to host and chair such a commission on establishing the Agricultural Science, Technology, and Innovation Trust Fund for Africa (ASTIA – Trust Fund).** AfDB would ensure a strong African voice in the analysis and deliberations as well as a focus on practical approaches that can be used by African governments and international development partners to address this critical issue together. The commission could also address whether funding models such as the ASTIA – Trust Fund proposed in Chapter 6 would improve funding for and the effectiveness of African-led agricultural R&D efforts.

5. **Strengthen pan-African databases on food systems dynamics**. The knowledge base on the value of and changes in African food systems is very weak. This limits the scope of actions which can be considered, and makes it virtually impossible to track trends, monitor outcomes and impacts, and hold actors accountable. While collecting and assembling the data is first and foremost the responsibility of national statistical systems (NSSs), pan-African organizations such as UNECA, AFDB, and others can effectively contribute by consolidating national data into user-friendly databases and encouraging the use of consistent approaches at the national level to effectively track progress and benchmark countries.

6. **Encourage an inter-ministerial approach to systemic thinking about the challenges facing African food systems**. The challenges facing African food systems are complex and multi-dimensional – most of them cut across ministries, requiring new approaches and experimentation. For example, several chapters of this report have stressed the important role of human capacity development and hence ministries of education in building resilient and sustainable food systems. Other chapters have highlighted how agricultural land expansion is contributing to deforestation, water stress, and the demand for energy in ways that may require ministries of agriculture, lands, natural resources, and energy to collaborate more closely to tackle these challenges more effectively. Moreover, the views of multiple stakeholders including farmers, other private sector actors, ministries and agencies, and civil society organizations (CSOs) must be integrated into policymaking to effectively reflect the collective action of communities and

specific groups. Holistic thinking, as embodied in circular economy principles and true cost accounting approaches, will require refining and experimentation before it can be a standard tool in African government policy development toolkits. Pan-African organizations can support knowledge development and exchange on the continent and with other developing countries to advance solutions to chronic food systems resilience and sustainability problems, especially if they are supported by external donors to do so.

Priorities for international organizations, bilateral and multi-lateral development partners

International development partners should encourage and permit African governments to formulate their own agendas for enhanced resilience and food system sustainability. This will require supporting governments as they formulate and implement their respective agendas including through technical assistance and following the lead of African governments and regional institutions in their own support programs. Development partners should avoid overloading African national governments with their own demands and requirements and instead support African governments to build the requisite state capacity to manage and develop their respective food systems at their own pace. In some cases, this may mean accommodating imperfections as these governments and societies learn and develop. With their longer-term financing, international development banks including AfDB and the World Bank should deepen their commitment to African food system resilience investments. Specific action areas for development partners include to:

1. **Refocus funding models to benefit long-term institutional capacity development and agricultural knowledge and technology transfer in the sector.** Supporting national, regional, and continental institutions through scaled agricultural R&D&E investments would help to leverage international development partner funding and enhance the multiplier effects. Current models focused on programmatic support crowd out opportunities for long-term institutional capacity and good governance of agricultural research, technology, and innovations, which are in themselves the foundations for structural transformation, resilience capacity, and sustainable development. Funding large-scale collaborative research involving national, regional, and international universities, think tanks, and research organizations will enhance knowledge integration and technology diffusion.
2. **Prioritize integrated inclusive demand-driven and adaptive agricultural research and technology development in their funding programs.** Public investment in homegrown adaptive agricultural R&D&E can promote climate-smart and sustainable 'improved practices' that are adapted to the highly-varied biophysical and economic conditions of rural Africa. Current financing models prioritizing funding for international research organizations crowds out endogenous knowledge systems. Notably, tacit knowledge that is context-specific and effective but which has yet to be codified in generally accepted knowledge products such as research reports, and journal articles is excluded in this model. Some of these tacit knowledge systems have worked for millennia and remain key parts of African AFSs today. They are therefore no doubt sustainable. Agricultural research funding that encourages the integration of both tacit and codified knowledge by fostering equal partnerships and collaboration among the different knowledge providers including local communities and CBOs, national universities, think tanks, NGOs, and the private sector is more likely to foster socio-technical transitions towards resilient and sustainable AFSs than current funding models that prioritize international originations. Homegrown social innovations transform societies more cost-effectively than externally driven R&D, education, and extension.

3. **Support for African-led food systems policy analysis capacity.** Building the capacity of African-led technical and policy expertise is an important element of sustainability and resilience as it ensures adequate internal capacity to guide national and regional policy decisions. Instead of continuing to rely on international partners to provide technical analysis and policy guidance, international development partners should therefore work to build up regional and national policy analysis capacity to ensure internal world-class policy guidance for African states, supported by international research institutes where necessary.

Priorities for the private sector

The vast majority of investment in African food systems comes from the private sector, which includes millions of smallholder farmers and informal traders. The private sector invests in productive capacity, imports and adapts new technologies, and innovates to respond to the African context and customer needs. Many private agribusiness firms, especially those engaged in foreign direct investment (FDI) in the developing world, have realized that a focus on short-term profits is neither enough to ensure their own sustainability and resilience nor the sustainability of the systems in which they operate. Companies are increasingly focused on the "triple bottom line" – people, profits, and the planet. Similar to the deficiencies of national accounts systems in measuring the true cost of food systems policies and practices, companies are also realizing that financial balance sheets do not measure the true value of doing business. Multi-national companies doing business in Africa can lead the reform of food systems through stronger analysis of the full costs and benefits of their production processes and interact with other stakeholders to develop solution-driven approaches to reduce the adverse effects that AFSs as currently constructed impose on our health, societal values, and planet.

In countries with favorable policy incentives, the private sector should also become the engine for solution-driven innovations, technology development, and commercialization in the AFS. Such innovations should target scaling agro-allied industrialization to drive value addition along key agricultural value chains in countries. The private sector can and should play key roles in operationalizing the AfCTA. Efforts should be focused on building sustainable and resilient regional value chains and providing technology-based solutions, innovative financing, and digital market platforms.

Conclusion

In the context of the UN Decade of Action to achieve the SDGs by 2030, in September 2021, the world will convene at the global UNFSS under the auspices of the UN Secretary-General. The Summit will focus on game-changing solutions to transform food systems across the globe. The African Governments' Common Position to the UNFSS recognizes the emerging broad consensus that African food systems are not providing adequate food and nutrition and are not resilient or sustainable. This AASR21 has laid out contributing factors at various stages of the food systems and outlined the characteristics of a new resilient and sustainable system.

Reforming food systems to achieve lasting change is a complex task. It requires cooperation from all system stakeholders with African governments firmly in the drivers' seat steering the required change. This AASR21 has argued that lasting change is possible if African governments play the role of leading domestic actors effectively with the support of external stakeholders. Africa can learn from the experiences of more developed countries and avoid their mistakes. However, Africa needs to step up and take the reins from others, however well intentioned, who have been directing the flows of international development assistance for decades. There is no substitute for African-led processes in local research and development, policy formulation and implementation, and institutional development. While international partners cannot develop Africa by themselves, they can substantially contribute if Africans and African organizations truly take ownership and lead the process. Evidence from the past two decades shows that this local dynamism has flourished in Africa where the necessary stability, sustainability, and resilience frameworks are in place. Now, African governments need to harness this energy toward strengthening AFSs, for the health and welfare of current and future populations.

Agricultural Data

Technical Notes

The following conventions are used in the Tables:
0 or 0.0 = nil or negligible
.. or () data not available or missing

Data and Sources

Sources of data as follows:

Population, total (millions)
Source: World Development Indicators, World Bank

Urban Population (% of Total Population)
Source: World Development Indicators, World Bank

Rural Population (% of Total Population)
Source: World Development Indicators, World Bank

Population Growth (Annual %)
Source: World Development Indicators, World Bank

GDP growth (annual %)
Source: World Development Indicators, World Bank

Adjusted savings: Net Forest Depletion (% of GNI)
Source: World Development Indicators, World Bank

Adjusted Savings: Net Forest Depletion (current US$)
Source: World Development Indicators, World Bank

Agricultural Land (% of Land Area)
Source: World Development Indicators, World Bank

Food Production Index (2014-2016 = 100)
Source: World Development Indicators, World Bank

Forest Area (% of Land Area)
Source: World Development Indicators, World Bank

Expected Years of School, Total
Source: Human Capital Index (https://databank.worldbank.org/source/human-capital-index#)

Harmonized Test Scores, Total
Source: Human Capital Index (https://databank.worldbank.org/source/human-capital-index#

Human Capital Index (HCI) (scale 0-1)
Source: Human Capital Index (https://databank.worldbank.org/source/human-capital-index#

Learning-Adjusted Years of School
Source: Human Capital Index (https://databank.worldbank.org/source/human-capital-index#

Probability of Survival to Age 5
Source: Human Capital Index (https://databank.worldbank.org/source/human-capital-index#

Survival Rate from Age 15-60
Source: Human Capital Index (https://databank.worldbank.org/source/human-capital-index#

Fraction of Children Under 5 Not Stunted
Source: Human Capital Index (https://databank.worldbank.org/source/human-capital-index#

Population, Total

Country Name	1980	1990	2000	2010	2020
Algeria	19.2	25.8	31.0	36.0	43.9
Angola	8.3	11.8	16.4	23.4	32.9
Benin	3.7	5.0	6.9	9.2	12.1
Botswana	0.9	1.3	1.6	2.0	2.4
Burkina Faso	6.8	8.8	11.6	15.6	20.9
Burundi	4.2	5.4	6.4	8.7	11.9
Cabo Verde	0.3	0.3	0.4	0.5	0.6
Cameroon	8.6	11.8	15.5	20.3	26.5
Central African Republic	2.2	2.8	3.6	4.4	4.8
Chad	4.5	6.0	8.4	12.0	16.4
Comoros	0.3	0.4	0.5	0.7	0.9
Congo, Dem. Rep.	26.4	34.6	47.1	64.6	89.6
Congo, Rep.	1.8	2.4	3.1	4.3	5.5
Cote d'Ivoire	8.0	11.9	16.5	20.5	26.4
Djibouti	0.4	0.6	0.7	0.8	1.0
Egypt, Arab Rep.	43.3	56.1	68.8	82.8	102.3
Equatorial Guinea	0.2	0.4	0.6	0.9	1.4
Eritrea	1.7	2.3	2.3	3.2	0.0
Eswatini	0.6	0.8	1.0	1.1	1.2
Ethiopia	35.1	47.9	66.2	87.6	115.0
Gabon	0.7	0.9	1.2	1.6	2.2
Gambia, The	0.6	1.0	1.3	1.8	2.4
Ghana	11.1	14.8	19.3	24.8	31.1
Guinea	4.9	6.4	8.2	10.2	13.1
Guinea-Bissau	0.8	1.0	1.2	1.5	2.0
Kenya	16.4	23.7	32.0	42.0	53.8
Lesotho	1.3	1.7	2.0	2.0	2.1
Liberia	1.9	2.1	2.8	3.9	5.1
Libya	3.2	4.4	5.4	6.2	6.9
Madagascar	8.7	11.6	15.8	21.2	27.7
Malawi	6.3	9.4	11.1	14.5	19.1
Mali	7.1	8.4	10.9	15.0	20.3
Mauritania	1.5	2.0	2.6	3.5	4.6
Mauritius	1.0	1.1	1.2	1.3	1.3

Country Name	1980	1990	2000	2010	2020
Morocco	20.0	24.8	28.8	32.3	36.9
Mozambique	11.6	13.0	17.7	23.5	31.3
Namibia	1.1	1.4	1.8	2.1	2.5
Niger	6.0	8.0	11.3	16.5	24.2
Nigeria	73.4	95.2	122.3	158.5	206.1
Rwanda	5.2	7.3	7.9	10.0	13.0
Sao Tome and Principe	0.1	0.1	0.1	0.2	0.2
Senegal	5.6	7.5	9.8	12.7	16.7
Seychelles	0.1	0.1	0.1	0.1	0.1
Sierra Leone	3.4	4.3	4.6	6.4	8.0
Somalia	6.3	7.2	8.9	12.0	15.9
South Africa	28.6	36.8	45.0	51.2	59.3
South Sudan	4.5	5.5	6.2	9.5	11.2
Sudan	14.5	20.1	27.3	34.5	43.8
Tanzania	18.5	25.2	33.5	44.3	59.7
Togo	2.7	3.8	4.9	6.4	8.3
Tunisia	6.4	8.2	9.7	10.6	11.8
Uganda	12.4	17.4	23.7	32.4	45.7
Zambia	5.9	8.0	10.4	13.6	18.4
Zimbabwe	7.4	10.4	11.9	12.7	14.9
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

License Type	CC BY-4.0
Indicator Name	Population, total
Long definition	Total population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship. The values shown are midyear estimates.
Source	(1) United Nations Population Division. World Population Prospects: 2019 Revision. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Reprot (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme.
Topic	Health: Population: Structure
Periodicity	Annual
Aggregation method	Sum

Urban Population (% of Total Population)

Country Name	1980	1990	2000	2010	2020
Algeria	43.5	52.1	59.9	67.5	73.7
Angola	24.3	37.1	50.1	59.8	66.8
Benin	27.3	34.5	38.3	43.1	48.4
Botswana	16.5	41.9	53.2	62.4	70.9
Burkina Faso	8.8	13.8	17.8	24.6	30.6
Burundi	4.3	6.3	8.2	10.6	13.7
Cabo Verde	23.5	44.1	53.4	61.8	66.7
Cameroon	31.9	39.7	45.5	51.6	57.6
Central African Republic	33.9	36.8	37.6	38.9	42.2
Chad	18.8	20.8	21.6	22.0	23.5
Comoros	23.2	27.9	28.1	28.0	29.4
Congo, Dem. Rep.	27.1	30.6	35.1	40.0	45.6
Congo, Rep.	47.9	54.3	58.7	63.3	67.8
Cote d'Ivoire	36.8	39.3	43.2	47.3	51.7
Djibouti	72.1	76.0	76.5	77.0	78.1
Egypt, Arab Rep.	43.9	43.5	42.8	43.0	42.8
Equatorial Guinea	27.9	34.7	49.1	65.9	73.1
Eritrea	14.4	18.9	26.6	35.2	..
Eswatini	16.5	20.2	22.7	22.5	24.2
Ethiopia	10.4	12.6	14.7	17.3	21.7
Gabon	54.7	69.1	78.9	85.5	90.1
Gambia, The	28.4	38.3	47.9	55.7	62.6
Ghana	31.2	36.4	43.9	50.7	57.3
Guinea	23.6	28.0	30.9	33.7	36.9
Guinea-Bissau	17.8	30.8	36.2	40.1	44.2
Kenya	15.6	16.7	19.9	23.6	28.0
Lesotho	11.5	14.0	19.5	24.8	29.0
Liberia	35.2	55.4	44.3	47.8	52.1
Libya	70.1	75.7	76.4	78.1	80.7
Madagascar	18.5	23.6	27.1	31.9	38.5
Malawi	9.1	11.6	14.6	15.5	17.4
Mali	18.5	23.3	28.4	36.0	43.9

Country Name	1980	1990	2000	2010	2020
Mauritania	27.4	39.3	38.1	46.6	55.3
Mauritius	42.4	43.9	42.7	41.6	40.8
Morocco	41.2	48.4	53.3	58.0	63.5
Mozambique	13.2	25.0	29.1	31.8	37.1
Namibia	25.1	27.7	32.4	41.6	52.0
Niger	13.4	15.4	16.2	16.2	16.6
Nigeria	22.0	29.7	34.8	43.5	52.0
Rwanda	4.7	5.4	14.9	16.9	17.4
Sao Tome and Principe	33.5	43.6	53.4	65.0	74.4
Senegal	35.8	38.9	40.3	43.8	48.1
Seychelles	49.4	49.3	50.4	53.3	57.5
Sierra Leone	29.8	33.3	35.6	38.9	42.9
Somalia	26.8	29.7	33.2	39.3	46.1
South Africa	48.4	52.0	56.9	62.2	67.4
South Sudan	8.5	13.3	16.5	17.9	20.2
Sudan	20.0	28.6	32.5	33.1	35.3
Tanzania	14.6	18.9	22.3	28.1	35.2
Togo	24.7	28.6	32.9	37.5	42.8
Tunisia	50.6	57.9	63.4	66.7	69.6
Uganda	7.5	11.1	14.8	19.4	25.0
Zambia	39.8	39.4	34.8	39.4	44.6
Zimbabwe	22.4	29.0	33.8	33.2	32.2
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

Indicator Name Urban population (% of total population)

Long definition Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division.

Source United Nations Population Division. World Urbanization Prospects: 2018 Revision.

Topic Environment: Density & urbanization

Periodicity Annual

Aggregation method Weighted average

Rural Population (% of Total Population)

Country Name	1980	1990	2000	2010	2020
Algeria	56.5	47.9	40.1	32.5	26.3
Angola	75.7	62.9	49.9	40.2	33.2
Benin	72.7	65.5	61.7	56.9	51.6
Botswana	83.5	58.1	46.8	37.6	29.1
Burkina Faso	91.2	86.2	82.2	75.4	69.4
Burundi	95.7	93.7	91.8	89.4	86.3
Cabo Verde	76.5	55.9	46.6	38.2	33.3
Cameroon	68.1	60.3	54.5	48.4	42.4
Central African Republic	66.1	63.2	62.4	61.1	57.8
Chad	81.2	79.2	78.4	78.0	76.5
Comoros	76.8	72.1	71.9	72.0	70.6
Congo, Dem. Rep.	72.9	69.4	64.9	60.0	54.4
Congo, Rep.	52.1	45.7	41.3	36.7	32.2
Cote d'Ivoire	63.2	60.7	56.8	52.7	48.3
Djibouti	27.9	24.0	23.5	23.0	21.9
Egypt, Arab Rep.	56.1	56.5	57.2	57.0	57.2
Equatorial Guinea	72.1	65.3	50.9	34.1	26.9
Eritrea	85.6	81.1	73.4	64.8	..
Eswatini	83.5	79.8	77.3	77.5	75.8
Ethiopia	89.6	87.4	85.3	82.7	78.3
Gabon	45.3	30.9	21.1	14.5	9.9
Gambia, The	71.6	61.7	52.1	44.3	37.4
Ghana	68.8	63.6	56.1	49.3	42.7
Guinea	76.4	72.0	69.1	66.3	63.1
Guinea-Bissau	82.2	69.2	63.8	59.9	55.8
Kenya	84.4	83.3	80.1	76.4	72.0
Lesotho	88.6	86.0	80.5	75.2	71.0
Liberia	64.8	44.6	55.7	52.2	47.9
Libya	29.9	24.3	23.6	21.9	19.3
Madagascar	81.5	76.4	72.9	68.1	61.5
Malawi	91.0	88.4	85.4	84.5	82.6
Mali	81.5	76.7	71.6	64.0	56.1
Mauritania	72.6	60.7	61.9	53.4	44.7

Country Name	1980	1990	2000	2010	2020
Mauritius	57.6	56.1	57.3	58.4	59.2
Morocco	58.8	51.6	46.7	42.0	36.5
Mozambique	86.8	75.0	70.9	68.2	62.9
Namibia	74.9	72.3	67.6	58.4	48.0
Niger	86.6	84.6	83.8	83.8	83.4
Nigeria	78.0	70.3	65.2	56.5	48.0
Rwanda	95.3	94.6	85.1	83.1	82.6
Sao Tome and Principe	66.5	56.4	46.6	35.0	25.6
Saudi Arabia	34.1	23.4	20.2	17.9	15.7
Senegal	64.2	61.1	59.7	56.2	51.9
Seychelles	50.6	50.7	49.6	46.7	42.5
Sierra Leone	70.2	66.7	64.4	61.1	57.1
Somalia	73.2	70.3	66.8	60.7	53.9
South Africa	51.6	48.0	43.1	37.8	32.6
South Sudan	91.5	86.7	83.5	82.1	79.8
Sudan	80.0	71.4	67.5	66.9	64.7
Tanzania	85.4	81.1	77.7	71.9	64.8
Togo	75.3	71.4	67.1	62.5	57.2
Tunisia	49.4	42.1	36.6	33.3	30.4
Uganda	92.5	88.9	85.2	80.6	75.0
Zambia	60.2	60.6	65.2	60.6	55.4
Zimbabwe	77.6	71.0	66.2	66.8	67.8
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

Population Growth (Annual %)

Country Name	1980	1990	2000	2010	2020
Algeria	3.0	2.6	1.4	1.8	1.8
Angola	3.5	3.4	3.3	3.7	3.2
Benin	2.7	3.2	3.0	2.8	2.7
Botswana	3.7	3.3	2.0	1.7	2.1
Burkina Faso	2.2	2.7	2.8	3.0	2.8
Burundi	2.6	2.5	1.8	3.3	3.1
Cabo Verde	1.5	2.0	1.8	1.2	1.1
Cameroon	3.0	3.1	2.6	2.7	2.6
Central African Republic	2.7	2.2	2.3	1.1	1.8
Chad	2.1	3.2	3.7	3.3	3.0
Comoros	3.4	2.9	2.5	2.4	2.2
Congo, Dem. Rep.	2.7	3.4	2.6	3.3	3.1
Congo, Rep.	2.9	2.7	2.9	3.0	2.5
Cote d'Ivoire	4.4	3.6	2.6	2.3	2.5
Djibouti	6.6	4.6	2.5	1.5	1.5
Egypt, Arab Rep.	2.4	2.4	1.9	2.0	1.9
Equatorial Guinea	3.2	3.0	4.1	4.6	3.4
Eritrea	2.9	1.2	2.4	1.6	..
Eswatini	3.4	3.0	1.1	0.7	1.0
Ethiopia	1.9	3.4	2.9	2.8	2.5
Gabon	2.4	2.8	2.4	3.5	2.4
Gambia, The	3.3	4.3	3.1	3.0	2.9
Ghana	2.3	2.9	2.4	2.5	2.1
Guinea	1.8	3.0	2.3	2.3	2.8
Guinea-Bissau	0.9	2.2	2.0	2.6	2.4
Kenya	3.8	3.4	2.7	2.7	2.3
Lesotho	2.8	2.2	0.6	0.3	0.8
Liberia	3.2	-1.5	5.4	3.6	2.4
Libya	3.9	2.5	1.5	1.0	1.4
Madagascar	2.9	2.9	3.1	2.8	2.6
Malawi	2.8	3.6	2.7	2.9	2.7
Mali	1.9	1.8	2.8	3.2	3.0
Malta	1.0	1.0	0.6	0.5	4.1
Mauritania	2.9	2.6	2.6	2.9	2.7
Mauritius	1.7	0.7	1.0	0.2	0.0

Country Name	1980	1990	2000	2010	2020
Morocco	2.4	1.8	1.2	1.3	1.2
Mozambique	2.5	1.4	2.7	2.7	2.9
Namibia	2.1	3.3	1.7	1.8	1.8
Niger	2.9	3.1	3.6	3.8	3.8
Nigeria	2.8	2.6	2.5	2.7	2.5
Rwanda	3.4	0.2	5.6	2.6	2.5
Sao Tome and Principe	2.5	2.5	1.6	2.5	1.9
Senegal	2.6	3.0	2.4	2.7	2.7
Seychelles	0.9	0.5	0.9	2.8	0.9
Sierra Leone	2.2	1.5	2.7	2.3	2.1
Somalia	6.4	1.3	3.7	2.7	2.9
South Africa	2.6	2.4	1.4	1.5	1.3
South Sudan	3.0	-0.3	4.4	3.9	1.2
Sudan	3.5	3.4	2.4	2.2	2.4
Tanzania	3.1	3.2	2.5	2.9	2.9
Togo	2.9	2.6	3.0	2.7	2.4
Tunisia	2.6	2.2	1.0	1.0	1.1
Uganda	3.0	3.5	3.0	3.2	3.3
Zambia	3.4	2.7	2.7	2.9	2.9
Zimbabwe	3.4	2.7	0.5	1.4	1.5

Source: World Development Indicators
https://databank.worldbank.org/source/world-development-indicators

Indicator Name Population growth (annual %)

Short definition Annual population growth rate. Population is based on the *de facto* definition of population, which counts all residents regardless of legal status or citizenship.

Long definition Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship.

Source Derived from total population. Population source: (1) United Nations Population Division. World Population Prospects: 2019 Revision, (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Report (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme.

Topic Health: Population: Dynamics

Periodicity Annual

Aggregation method Weighted average

GDP Growth (Annual %)

Country Name	1980	1990	2000	2010	2020
Algeria	0.8	0.8	3.8	3.6	-5.5
Angola	..	-3.5	3.1	4.4	-4.0
Benin	6.8	9.0	5.9	2.1	3.8
Botswana	12.0	6.8	2.0	8.6	-7.9
Burkina Faso	0.8	-0.6	1.9	8.4	2.0
Burundi	1.0	3.5	-0.9	5.1	0.3
Cabo Verde	..	0.7	14.3	1.5	-14.8
Cameroon	-2.0	-6.1	3.6	3.4	0.7
Central African Republic	-4.5	-2.1	-2.5	4.6	0.0
Chad	-6.0	-4.2	-0.9	13.6	-0.9
Comoros	..	5.1	10.8	3.8	4.9
Congo, Dem. Rep.	2.2	-6.6	-6.9	7.1	0.8
Congo, Rep.	17.6	1.0	7.6	9.9	-7.9
Cote d'Ivoire	-11.0	-1.1	-2.1	2.0	1.8
Djibouti	..	..	..	..	0.5
Egypt, Arab Rep.	10.0	5.7	6.4	5.1	3.6
Equatorial Guinea	..	-1.8	18.2	-8.9	-4.9
Eritrea	..	..	-3.1	2.2	..
Eswatini	12.4	21.0	1.8	3.8	-1.6
Ethiopia	..	2.7	6.1	12.6	6.1
Gabon	2.6	5.2	-1.9	7.1	-1.3
Gambia, The	6.3	3.6	5.5	5.9	0.0
Ghana	0.5	3.3	3.7	7.9	0.4
Guinea	..	4.3	2.5	4.8	7.0
Guinea-Bissau	-16.0	6.1	5.4	4.6	-2.4
Kenya	5.6	4.2	0.6	8.4	-0.3
Lesotho	-2.7	6.0	3.9	5.3	-11.1
Liberia	..	..	..	6.1	-2.9
Libya	..	..	3.7	5.0	-31.3
Madagascar	1.0	3.1	4.5	0.6	-4.2
Malawi	0.4	5.7	1.6	6.9	0.8
Mali	-4.3	-2.5	-0.1	5.3	-1.6
Mauritania	3.4	-1.8	-3.9	2.6	-1.5

Country Name	1980	1990	2000	2010	2020
Mauritius	-10.1	7.2	8.2	4.4	-14.9
Morocco	3.6	3.4	1.9	3.8	-7.1
Mozambique	..	1.0	1.2	6.5	-1.3
Namibia	..	2.0	3.5	6.0	-8.0
Niger	-2.5	-1.3	-1.2	8.6	1.5
Nigeria	4.2	11.8	5.0	8.0	-1.8
Rwanda	9.0	-2.4	8.4	7.3	-3.4
Sao Tome and Principe	..	..	..	6.7	3.1
Senegal	4.0	-0.7	3.9	3.4	0.9
Seychelles	-4.2	7.0	1.5	6.0	-10.7
Sierra Leone	4.8	3.3	6.7	5.3	-2.2
Somalia	-3.9	-1.5	..	..	-1.5
South Africa	6.6	-0.3	4.2	3.0	-7.0
South Sudan	..	..	..	5.5	..
Sudan	1.5	-5.5	6.3	3.5	-1.6
Tanzania	..	7.0	4.5	6.3	2.0
Togo	14.6	-0.2	-0.8	6.1	1.8
Tunisia	7.4	7.9	4.7	3.5	-8.6
Uganda	..	6.5	3.1	5.6	2.9
Zambia	3.0	-0.5	3.9	10.3	-3.0
Zimbabwe	14.4	7.0	-3.1	19.7	-8.0
https://databank.worldbank.org/source/world-development-indicators					

License Type	CC BY-4.0
Indicator Name	GDP growth (annual %)
Long definition	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.
Source	World Bank national accounts data, and OECD National Accounts data files.
Topic	Economic Policy & Debt: National accounts: Growth rates
Periodicity	Annual
Aggregation method	Weighted average

Adjusted savings: Net Forest Depletion (% of GNI)

Country Name	1980	1990	2000	2010	2019
Algeria	0.1	0.1	0.1	0.1	0.1
Angola	..	0.0	0.0	0.0	0.0
Bahrain	0.0	0.0	0.0	0.0	0.0
Benin	0.0	1.1	1.3	1.9	1.3
Botswana	0.0	0.0	0.0	0.0	0.0
Burkina Faso	0.4	1.8	1.1	4.2	2.9
Burundi	8.0	13.0	14.5	23.4	8.9
Cabo Verde	0.6	0.3	0.2	0.3	0.2
Cameroon	0.0	0.0	0.0	0.0	0.2
Central African Republic	0.0	0.0	0.0	0.0	0.0
Chad	0.0	0.0	0.5	1.1	1.7
Comoros	0.6	0.6	1.3	1.5	1.2
Congo, Dem. Rep.	..	..	0.0	2.4	2.4
Congo, Rep.	0.0	0.0	0.0	0.0	0.0
Cote d'Ivoire	0.0	0.0	0.0	0.0	0.0
Djibouti	..	..	0.4	0.8	0.3
Egypt, Arab Rep.	0.5	0.4	0.1	0.2	0.1
Equatorial Guinea	0.0	0.0	0.0	0.0	0.0
Eritrea	..	..	1.4	0.0	..
Eswatini	..	0.0	0.0	0.0	0.0
Ethiopia	..	9.5	15.7	13.7	3.9
Gabon	0.0	0.0	0.0	0.0	0.0
Gambia, The	0.0	0.3	0.7	1.1	0.9
Ghana	0.0	0.0	0.0	0.5	0.7
Guinea	..	1.7	2.6	3.5	1.9
Guinea-Bissau	0.0	0.0	0.0	0.0	0.3
Iran, Islamic Rep.	0.1	0.0	0.0	0.0	..
Iraq	0.0	0.0	..	0.0	0.0
Israel	0.0	0.0	0.0	0.0	0.0
Jordan	0.0	0.0	0.0	0.0	0.0
Kenya	0.0	1.0	1.6	1.8	0.6
Kuwait	0.0	0.0	0.0	0.0	..
Lebanon	..	0.0	0.0	0.0	0.0

Country Name	1980	1990	2000	2010	2019
Lesotho	4.2	2.4	2.7	2.9	2.5
Liberia	..	..	0.0	3.4	5.9
Libya	..	..	..	0.0	0.1
Madagascar	0.0	0.0	0.0	0.0	0.0
Malawi	1.2	4.3	5.7	3.8	3.6
Mali	0.3	1.7	2.3	2.2	1.3
Malta	..	..	..	..	..
Mauritania	0.0	0.5	0.7	1.1	0.9
Mauritius	0.0	0.0	0.0	0.0	0.0
Morocco	0.0	0.0	0.0	0.2	0.1
Mozambique	..	..	0.0	0.0	0.0
Namibia	0.0	0.0	0.0	0.0	0.0
Niger	1.4	2.6	6.0	5.6	3.4
Nigeria	0.0	0.0	0.0	0.4	0.6
Oman	0.0	0.0	0.0	0.0	0.0
Qatar	0.0	0.0	0.0	0.0	0.0
Rwanda	7.5	4.5	4.7	5.5	3.0
Sao Tome and Principe	..	..	..	0.0	0.0
Saudi Arabia	0.0	0.0	0.0	0.0	0.0
Senegal	0.0	0.0	0.0	0.0	0.0
Seychelles	..	0.0	0.0	0.0	0.0
Sierra Leone	0.0	0.5	3.4	3.2	1.7
Somalia	0.0	0.0	..	..	..
South Africa	0.0	0.1	0.2	0.1	0.1
South Sudan	..	..	..	..	..
Sudan	..	..	..	..	0.4
Syrian Arab Republic	0.0	0.0	0.0	..	..
Tanzania	..	0.0	0.0	0.0	0.0
Togo	5.3	5.3	6.7	5.7	3.1
Tunisia	0.2	0.2	0.1	0.1	0.2
Uganda	35.2	13.6	11.0	7.8	6.2
United Arab Emirates	..	..	0.0	0.0	0.0
West Bank and Gaza	..	..	..	..	..
Yemen, Rep.	..	0.0	0.0	0.0	0.0

Country Name	1980	1990	2000	2010	2019
Zambia	0.0	0.0	0.0	0.0	0.0
Zimbabwe	0.0	0.0	0.0	0.0	0.0
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

Indicator Name	Adjusted savings: net forest depletion (current US$)
Long definition	Net forest depletion is calculated as the product of unit resource rents and the excess of roundwood harvest over natural growth. If growth exceeds harvest, this figure is zero.
Source	World Bank staff estimates based on sources and methods described in the World Bank's The Changing Wealth of Nations.
Topic	Economic Policy & Debt: National accounts: Adjusted savings & income
Periodicity	Annual

Adjusted Savings: Net Forest Depletion (current US$)

Country Name	1980	1990	2000	2010	2019
Algeria	25,925,810	57,724,213	43,719,378	173,349,260	166,769,816
Angola	-	-	-	-	-
Benin	-	21,272,479	44,753,740	178,144,841	182,205,697
Botswana	-	-	-	-	-
Burkina Faso	8,174,559	55,442,080	33,162,537	414,780,833	437,839,856
Burundi	74,195,909	144,815,559	128,083,749	472,818,506	269,599,976
Cabo Verde	842,266	775,033	1,040,365	4,386,642	3,202,621
Cameroon	-	-	-	-	75,988,947
Cent. African Rep.	-	-	-	-	-
Chad	-	-	7,073,136	118,294,794	191,210,898
Comoros	1,237,622	2,601,805	4,411,347	13,475,066	13,709,716
Congo, Dem. Rep.	-	-	-	501,932,955	1,156,368,843
Congo, Rep.	-	-	-	-	-
Cote d'Ivoire	-	-	-	-	-
Djibouti	682,780	2,499,225	2,065,932	9,310,707	9,413,083
Egypt, Arab Rep.	95,656,111	178,059,650	121,706,116	474,800,055	434,000,704
Equatorial Guinea	-	-	-	-	-
Eritrea	..	..	10,216,375	-	-
Eswatini	-	-	-	-	-
Ethiopia	752,520,856	1,145,802,141	1,282,444,835	4,098,904,862	3,739,099,115
Gabon	-	-	-	-	-
Gambia, The	-	882,739	5,064,549	17,075,161	16,694,679
Ghana	-	-	-	162,850,607	483,311,734
Guinea	256,471	43,390,821	75,567,287	235,997,624	227,236,349
Guinea-Bissau	-	-	-	-	4,864,818
Kenya	-	78,916,463	205,283,992	732,472,420	519,076,945
Lesotho	29,424,960	22,526,269	30,066,690	86,115,940	70,813,422
Liberia	-	-	-	61,874,236	159,048,649
Libya	4,815,389	7,069,437	7,175,535	27,413,563	28,717,378
Madagascar	-	-	-	-	-
Malawi	14,047,599	79,418,210	97,675,438	261,862,518	269,783,058
Mali	5,988,842	44,971,223	68,550,819	228,419,242	221,595,119
Mauritania	82,912	7,655,892	13,323,307	62,461,477	65,168,117

Country Name	1980	1990	2000	2010	2019
Mauritius	-	-	-	-	-
Morocco	-	-	-	201,934,290	112,838,591
Mozambique	-	-	-	-	-
Namibia	-	-	-	-	-
Niger	35,525,382	92,182,694	140,772,457	461,371,989	461,271,211
Nigeria	-	-	-	1,450,251,538	2,686,944,616
Rwanda	94,161,584	113,429,948	97,517,464	334,991,579	301,182,812
Sao Tome and Principe	-	-	-	-	-
Senegal	-	-	-	-	-
Seychelles	..	-	16,771	252,216	261,561
Sierra Leone	-	3,062,470	20,943,986	83,481,297	69,845,180
Somalia	-	-	28,965,085	293,583,171	344,220,525
South Africa	-	149,363,051	245,002,118	290,309,061	273,253,727
South Sudan	..	..	..	..	36,755,285
Sudan	..	..	..	..	119,955,665
Tanzania	-	-	-	-	-
Togo	58,650,369	85,221,075	97,658,172	195,099,421	170,277,730
Tunisia	13,030,000	22,981,562	15,032,587	50,285,246	80,850,789
Uganda	434,906,127	574,667,927	670,739,529	2,040,528,132	2,110,041,264
Zambia	0	0	0	0	0
Zimbabwe	0	0	0	0	0
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

Indicator Name Adjusted savings: net forest depletion (% of GNI)

Long definition Net forest depletion is calculated as the product of unit resource rents and the excess of roundwood harvest over natural growth. If growth exceeds harvest, this figure is zero.

Source World Bank staff estimates based on sources and methods described in the World Bank's The Changing Wealth of Nations.

Topic Economic Policy & Debt: National accounts: Adjusted savings & income

Periodicity Annual

Aggregation method Weighted average

Agricultural Land (% of Land Area)

Country Name	1980	1990	2000	2010	2018
Algeria	18	16	17	17	17
Angola	46	46	38	42	46
Benin	18	20	28	32	35
Botswana	46	46	46	46	46
Burkina Faso	32	35	36	44	44
Burundi	81	82	73	71	79
Cabo Verde	16	17	18	19	20
Cameroon	19	19	19	21	21
Central African Republic	8	8	8	8	8
Chad	38	38	39	39	40
Comoros	54	61	71	71	70
Congo, Dem. Rep.	11	11	11	11	14
Congo, Rep.	31	31	31	31	31
Equatorial Guinea	12	12	12	10	10
Eritrea	..	..	75	75	75
Eswatini	75	72	71	71	71
Ethiopia	54	51	31	32	34
Gabon	20	8	8	8	9
Gambia, The	56	58	55	61	60
Ghana	53	55	61	65	65
Guinea	58	58	55	58	59
Guinea-Bissau	49	51	24	27	29
Kenya	45	47	47	48	49
Lesotho	76	76	77	77	80
Liberia	27	26	15	18	20
Libya	9	9	9	9	9
Madagascar	62	62	70	70	70
Malawi	41	45	50	60	60
Mali	26	26	32	34	34
Mauritania	38	38	39	39	38
Mauritius	56	55	50	45	42
Morocco	65	68	69	67	67

Country Name	1980	1990	2000	2010	2018
Mozambique	60	45	48	50	53
Namibia	47	47	47	47	47
Niger	24	26	29	35	37
Nigeria	55	68	73	74	76
Rwanda	70	76	68	73	73
Sao Tome and Principe	39	44	51	48	46
Senegal	46	46	47	49	46
Seychelles	11	9	9	5	3
Sierra Leone	38	39	39	54	55
Somalia	70	70	70	70	70
South Africa	78	79	81	80	79
South Sudan	..	..	..	..	45
Sudan	..	..	..	..	37
Tanzania	34	35	38	42	45
Togo	56	59	67	67	70
Tunisia	56	56	61	65	63
Uganda	53	60	63	71	72
Zambia	27	28	30	32	32
Zimbabwe	32	34	39	42	42
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

Indicator Name Agricultural land (sq. km)

Long definition Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. Land under permanent crops is land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee, and rubber. This category includes land under flowering shrubs, fruit trees, nut trees, and vines, but excludes land under trees grown for wood or timber. Permanent pasture is land used for five or more years for forage, including natural and cultivated crops.

Source Food and Agriculture Organization, electronic files and web site.

Topic Environment: Land use

Periodicity Annual

Aggregation method Sum

Food Production Index (2014-2016 = 100)

Country Name	1980	1990	2000	2010	2018
Algeria	18.88	25.77	41.85	88.39	89.97
Angola	18.3	20.05	33.81	90.87	99.02
Benin	21.24	31.09	54.8	79.86	108.98
Botswana	53.03	73.19	95.15	124.19	97.19
Burkina Faso	24.33	41.29	52.25	95.11	103.58
Burundi	65.8	85.7	76.99	96.58	120.64
Cabo Verde	44.88	69.18	105.1	114.95	82.88
Cameroon	26.13	32.72	45.45	83.52	103.49
Central African Republic	41.67	51.46	76.82	95.93	107.25
Chad	18.57	21.08	43.24	88.25	113.76
Comoros	53.67	67.19	84.35	96.57	102.98
Congo, Dem. Rep.	42.97	59.4	50.8	57.71	92.24
Congo, Rep.	37.93	45.91	60.06	87.75	103.1
Cote d'Ivoire	32.76	47.07	66.31	77.07	109.13
Djibouti	72.93	133.82	110.86	114.98	123.49
Egypt, Arab Rep.	25.81	43.23	70.09	90.1	96.69
Equatorial Guinea	38.21	63.81	70	89.92	104.9
Eritrea	..	..	74.7	93.39	101.83
Eswatini	66.59	78.49	76.26	94.84	101.69
Ethiopia	..	..	42.09	82.69	100.37
Gabon	57.12	67.71	82.53	91.3	103.01
Gambia, The	47.32	54.17	98.92	133.94	106.36
Ghana	20.99	24.99	52.19	84.26	111.87
Guinea	30.35	37.87	56.08	83.09	113.73
Guinea-Bissau	27.78	41.02	64.64	92.66	103.63
Kenya	33.98	49.81	55.98	96.1	109.51
Lesotho	65.24	74.36	99.83	101.63	95.7
Liberia	59.3	58.64	69.96	91.31	99.95
Libya	52.55	70.15	85.35	103.11	101.59
Madagascar	57.91	67.66	72.17	102.48	101.62
Malawi	16.11	17.4	50.9	78.49	117.66
Mali	21.57	27.47	42.2	82.94	125.32

Country Name	1980	1990	2000	2010	2018
Mauritania	46.65	54.08	72.39	87.13	102.96
Mauritius	75.06	96.73	102.2	106.26	89.23
Morocco	32.33	51.64	53.06	93	112.89
Mozambique	40.49	41.57	63.46	108.57	102.81
Namibia	126.82	112.84	107.07	99.62	101.92
Niger	31.29	33.39	39.23	83.98	119.29
Nigeria	23.98	40.28	67.25	86.85	101.9
Rwanda	52.28	60.18	67.41	103.46	89.59
Sao Tome and Principe	45.08	38.32	77.02	76.2	75.47
Senegal	38.31	53.86	73.87	103.62	104.18
Seychelles	159.27	132.58	154.57	104.34	103.38
Sierra Leone	31.39	37.39	29.43	105.42	74.19
Somalia	92.48	104.76	94.38	108.01	97.81
South Africa	55.37	61.85	71.57	90.5	103.62
South Sudan	..	..	..	..	98.52
Sudan	41.07	39.81	78.67	99.78	117.34
Tanzania	24.75	34.18	38.95	69.82	92.05
Togo	33.6	42.56	56.42	90.26	104.74
Tunisia	41.56	56.6	67.05	84.56	101.43
Uganda	54.34	79.4	101.22	96.98	100.86
Zambia	27.03	37.68	46.81	93.44	102.65
Zimbabwe	79.04	101.89	107.1	108.62	103.73
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

Indicator Name Food production index (2014-2016 = 100)

Long definition Food production index covers food crops that are considered edible and that contain nutrients. Coffee and tea are excluded because, although edible, they have no nutritive value.

Source Food and Agriculture Organization, electronic files and web site.

Topic Environment: Agricultural production

Periodicity Annual

Base Period 2014-16

Aggregation method Weighted average

Forest Area (% of Land Area)

Country Name	1980	1990	2000	2010	2018
Algeria	..	0.7	0.7	0.8	0.8
Angola	..	63.6	62.3	57.9	54.3
Benin	..	42.9	36.7	32.2	28.7
Botswana	..	33.2	31.1	29.0	27.3
Burkina Faso	..	28.2	26.4	24.5	23.1
Burundi	..	10.8	7.6	7.6	10.9
Cabo Verde	..	3.8	9.9	10.6	11.2
Cameroon	..	47.6	45.7	44.2	43.3
Central African Republic	..	37.2	36.8	36.3	35.9
Chad	..	5.3	5.0	4.4	3.6
Comoros	..	24.8	22.4	20.0	18.2
Congo, Dem. Rep.	..	66.4	63.5	60.5	56.6
Congo, Rep.	..	65.3	65.0	64.6	64.4
Cote d'Ivoire	..	24.7	16.0	12.5	9.6
Djibouti	..	0.2	0.2	0.2	0.2
Egypt, Arab Rep.	..	0.0	0.1	0.1	0.0
Equatorial Guinea	..	96.2	93.2	90.3	87.9
Eritrea	..	16.0	11.1	10.8	10.5
Eswatini	..	26.8	27.5	28.2	28.8
Ethiopia	..	18.5	18.5	15.8	15.2
Gabon	..	92.2	92.0	91.8	91.4
Gambia, The	..	41.0	35.3	29.6	25.1
Ghana	..	43.6	38.9	34.9	35.0
Guinea	..	29.6	28.2	26.7	25.5
Guinea-Bissau	..	79.4	76.4	73.4	71.0
Kenya	..	6.8	7.0	6.4	6.3
Lesotho	..	1.1	1.1	1.1	1.1
Liberia	..	88.5	85.4	82.2	79.7
Libya	..	0.1	0.1	0.1	0.1
Madagascar	..	23.5	22.4	21.6	21.4
Malawi	..	37.1	32.7	28.2	24.7
Mali	..	10.9	10.9	10.9	10.9
Mauritania	..	0.5	0.4	0.4	0.3
Mauritius	..	20.2	20.7	18.9	19.1
Morocco	..	12.3	12.3	12.7	12.8

Country Name	1980	1990	2000	2010	2018
Mozambique	..	55.2	52.4	49.6	47.3
Namibia	..	10.7	9.8	8.9	8.2
Niger	..	1.5	1.0	1.0	0.9
Nigeria	..	29.1	27.3	25.5	24.1
Rwanda	..	12.8	11.6	10.7	11.1
Sao Tome and Principe	..	61.1	60.8	60.5	55.4
Senegal	..	48.3	46.0	44.0	42.3
Seychelles	..	73.3	73.3	73.3	73.3
Sierra Leone	..	43.3	40.6	37.9	35.7
Somalia	..	13.2	12.0	10.8	9.8
South Africa	..	15.0	14.7	14.4	14.1
South Sudan	..	..	..	..	11.3
Sudan	..	..	..	..	10.1
Tanzania	..	64.8	60.6	56.4	52.7
Togo	..	25.0	23.3	22.8	22.3
Tunisia	..	4.1	4.3	4.4	4.5
Uganda	..	17.9	15.8	13.7	12.1
Zambia	..	63.8	63.3	62.8	60.8
Zimbabwe	..	48.7	47.5	46.3	45.3
Source: World Development Indicators					
https://databank.worldbank.org/source/world-development-indicators					

Indicator Name Forest rents (% of GDP)
Long definition Forest rents are roundwood harvest times the product of regional prices and a regional rental rate.
Source World Bank staff estimates based on sources and methods described in the World Bank's The Changing Wealth of Nations.
Topic Environment: Natural resources contribution to GDP
Periodicity Annual
Aggregation method Weighted average

Expected Years of School

	Expected Years of School, Total				Expected Years of School, Female				Expected Years of School, Male			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Algeria	11.3	11.4	11.8	11.8	11.6	11.8	12.1	12.2	11.0	11.0	11.4	11.5
Angola	..	7.9	8.1	8.1	..	7.1	7.0	7.0	..	8.7	9.2	9.2
Benin	8.2	9.3	9.2	9.2	7.6	8.9	8.8	8.8	8.9	9.8	9.6	9.6
Botswana	7.8	8.4	8.1	8.1	8.3	8.8	8.5	8.5	7.4	8.0	7.7	7.7
Burkina Faso	4.9	6.5	6.7	7.0	4.6	6.4	6.7	7.0	5.2	6.6	6.8	7.0
Burundi	6.4	7.5	8.0	7.6	6.2	7.3	8.2	7.9	6.6	7.7	7.7	7.4
Cameroon	7.6	9.1	8.7	8.7	7.0	8.7	8.3	8.3	8.0	9.5	9.1	9.1
Cent. African Rep.	..	..	4.6	4.6	..	..	3.8	3.8	..	..	5.3	5.3
Chad	4.3	5.0	5.4	5.3	3.4	4.3	4.5	4.4	5.2	5.6	6.3	6.2
Comoros	..	8.5	8.1	8.2	..	8.3	8.1	8.4	..	8.6	8.0	8.0
Congo, Dem. Rep.	..	9.2	9.1	9.1	..	8.9	8.8	8.8	..	9.5	9.5	9.5
Congo, Rep.	8.8	8.8	8.9	8.9	8.6	9.0	9.1	9.1	8.9	8.6	8.7	8.7
Cote d'Ivoire	5.0	7.0	7.6	8.1	4.4	6.6	7.1	7.6	5.6	7.5	8.1	8.5
Egypt, Arab Rep.	10.2	11.1	11.4	11.5	10.1	11.2	11.5	11.6	10.2	11.0	11.3	11.4
Eswatini	6.1	8.2	6.4	6.4	6.3	8.5	6.8	6.8	5.9	7.9	6.1	6.1
Ethiopia	6.6	7.9	7.8	7.8	6.2	7.6	7.5	7.5	6.9	8.1	8.1	8.1
Gabon	..	8.3	8.3	8.3	..	8.5	8.5	8.5	..	7.9	7.9	7.9
Gambia, The	7.9	9.0	8.9	9.5	7.8	9.3	9.2	9.8	7.9	..	8.6	9.2
Ghana	..	11.6	11.9	12.1	..	11.7	11.9	12.2	..	11.5	11.8	12.0
Guinea	..	7.0	7.1	7.0	..	6.2	6.2	6.2	..	7.7	7.9	7.8
Kenya	..	10.7	11.6	11.6	..	..	11.3	11.4	..	..	11.8	11.9
Lesotho	9.3	8.7	10.0	10.0	9.8	9.1	10.4	10.4	8.8	8.4	9.7	9.7
Liberia	..	4.4	4.2	4.2	..	4.4	4.2	4.2	..	4.4	4.1	4.1
Madagascar	7.4	7.5	8.4	8.4	7.4	7.6	8.6	8.6	7.3	7.4	8.2	8.2
Malawi	9.5	9.4	9.6	9.6	9.4	9.4	9.6	9.6	9.6	9.4	9.6	9.5
Mali	6.5	5.6	5.8	5.2	5.8	5.1	5.4	4.9	7.2	6.0	6.2	5.6
Mauritania	..	6.3	7.4	7.7	..	6.4	7.6	7.9	..	6.1	7.2	7.5
Mauritius	12.3	12.5	12.5	12.4	12.5	12.8	12.8	12.7	12.1	12.2	12.2	12.2
Morocco	9.6	10.6	10.3	10.4	9.4	10.7	10.4	10.5	9.8	10.6	10.2	10.3
Mozambique	..	7.4	7.3	7.6	..	..	..	..	..	..	..	..
Namibia	9.1	8.9	9.4	9.4	9.4	..	9.7	9.7	8.9	..	9.1	9.1

	Expected Years of School, Total				Expected Years of School, Female				Expected Years of School, Male			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Niger	4.3	5.3	5.5	5.5	3.8	4.9	5.1	5.0	4.8	5.8	6.0	5.9
Nigeria	..	8.2	10.2	10.2	..	7.6	10.1	10.1	..	8.7	10.3	10.3
Rwanda	..	6.6	6.8	6.9	..	6.8	7.0	7.1	..	6.4	6.6	6.6
Senegal	6.8	7.3	7.4	7.3	7.0	7.4	7.8	7.9	6.7	7.1	6.9	6.8
Seychelles	12.4	13.7	13.0	13.1	12.5	13.8	13.5	13.4	12.2	13.6	12.6	12.7
Sierra Leone	..	9.0	9.2	9.6	..	8.9	9.3	9.7	..	9.0	9.1	9.5
South Africa	10.2	9.3	10.2	10.2	10.1	9.3	10.1	10.1	10.6	9.4	10.1	10.2
South Sudan	..	4.2	4.7	4.7	..	3.6	3.9	3.9	..	4.9	5.4	5.4
Sudan	..	7.3	7.1	7.1	..	..	6.9	6.9	..	..	7.2	7.2
Tanzania	..	7.8	7.2	7.2	..	7.8	7.3	7.3	..	7.7	7.1	7.1
Togo	7.4	9.1	9.3	9.7	7.1	8.6	9.1	9.4	7.7	9.5	9.5	10.1
Tunisia	10.5	10.2	10.4	10.6	10.9	10.8	11.0	11.2	10.1	9.7	9.8	10.0
Uganda	6.6	7.0	6.8	6.8	..	7.0	..	..	..	7.0	..	..
Zambia	..	9.2	8.8	8.8	..	..	8.7	8.8	..	..	8.8	8.8
Zimbabwe	10.8	10.0	11.1	11.1	10.7	10.0	11.0	11.0	11.0	10.0	11.1	11.1
https://databank.worldbank.org/source/human-capital-index#												

Indicator Name Forest rents (% of GDP)
Long definition Forest rents are roundwood harvest times the product of regional prices and a regional rental rate.
Source World Bank staff estimates based on sources and methods described in the World Bank's The Changing Wealth of Nations.
Topic Environment: Natural resources contribution to GDP
Periodicity Annual
Aggregation method Weighted average

Harmonized Test Scores

	Harmonized Test Scores, Female				Harmonized Test Scores, Male				Harmonized Test Scores, Total			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Algeria	396	383	383	383	399	366	366	366	397	374	374	374
Angola	..	325	325	325	..	327	327	327	..	326	326	326
Benin	371	384	384	384	382	384	384	384	377	384	384	384
Botswana	418	401	401	401	397	381	381	381	408	391	391	391
Burkina Faso	397	400	400	400	409	407	407	407	402	404	404	404
Burundi	419	432	432	432	430	415	415	415	425	423	423	423
Cameroon	454	383	383	383	449	376	376	376	451	379	379	379
Chad	404	323	323	323	403	338	338	338	403	333	333	333
Comoros	..	387	387	387	..	400	400	400	..	392	392	392
Congo, Dem. Rep.	..	316	308	308	..	320	312	312	..	318	310	310
Congo, Rep.	398	369	369	369	398	372	372	372	398	371	371	371
Cote d'Ivoire	377	371	371	371	376	375	375	375	377	373	373	373
Egypt, Arab Rep.	407	368	368	368	392	344	344	344	399	356	356	356
Eswatini	418	..	..	..	418	..	..	..	418	440	440	440
Ethiopia	..	356	356	344	..	363	363	352	..	359	359	348
Gabon	..	454	454	454	..	458	458	458	..	456	456	456
Gambia, The	340	340	354	354	336	336	352	352	338	338	353	353
Ghana	..	306	306	306	..	308	308	308	..	307	307	307
Guinea	..	397	397	397	..	417	417	417	..	408	408	408
Kenya	427	..	..	..	417	..	..	..	422	455	455	455
Lesotho	361	..	..	..	364	..	..	..	362	393	393	393
Liberia	..	328	328	328	..	335	335	335	..	332	332	332
Madagascar	434	352	352	352	434	350	350	350	434	351	351	351
Malawi	342	..	..	..	334	..	..	..	338	359	359	359
Mali	..	307	307	307	..	307	307	307	..	307	307	307
Mauritania	..	343	343	343	..	340	340	340	..	342	342	342
Mauritius	451	..	..	..	468	..	..	..	459	473	473	473
Morocco	374	376	376	386	373	359	359	375	374	367	367	380
Mozambique	..	371	371	371	..	365	365	365	..	368	368	368
Namibia	369	..	..	..	373	..	..	..	371	407	407	407
Niger	..	302	302	302	..	307	307	307	..	305	305	305

	Harmonized Test Scores, Female				Harmonized Test Scores, Male				Harmonized Test Scores, Total			
Nigeria	..	321	308	308	..	329	310	310	..	325	309	309
Rwanda	..	365	365	365	..	351	351	351	..	358	358	358
Saudi Arabia	426	436	436	416	405	380	380	383	415	407	407	399
Senegal	409	408	408	408	420	417	417	417	415	412	412	412
Seychelles	414	..	..	..	450	..	..	..	432	463	463	463
Sierra Leone	..	314	314	314	..	318	318	318	..	316	316	316
South Africa	389	359	359	359	374	328	328	328	381	343	343	343
Sudan	..	389	389	389	..	371	371	371	..	380	380	380
Tanzania	..	395	395	395	..	382	382	382	..	388	388	388
Togo	380	383	383	383	386	384	384	384	384	384	384	384
Tunisia	408	386	386	386	402	381	381	381	405	384	384	384
Uganda	371	..	..	..	366	..	..	..	369	397	397	397
Zambia	337	..	..	..	330	..	..	..	334	358	358	358
Zimbabwe	392	..	..	..	396	..	..	..	394	396	396	396
Source: Human Capital Index												
https://databank.worldbank.org/source/human-capital-index#												

Indicator Name Harmonized Test Scores

Long definition Harmonized test scores from major international student achievement testing programs.They are measured in TIMMS-equivalent units, where 300 is minimal attainment and 625 is advanced attainment. Most recent estimates are used. Year of most recent estimate shown in data notes.

Test scores from the following testing programs are included:

- TIMSS/PIRLS: Refers to average of test scores from TIMSS (Trends in International Maths and Science Study) and PIRLS (Progress in International Reading Literacy Study), both carried out by the International Association for the Evaluation of Educational Achievement. Data from each PIRLS round is moved to the year of the nearest TIMSS round and averaged with the TIMSS data.
- PISA: Refers to test scores from Programme for International Student Assessment
- PISA+TIMSS/PIRLS: Refers to the average of these programs for countries and years where both are available
- SACMEQ: Refers to test scores from Southern and Eastern Africa Consortium for Monitoring Educational Quality
- PASEC: Refers to test scores from Program of Analysis of Education Systems
- LLECE: Refers to test scores from Latin American Laboratory for Assessment of the Quality of Education
- PILNA: Refers to test scores from Pacific Islands Literacy and Numeracy Assessment
- EGRA: Refers to test scores from nationally-representative Early Grade Reading Assessments
- EGRANR: Refers to test scores from non-nationally-representative Early Grade Reading Assessments

Human Capital index

	Human Capital Index (HCI) (scale 0-1)				Human Capital Index (HCI), Female (scale 0-1)				Human Capital Index (HCI), Male (scale 0-1)			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Algeria	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.5	0.5	0.5	0.5
Angola	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.4	0.4
Benin	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Botswana	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4
Burkina Faso	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4
Burundi	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4
Cameroon	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Chad	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Comoros	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.4	0.4
Congo, Dem. Rep.	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.4	0.4
Congo, Rep.	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Cote d'Ivoire	0.3	0.4	0.4	0.4	0.3	0.3	0.4	0.4	0.3	0.3	0.4	0.4
Egypt, Arab Rep.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Eswatini	0.3	0.4	0.4	0.4	0.3	..	..	..	0.3	..	..	..
Ethiopia	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.4	0.4
Gabon	..	0.5	0.5	0.5	..	0.5	0.5	0.5	..	0.4	0.4	0.4
Gambia, The	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	..	0.4	0.4
Ghana	..	0.4	0.4	0.5	..	0.4	0.5	0.5	..	0.4	0.4	0.4
Guinea	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.4	0.4
Kenya	..	0.5	0.5	0.5	..	..	..	..	..	..	..	..
Liberia	..	0.3	0.3	0.3	..	0.3	0.3	0.3	..	0.3	0.3	0.3
Madagascar	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Malawi	0.4	0.4	0.4	0.4	0.4	..	..	..	0.4	..	..	..
Mali	..	0.3	0.3	0.3	..	0.3	0.3	0.3	..	0.3	0.3	0.3
Mauritania	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.3	0.4	0.4
Mauritius	0.6	0.6	0.6	0.6	0.6	..	..	..	0.6	..	..	..
Morocco	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Mozambique	..	0.4	0.4	0.4	..	..	..	..	..	..	..	..
Namibia	0.4	0.4	0.4	0.4	0.4	..	..	..	0.4	..	..	..
Niger	..	0.3	0.3	0.3	..	0.3	0.3	0.3	..	0.3	0.3	0.3
Nigeria	..	0.3	0.4	0.4	..	0.3	0.4	0.4	..	0.3	0.3	0.4
Rwanda	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.4	0.4

	Human Capital Index (HCI) (scale 0-1)				Human Capital Index (HCI), Female (scale 0-1)				Human Capital Index (HCI), Male (scale 0-1)			
Senegal	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Seychelles	0.6	0.7	0.6	0.6	0.6	..	..	..	0.6	..	..	..
Sierra Leone	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.3	0.4
South Africa	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
South Sudan	..	0.3	0.3	0.3	..	..	..	..	..	..	..	..
Sudan	..	0.4	0.4	0.4	..	..	0.4	0.4	..	..	0.4	0.4
Tanzania	..	0.4	0.4	0.4	..	0.4	0.4	0.4	..	0.4	0.4	0.4
Togo	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Tunisia	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Uganda	0.3	0.4	0.4	0.4	..	..	..	..	..	..	..	..
Zambia	..	0.4	0.4	0.4	..	..	..	..	..	..	..	..
Zimbabwe	0.4	0.4	0.5	0.5	0.4	..	..	..	0.4	..	..	..
Source: Human Capital Index												
https://databank.worldbank.org/source/human-capital-index#												

Indicator Name Human Capital Index (HCI) (scale 0-1)

Long definition The HCI calculates the contributions of health and education to worker productivity. The final index score ranges from zero to one and measures the productivity as a future worker of child born today relative to the benchmark of full health and complete education.

Learning-Adjusted Years of School

	Learning-Adjusted Years of School				Learning-Adjusted Years of School, Female				Learning-Adjusted Years of School, Male			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Algeria	7.2	6.8	7.0	7.1	7.4	7.3	7.4	7.5	7.0	6.5	6.7	6.7
Angola	..	4.1	4.2	4.2	..	3.7	3.6	3.6	..	4.5	4.8	4.8
Benin	5.0	5.7	5.6	5.7	4.5	5.4	5.4	5.4	5.4	6.0	5.9	5.9
Botswana	5.1	5.3	5.1	5.1	5.5	5.7	5.5	5.5	4.7	4.9	4.7	4.7
Burkina Faso	3.2	4.2	4.4	4.5	2.9	4.1	4.3	4.5	3.4	4.3	4.4	4.6
Burundi	4.4	5.1	5.4	5.2	4.2	5.1	5.7	5.5	4.5	5.1	5.1	4.9
Cameroon	5.5	5.5	5.3	5.3	5.1	5.3	5.1	5.1	5.8	5.7	5.5	5.5
Cent. African Rep.	..	..	..	2.7	..	..	..	..	..	..	..	..
Chad	2.8	2.6	2.9	2.8	2.2	2.2	2.3	2.3	3.3	3.0	3.4	3.4
Comoros	..	5.3	5.1	5.1	..	5.1	5.0	5.2	..	5.5	5.1	5.1
Congo, Dem. Rep.	..	4.7	4.5	4.5	..	4.5	4.3	4.3	..	4.9	4.7	4.7
Congo, Rep.	5.6	5.2	5.3	5.3	5.5	5.3	5.4	5.4	5.7	5.1	5.2	5.2
Cote d'Ivoire	3.0	4.2	4.6	4.8	2.7	3.9	4.2	4.5	3.4	4.5	4.9	5.1
Egypt, Arab Rep.	6.5	6.3	6.5	6.5	6.6	6.6	6.8	6.8	6.4	6.1	6.2	6.3
Eswatini	4.1	5.7	4.5	4.5	4.2	..	..	..	3.9	..	..	..
Ethiopia	..	4.5	4.5	4.3	..	4.3	4.3	4.1	..	4.7	4.7	4.6
Gabon	..	6.0	6.0	6.0	..	6.2	6.2	6.2	..	5.8	5.8	5.8
Gambia, The	4.3	4.8	5.0	5.4	4.3	5.0	5.2	5.6	4.3	..	4.8	5.2
Ghana	..	5.7	5.8	6.0	..	5.7	5.8	6.0	..	5.7	5.8	5.9
Guinea	..	4.5	4.6	4.6	..	3.9	3.9	3.9	..	5.2	5.3	5.2
Kenya	..	7.8	8.4	8.5	..	..	..	..	..	..	..	..
Lesotho	5.4	5.5	6.3	6.3	5.6	..	..	..	5.1	..	..	..
Liberia	..	2.3	2.2	2.2	..	2.3	2.2	2.2	..	2.4	2.2	2.2
Libya	..	..	..	..	..	..	..	..	..	..	..	..
Madagascar	5.1	4.2	4.7	4.7	5.1	4.3	4.8	4.8	5.1	4.1	4.6	4.6
Malawi	5.1	5.4	5.5	5.5	5.2	..	..	..	5.1	..	..	..
Mali	..	2.7	2.9	2.6	..	2.5	2.7	2.4	..	3.0	3.0	2.7
Malta	9.7	10.1	10.2	10.2	10.2	10.5	10.4	10.6	9.2	9.7	10.0	9.8
Mauritania	..	3.4	4.0	4.2	..	3.5	4.2	4.4	..	3.3	3.9	4.1
Mauritius	9.1	9.5	9.4	9.4	9.0	..	..	..	9.1	..	..	..

	Learning-Adjusted Years of School				Learning-Adjusted Years of School, Female				Learning-Adjusted Years of School, Male			
Morocco	5.8	6.2	6.1	6.3	5.6	6.4	6.3	6.5	5.9	6.1	5.9	6.2
Mozambique	..	4.4	4.3	4.5	..	..	..	..	..	..	..	..
Namibia	5.4	5.8	6.1	6.1	5.5	..	..	..	5.3	..	..	..
Niger	..	2.6	2.7	2.7	..	2.4	2.4	2.4	..	2.9	2.9	2.9
Nigeria	..	4.3	5.0	5.0	..	3.9	5.0	5.0	..	4.6	5.1	5.1
Rwanda	..	3.8	3.9	3.9	..	3.9	4.1	4.1	..	3.6	3.7	3.7
Saudi Arabia	7.4	8.1	8.0	7.9	7.6	8.6	8.6	8.2	7.3	7.7	7.5	7.6
Senegal	4.5	4.8	4.9	4.8	4.6	4.9	5.1	5.2	4.5	4.7	4.6	4.5
Seychelles	8.6	10.1	9.7	9.7	8.3	..	..	..	8.8	..	..	..
Sierra Leone	..	4.5	4.7	4.9	..	4.5	4.7	4.9	..	4.6	4.7	4.8
South Africa	6.2	5.1	5.6	5.6	6.3	5.3	5.8	5.8	6.3	4.9	5.3	5.4
South Sudan	..	2.3	2.5	2.5	..	..	..	..	..	..	..	..
Sudan	..	4.4	4.3	4.3	..	..	4.3	4.3	..	..	4.3	4.3
Tanzania	..	4.8	4.5	4.5	..	5.0	4.6	4.6	..	4.7	4.3	4.3
Togo	4.5	5.6	5.7	6.0	4.3	5.3	5.6	5.8	4.8	5.8	5.8	6.2
Tunisia	6.8	6.3	6.4	6.5	7.1	6.7	6.8	6.9	6.5	5.9	6.0	6.1
Uganda	3.9	4.5	4.3	4.3	..	..	..	..	..	..	..	..
Zambia	..	5.3	5.0	5.0	..	..	..	..	..	..	..	..
Zimbabwe	6.8	6.4	7.0	7.0	6.7	..	..	..	6.9	..	..	..
Source: Human Capital Index												
https://databank.worldbank.org/source/human-capital-index#												

Indicator Name Learning-Adjusted Years of School

Long definition Learning-adjusted years of school are calculated by multiplying the estimates of expected years of school by the ratio of most recent harmonized test scores to 625.

Probability of Survival to Age 5

	Probability of Survival to Age 5				Probability of Survival to Age 5, Female				Probability of Survival to Age 5, Male				Probability of Survival to Age 5			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Algeria	0.97	0.98	0.98	0.98	0.97	0.98	0.98	0.98	0.97	0.97	0.97	0.98	0.97	0.98	0.98	0.98
Angola	0.88	0.92	0.92	0.92	0.89	0.93	0.93	0.93	0.87	0.91	0.91	0.92	0.88	0.92	0.92	0.92
Benin	0.89	0.90	0.90	0.91	0.90	0.91	0.91	0.91	0.88	0.90	0.90	0.90	0.89	0.90	0.90	0.91
Botswana	0.95	0.96	0.96	0.96	0.95	0.97	0.97	0.97	0.95	0.96	0.96	0.96	0.95	0.96	0.96	0.96
Burkina Faso	0.89	0.92	0.92	0.92	0.89	0.92	0.92	0.93	0.88	0.91	0.92	0.92	0.89	0.92	0.92	0.92
Burundi	0.91	0.94	0.94	0.94	0.92	0.94	0.94	0.95	0.90	0.93	0.93	0.94	0.91	0.94	0.94	0.94
Cameroon	0.89	0.92	0.92	0.92	0.90	0.92	0.93	0.93	0.89	0.91	0.92	0.92	0.89	0.92	0.92	0.92
Cent. African Rep.	0.85	..	0.88	0.88	0.86	..	0.89	0.89	0.84	..	0.87	0.88	0.85	..	0.88	0.88
Chad	0.85	0.88	0.88	0.88	0.86	0.88	0.88	0.89	0.84	0.87	0.87	0.87	0.85	0.88	0.88	0.88
Comoros	0.91	0.93	0.93	0.93	0.92	0.94	0.94	0.94	0.91	0.93	0.92	0.93	0.91	0.93	0.93	0.93
Congo, Dem. Rep.	0.88	0.91	0.91	0.91	0.89	0.92	0.92	0.92	0.88	0.90	0.90	0.91	0.88	0.91	0.91	0.91
Congo, Rep.	0.94	0.95	0.95	0.95	0.94	0.96	0.95	0.95	0.93	0.95	0.94	0.95	0.94	0.95	0.95	0.95
Cote d'Ivoire	0.89	0.91	0.92	0.92	0.90	0.92	0.92	0.93	0.88	0.90	0.91	0.91	0.89	0.91	0.92	0.92
Egypt, Arab Rep.	0.97	0.98	0.98	0.98	0.97	0.98	0.98	0.98	0.97	0.98	0.98	0.98	0.97	0.98	0.98	0.98
Eswatini	0.91	0.95	0.94	0.95	0.92	0.95	0.95	0.95	0.91	0.94	0.94	0.94	0.91	0.95	0.94	0.95
Ethiopia	0.92	0.94	0.94	0.94	0.93	0.95	0.95	0.95	0.91	0.94	0.94	0.94	0.92	0.94	0.94	0.94
Gabon	0.94	0.95	0.95	0.96	0.94	0.96	0.96	0.96	0.93	0.95	0.95	0.95	0.94	0.95	0.95	0.96
Gambia, The	0.92	0.94	0.94	0.94	0.93	0.94	0.94	0.95	0.92	0.93	0.93	0.94	0.92	0.94	0.94	0.94
Ghana	0.93	0.95	0.95	0.95	0.94	0.96	0.95	0.96	0.92	0.95	0.95	0.95	0.93	0.95	0.95	0.95
Guinea	0.88	0.91	0.90	0.90	0.89	0.92	0.90	0.90	0.88	0.91	0.89	0.89	0.88	0.91	0.90	0.90
Kenya	0.94	0.95	0.96	0.96	0.95	0.96	0.96	0.96	0.94	0.95	0.95	0.96	0.94	0.95	0.96	0.96
Lesotho	0.90	0.91	0.92	0.92	0.91	0.92	0.92	0.93	0.89	0.91	0.91	0.91	0.90	0.91	0.92	0.92
Liberia	0.90	0.93	0.93	0.93	0.91	0.93	0.93	0.93	0.90	0.92	0.92	0.92	0.90	0.93	0.93	0.93
Madagascar	0.93	0.96	0.94	0.95	0.94	0.96	0.95	0.95	0.93	0.95	0.94	0.94	0.93	0.96	0.94	0.95
Malawi	0.91	0.94	0.95	0.95	0.92	0.95	0.95	0.96	0.91	0.94	0.94	0.95	0.91	0.94	0.95	0.95
Mali	0.87	0.89	0.90	0.90	0.87	0.90	0.90	0.91	0.86	0.89	0.89	0.90	0.87	0.89	0.90	0.90
Mauritania	0.90	0.92	0.92	0.92	0.91	0.93	0.93	0.93	0.90	0.92	0.92	0.92	0.90	0.92	0.92	0.92
Mauritius	0.98	0.99	0.99	0.98	0.99	0.99	0.99	0.99	0.98	0.99	0.98	0.98	0.98	0.99	0.99	0.98
Morocco	0.97	0.98	0.98	0.98	0.97	0.98	0.98	0.98	0.96	0.97	0.97	0.98	0.97	0.98	0.98	0.98
Mozambique	0.90	0.93	0.92	0.93	0.90	0.93	0.93	0.93	0.89	0.92	0.92	0.92	0.90	0.93	0.92	0.93
Namibia	0.95	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95	0.96	0.95	0.96	0.96	0.96

	Probability of Survival to Age 5				Probability of Survival to Age 5, Female				Probability of Survival to Age 5, Male				Probability of Survival to Age 5			
Niger	0.88	0.92	0.91	0.92	0.88	0.92	0.92	0.92	0.87	0.91	0.91	0.91	0.88	0.92	0.91	0.92
Nigeria	0.86	0.90	0.88	0.88	0.87	0.91	0.88	0.89	0.86	0.89	0.87	0.87	0.86	0.90	0.88	0.88
Rwanda	0.94	0.96	0.96	0.96	0.94	0.97	0.97	0.97	0.93	0.96	0.96	0.96	0.94	0.96	0.96	0.96
Senegal	0.93	0.95	0.95	0.96	0.94	0.96	0.96	0.96	0.93	0.95	0.95	0.95	0.93	0.95	0.95	0.96
Seychelles	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99
Sierra Leone	0.84	0.89	0.89	0.89	0.84	0.90	0.90	0.90	0.83	0.88	0.88	0.89	0.84	0.89	0.89	0.89
South Africa	0.95	0.96	0.96	0.97	0.95	0.97	0.97	0.97	0.94	0.96	0.96	0.96	0.95	0.96	0.96	0.97
South Sudan	0.89	0.90	0.90	0.90	0.90	0.91	0.91	0.91	0.89	0.90	0.90	0.90	0.89	0.90	0.90	0.90
Sudan	0.92	0.94	0.94	0.94	0.93	0.94	0.94	0.94	0.92	0.93	0.93	0.93	0.92	0.94	0.94	0.94
Tanzania	0.93	0.95	0.95	0.95	0.93	0.95	0.95	0.95	0.92	0.94	0.94	0.94	0.93	0.95	0.95	0.95
Togo	0.91	0.93	0.93	0.93	0.92	0.93	0.93	0.94	0.90	0.92	0.92	0.92	0.91	0.93	0.93	0.93
Tunisia	0.98	0.99	0.98	0.98	0.98	0.99	0.98	0.98	0.98	0.99	0.98	0.98	0.98	0.99	0.98	0.98
Uganda	0.92	0.95	0.95	0.95	0.93	0.96	0.96	0.96	0.92	0.95	0.95	0.95	0.92	0.95	0.95	0.95
Zambia	0.92	0.94	0.94	0.94	0.93	0.94	0.95	0.95	0.91	0.94	0.94	0.94	0.92	0.94	0.94	0.94
Zimbabwe	0.91	0.95	0.95	0.95	0.92	0.95	0.96	0.96	0.91	0.95	0.95	0.95	0.91	0.95	0.95	0.95
Source: Human Capital Index																
https://databank.worldbank.org/source/human-capital-index#																

Indicator Name Probability of Survival to Age 5

Long definition Probability of survival to age 5 is calculated by subtracting the under-5 mortality rate from 1. Most recent estimates are used. Year of most recent estimate shown in data notes.

Survival Rate from Age 15-60

	Survival Rate from Age 15-60				Survival Rate from Age 15-60, Female				Survival Rate from Age 15-60, Male			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Algeria	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Angola	0.7	0.8	0.7	0.7	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.7
Benin	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Botswana	0.6	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.8
Burkina Faso	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Burundi	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.7	0.7	0.7
Cameroon	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7
Cent. African Rep.	0.5	..	0.6	0.6	0.5	..	0.6	0.6	0.5	..	0.5	0.6
Chad	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6
Comoros	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Congo, Dem. Rep.	0.7	0.7	0.7	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Congo, Rep.	0.7	0.8	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Cote d'Ivoire	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.6	0.6
Eswatini	0.3	0.6	0.6	0.6	0.4	0.6	0.7	0.7	0.3	0.5	0.5	0.5
Ethiopia	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Gabon	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Gambia, The	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Ghana	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Guinea	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Kenya	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Lesotho	0.3	0.5	0.5	0.5	0.4	0.5	0.6	0.6	0.3	0.5	0.4	0.5
Liberia	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.7	0.8
Madagascar	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Malawi	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.7
Mali	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Mauritania	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Mauritius	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8
Morocco	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Mozambique	0.5	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.5	0.7	0.6	0.6
Namibia	0.6	0.7	0.7	0.7	0.6	0.8	0.7	0.8	0.5	0.7	0.6	0.7
Niger	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.8

	Survival Rate from Age 15-60				Survival Rate from Age 15-60, Female				Survival Rate from Age 15-60, Male			
Nigeria	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6
Rwanda	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Senegal	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.8
Seychelles	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8
Sierra Leone	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6
South Africa	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.8	0.5	0.6	0.6	0.6
South Sudan	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7
Sudan	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Tanzania	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.6	0.8	0.7	0.8
Togo	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Tunisia	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Uganda	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.6	0.7	0.7	0.7
Zambia	0.6	0.7	0.7	0.7	0.6	0.8	0.8	0.8	0.6	0.7	0.7	0.7
Zimbabwe	0.5	0.7	0.6	0.7	0.5	0.7	0.7	0.7	0.4	0.6	0.6	0.6
Source: Human Capital Index												
https://databank.worldbank.org/source/human-capital-index#												

Indicator Name Survival Rate from Age 15-60

Long definition Adult survival rate is calculated by subtracting the mortality rate for 15-60 year-olds from 1. Most recent estimates are used. Year of most recent estimate shown in data notes.

Fraction of Children Under 5 Not Stunted

	Fraction of Children Under 5 Not Stunted				Fraction of Children Under 5 Not Stunted, Female				Fraction of Children Under 5 Not Stunted, Male			
Country Name	2010	2017	2018	2020	2010	2017	2018	2020	2010	2017	2018	2020
Algeria	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9
Angola	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6
Benin	..	0.7	..	..	..	0.7	..	..	..	0.6	..	..
Botswana	..	0.7	..	..	..	..	..	..	..	..	..	..
Burkina Faso	0.7	0.7	0.8	0.8	0.7	..	0.8	0.8	0.6	..	0.8	0.7
Burundi	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4
Cameroon	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7
Cent. African Rep.	0.6	..	0.6	0.6	0.6	..	0.6	0.6	0.6	..	0.6	0.6
Chad	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Comoros	..	0.7	0.7	0.7	..	0.7	0.7	0.7	..	0.7	0.7	0.7
Congo, Dem. Rep.	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5
Congo, Rep.	0.7	0.8	0.8	0.8	0.7	..	0.8	0.8	0.7	..	0.8	0.8
Cote d'Ivoire	0.6	0.8	0.8	0.8	0.6	..	0.8	0.8	0.6	..	0.8	0.8
Egypt, Arab Rep.	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Eswatini	0.6	0.7	0.7	0.7	0.6	0.8	0.8	0.8	0.5	0.7	0.7	0.7
Ethiopia	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.5	0.6	0.6	0.6
Gabon	..	0.8	0.8	0.8	..	0.9	0.9	0.9	..	0.8	0.8	0.8
Gambia, The	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.8
Ghana	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.8
Guinea	0.7	0.7	0.7	0.7	0.7	..	0.7	0.7	0.7	..	0.7	0.7
Kenya	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.7
Lesotho	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6
Liberia	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7
Madagascar	0.5	0.5	0.5	0.6	0.5	..	0.5	0.6	0.5	..	0.5	0.6
Malawi	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	0.6	0.6
Mali	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Mauritania	0.7	0.7	0.7	0.8	0.7	..	0.7	0.8	0.7	..	0.7	0.7
Morocco	0.9	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.8
Mozambique	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5
Namibia	0.7	0.8	0.8	0.8	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.7
Niger	0.6	0.6	0.6	0.5	0.6	..	0.6	0.5	0.5	..	0.6	0.5

	Fraction of Children Under 5 Not Stunted				Fraction of Children Under 5 Not Stunted, Female				Fraction of Children Under 5 Not Stunted, Male			
Nigeria	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.7	0.6	0.5	0.5	0.6
Rwanda	0.6	0.6	0.6	0.6	0.6	..	0.7	0.7	0.5	..	0.6	0.6
Senegal	0.7	0.8	0.8	0.8	0.7	0.9	0.9	0.8	0.7	0.8	0.8	0.8
Seychelles	..	0.9	..	..	..	..	..	..	..	..	..	..
Sierra Leone	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.5	0.8	0.7	0.7
South Africa	0.8	0.7	0.7	0.7	0.8	..	0.7	0.7	0.7	..	0.7	0.7
South Sudan	..	0.7	0.7	0.7	..	0.7	0.7	0.7	..	0.7	0.7	0.7
Sudan	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Tanzania	0.6	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.5	0.6	0.6	0.7
Togo	0.7	0.7	0.8	0.8	0.7	0.7	0.8	0.8	0.7	0.7	0.8	0.8
Tunisia	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Uganda	0.6	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7
Zambia	0.5	0.6	0.6	0.7	0.6	0.6	0.6	0.7	0.5	0.6	0.6	0.6
Zimbabwe	0.7	0.7	0.7	0.8	0.7	0.8	0.8	0.8	0.6	0.7	0.7	0.7
Source: Human Capital Index												
https://databank.worldbank.org/source/human-capital-index#												

Indicator Name Fraction of Children Under 5 Not Stunted
Long definition Percentage not stunted is calculated by subtracting stunting rates from 1. Most recent estimates are used. Year of most recent estimate shown in data notes.

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